European Commission

Mainstreaming climate change into rural development policy post 2013

Final Report

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Table of Contents

List of Figures

List of Tables

List of Boxes

Acronyms

AEM	Agri-environment measure
CAP	Common Agricultural Policy
CAPRI	Common Agricultural Policy Regionalised Impact modelling system
CC	Climate Change
CE	Cost-effectiveness
CLLD	Community-led local development
CMEF	Common Monitoring and Evaluation Framework
EAFRD	European Agricultural Fund for Rural Development
EIP	European Innovation Partnership
ENRD	European Network for Rural Development
GDP	Gross domestic product
GHG	Greenhouse Gas
LAG	Local Action Group
LCA	Life Cycle Assessment
LDS	Local Development Strategy
LEADER	Liaisons entre Actions de Développement de l'Economie Rurale
LULUCF	Land use, land-use change, and forestry
MA	Managing Authority
MS	Member State
OECD	Organisation for Economic Co-operation and Development
PA	Programming Authority
RD	Rural Development
RDP	Rural Development Programme
SOC	Soil organic carbon
SWOT	Strengths, Weaknesses, Opportunities, Threats
TSP	Thematic Sub-Programme

Abstract

This is the final report of the project "Mainstreaming climate change into rural development policy post 2013". The project aimed to support the mainstreaming of climate change into Rural Development Programmes (RDPs) 2014-2020 by providing Technical Guidance for Member States' Managing Authorities on the design and integration of new and innovative climate operations. The main body of the report, which summarises the project methodology and key findings, is accompanied by six Annexes which give more detailed guidance and examples. The Technical Guidance includes 25 technical fiches for new and innovative climate actions. Moreover, the project developed suggestions and guidelines for potential combinations of rural development (RD) measures which could enhance synergies for climate objectives under Priority 4 and Priority 5 of RDPs. The project also explored the potential for increased climate action through LEADER and joint actions under the Cooperation Measure, highlighting best practice examples of 2007–2013 LEADER climate action projects, and developed suggestions for promoting climate action in future LEADER activities, as well as examples of potential climate-focused topics for joint actions under the Cooperation Measure. Finally, indicators were identified to evaluate the contribution of the RDP measures and combinations of measures to climate change mitigation and adaptation objectives, as well as green growth in the EU.

Executive Summary

This is the final report of the project 'Mainstreaming climate change into rural development policy post 2013'. It presents the methodology and outcomes of a nine-month project, undertaken between December 2013 and September 2014.

The project included five tasks: Task 1 identified new and innovative climate actions and developed technical fiches for 25 actions. Task 2 examined how climate actions have been and could further be integrated into LEADER, as well as the Cooperation Measure. Task 3 identified possible combinations of RDP measures that would increase synergies for climate objectives. Task 4 identified criteria and indicators for measuring the contribution of RDP measures and combinations of measures to climate change mitigation and adaptation and green growth. Task 5 focused on outreach and consultation with practitioners as well as dissemination of project results through a project workshop and outreach tools.

Task 1 aimed to: (a) identify a range of new and innovative RDP actions that could have significant benefits in terms of mitigation and/or adaptation, and (b) create a suite of technical fiches describing a subset of 25 of these actions. The fiches are brief summary documents providing an explanation of how a particular action (such as planting cover crops) could reduce GHG emissions or help to adapt to climate change, and an example of how the action could be translated into an RDP operation. They provide guidance on key points such as the conditions likely to favour the operation, the likely mitigation/adaptation effect, and any ancillary effects. They also provide brief explanations of the main cost elements likely to arise from the operation.

Mitigation of GHG and adaptation to climate change are complex processes and the fiches, by necessity, somewhat simplify this complexity. Key parameters, such as abatement rates, cost-effectiveness and likely uptake rates can be highly variable and difficult to quantify, and the values presented in the fiches should be seen as illustrative rather than definitive. However, the purpose of the fiches is to provide inspiration and examples rather than detailed technical guidance. A workshop with practitioners was held in the framework of the project. At this workshop, the following potential barriers to the uptake of climate change actions were highlighted: (a) lack of knowledge of the rate of climate change, and its implications; (b) lack of knowledge regarding the potential (win-win) benefits of climate change actions; and (c) the difficulties of measuring and verifying (and therefore rewarding) the impact of actions. Improving understanding of the impacts could be achieved through more widespread and consistent use of carbon audits; however reservations were expressed during the workshop that measurement methods can be inconsistent and open to manipulation. In general the fiches were welcomed by the participants at the project workshop.

Task 2 aimed to identify best practice examples of LEADER projects from the 2007-2013 programming period, and outline the options for how to further promote climate action through LEADER in 2014 – 2020, as well as through the joint actions under the Cooperation Measure and thematic-sub-programmes. The LEADER instrument has so far supported different types of climate actions, focusing more on capacity building, renewable energy, and energy efficiency, with a limited focus on explicit adaptation activities. The LEADER project factsheets illustrate that LEADER can deliver concrete benefits beyond climate mitigation and adaptation such as for rural economies, social development and rural quality of life. There is further potential to increase climate action under LEADER, although a number of/several challenges need to be addressed to realise the potential of this instrument for climate mitigation and adaptation.

Managing Authorities can play an important role in increasing the role of climate action in local development strategies and LEADER projects by how they administer the LEADER instrument and by providing technical guidance to LAGs, and increasing experience sharing and knowledge exchange. LEADER can continue to mobilise low carbon initiatives in rural areas through capacity building for carbon consciousness among rural population and rural business, low carbon planning activities, as well as directly support the innovative actions outlined in Annex 1. In addition, more emphasis can be placed on adaptation activities under LEADER.

Joint actions under the Cooperation Measure offer the opportunity for setting-up cooperation groups to test and implement innovative collective projects. As a testing ground for locally specific and appropriate solutions, joint actions can be used to develop solutions related to emission reduction or climate adaptation, which can later be rolled-out more broadly through other RD measures. The Cooperation Measure is also a very useful instrument to support collective landscape level solutions, where the added value of joint action is significant and required (for example, in the case of wetland restoration).

The objective of Task 3 was to identify and describe appropriate combinations of climate-oriented RD measures for promoting specific mitigation or adaptation operations, considering requirements for programming and overall effectiveness of the mix of measures. Although a combination of measures is often considered useful in order to exploit synergies, only few member state Managing Authorities have experience with the implementation of combined measures in a formal and obligatory way, which means by joint programming and implementation. It is considered to be associated with increased efforts for programming and administration. Measures have been mostly implemented separately without using obligatory measure combinations which leads to more flexibility. Nevertheless, synergies and complementarities between measures can also be achieved if measures are combined on a voluntary basis, i.e. beneficiaries have the flexibility to select one or several RD measures that suit their specific conditions and needs. For this, RD programmes should be designed to consist of a set of single measures that could also be implemented in combination when they complement each other.

In Task 4 a number of criteria and indicators were compiled in order to evaluate the contribution of the RD measures and measure combinations to climate change mitigation and adaptation, as well as to green growth. While result indicators are suited for the evaluation at the RD measure level, impact and green growth indicators can be used on a sectoral or national scale. On this aggregated scale, effects of single measures/measure combinations are difficult to separate from other influences and might be too small to measure. Indicators that are used on local or regional levels, however, normally cannot account for leakage effects (e.g. a displacement of GHG emissions due to increased imports from other regions or countries). Nevertheless, indicators measuring resource-use efficiency and relating GHG emissions to farm outputs or GDP are especially useful for the evaluation of the contribution to green growth objectives.

In Task 5, a project workshop was organised and outreach tools developed. Complementing the ongoing consultations with experts and practitioners which were carried out under Tasks 1 – 3, a one-day workshop was organised where preliminary project results were presented, and feedback was sought from Managing Authorities and other relevant stakeholders. Over 40 participants attended the workshop, and valuable insights were obtained. The technical guidance for Managing Authorities, comprising the different annexes to this report that can be read as stand-alone documents or in combination with the final report, is the core output of the project. In order to disseminate the project outputs to Managing Authorities and other relevant RD practitioners involved in the design and implementation of RDPs (e.g., ministries, environmental and farming organisations), different outreach tools have been made available.

The report is structured in two parts. In the main body of the report, the methodology is presented and key findings are summarised. The annexes give more detailed guidance and examples, and should be read in conjunction with the relevant chapter (See Table 1 in Chapter 1).

1. Introduction

Policy context

Climate change presents one of the most central challenges for agriculture and rural areas in the European Union (EU). On the one hand, EU agriculture is an important source of greenhouse gas (GHG) emissions (EEA 2014b). On the other hand, agriculture and rural areas are heavily exposed to the effects of climate change. The complex challenge of mitigating (i.e. reducing) GHG emissions while meeting the global demand for food under a changing climate requires concerted and systematic efforts across the EU.

Rural development programmes (RDPs) are a key funding instrument for sustainable management of natural resources and climate action in the EU. In addition to the greening of direct payments under Pillar 1 of the Common Agricultural Policy (CAP), RDPs or Pillar 2 of the CAP provide significant opportunities to advance the response to climate change, thereby delivering numerous benefits for farming, the countryside and wider society.

Rural Development Programmes can provide funding for practical actions to help mitigate emissions and adapt to the changing climate in the agricultural sector and land management more broadly. In the programming period 2007 – 2013, and in particular following the CAP Health Check in 2008, Member States already included various climate activities in RDPs with the focus being more prominently on mitigation actions, such as renewable energy (especially bioenergy, biomass and small-scale hydro and wind), energy efficiency, afforestation, improved N-efficiency and manure management.

In the programming period 2014 -2020, the European Agricultural Fund for Rural Development (EAFRD, No. 1305/2013) Regulation builds on these past experiences. The EAFRD Regulation contains several elements that aim to strengthen the strategic programming and enhance the contribution of RDPs towards the EU’s climate objectives. These elements include (EC 2013a):

- The setting of clear policy objectives through six strategic priorities, with two of these priorities directly addressing climate change:
    - Priority 4: Restoring, preserving and enhancing ecosystems dependent on agriculture and forestry;
    - Priority 5: Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in the agriculture and food sectors and the forestry sector;
- The requirement that climate change mitigation and adaptation are addressed in RDPs horizontally as cross-cutting objectives
- Increased flexibility, enabling RD measures to be programmed in relation to several priorities and focus areas
- Result-based orientation of programmes - setting targets for the programmes by focus areas that are linked to rural development priorities.

The EAFRD Regulation allows for a range of measures that can be used to provide targeted support for climate operations. Among others, the key rural development measures for mitigation and adaptation include:

- The **agri-environment-climate** measure (Article 28), which provides support to farmers for adopting environmental or climate related management on their land;
- **Investments in physical assets** (Article 17), providing support for tangible and/or intangible investments which can improve the competitiveness of the business or be non-productive in nature, linked to achieving requirements under the agri-environment-climate or forest-environment measures;
- **Knowledge transfer and information** actions (Article 14) and providing support for **advisory services**, farm management and farm relief services (Article 15);
- **Basic services and village renewal in rural areas** (Article 20)
- **Restoring agricultural production potential** and introduction of appropriate **prevention actions** (Article 18);
- **Investments in irrigation** (Article 46);
- **Quality schemes for agricultural products and foodstuffs** (Article 16); and
- **Organic farming** (Article 29).

Moreover, opportunities are also available to support coordinated climate actions beyond farm holding level through the **LEADER Instrument** (Art. 42-44), the **Cooperation Measure** (Art.35), as well as through combinations of several RD measures.

The extent to which RDPs can effectively promote climate objectives, however, depends on how the objectives and requirements are translated into the specific programmes through the inclusion and design of specific climate actions and operations.

Objectives of the study

In this context, the study aimed to further support the mainstreaming of climate change into Rural Development Programmes 2014-2020 by providing Technical Guidance for Member States' Managing Authorities on the design and integration of new and innovative climate operations. "New and innovative" actions are defined in the study as:

- actions either not commonly implemented in the past RDPs (but which have significant mitigation or adaptation potential), or
- actions which have already been commonly implemented in RDPs but which have significant additional mitigation or adaptation potential that could be realised through, for example, changed scope, content or requirements.

The specific objectives of the study were to:

- Develop an inventory of new and innovative types of climate operations which are explicitly targeted to address climate objectives, and which can fit within rural development measures while contributing to the EU's 'green growth' priorities.
- Carry out an assessment of these operations according to relevant criteria and provide technical guidance on how to design and incorporate these operations within different rural development measures.

- Provide guidance and best practice examples on how to address climate change through LEADER, the Cooperation Measure, and the thematic sub-programmes.
- Develop guidance on relevant combinations of rural development measures and sub-measures.
- Develop criteria for assessment of these combinations' climate effects and contribution to green growth in the EU, in particular the creation of jobs.
- Assist the Commission in disseminating the study results by preparing outreach tools and supporting a workshop.

The overall structure of the project can be seen in Figure 1 below, where tasks are linked to specific elements of the Technical Guidance.

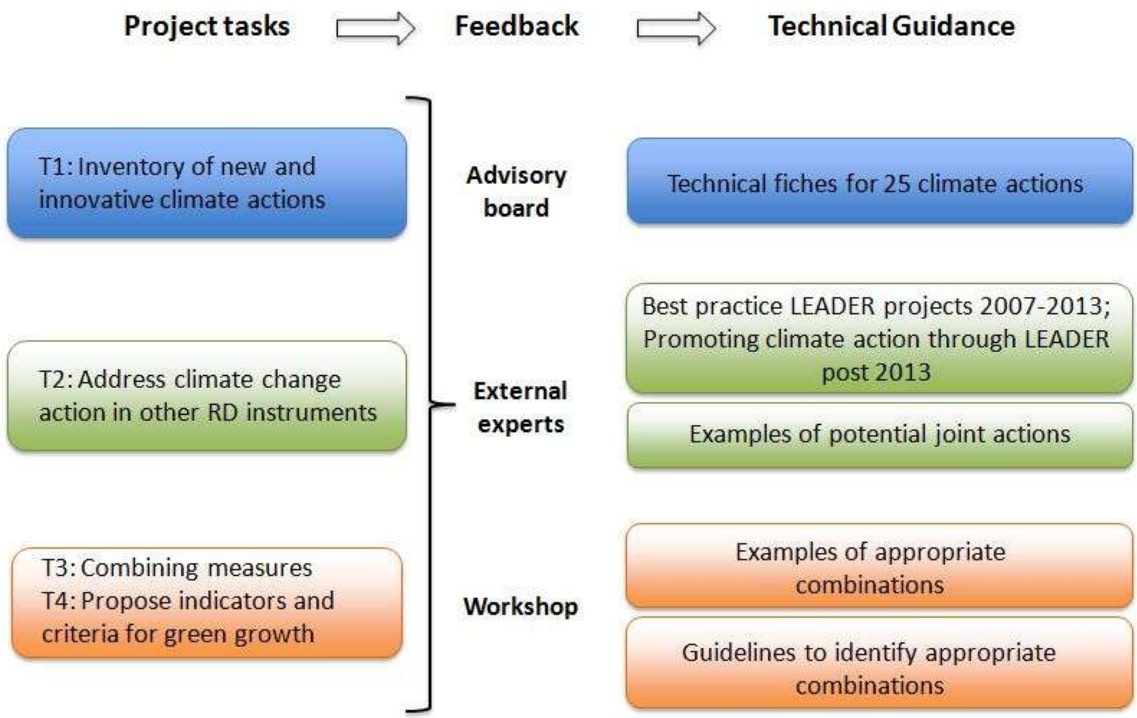

Figure 1: Project overview

Although the programming process for the 2014 – 2020 period is nearing completion, the Technical Guidance remains relevant as inspiration for adjusting or improving the climate aspects of RDPs, during informal annual modifications, as well as during a potential mid-term review of the CAP, or also as inspiration for national activities that might be taking place outside of the RD policy framework, whether this is in relation to the Land Use Land Use Change and Forestry sector or other initiatives.

For easy reference, Table 1 below shows the links between individual project tasks and the different sections of the report.

Table 1. Overview matrix of tasks and sections of the report

Tasks	Description	Chapter 1	Chapter 2	Chapter 3	Chapter 4	Chapter 5	Chapter 6	Chapter 7	Annex 1	Annex 2	Annex 3	Annex 4	Annex 5	Annex 6
Task 1	Design new climate relevant operations to be included under the post 2013 rural development measures		x						x					x
Task 2	Addressing climate action in other RD instruments				x	x					x	x	x	x
2.1	LEADER instrument				x						x	x		x
2.2	Co-operation measure					x							x	
2.3	Thematic sub-programmes				x									
Task 3	Combining measures			x						x				
Task 4	Indicators and criteria – green growth						x							
Task 5	Outreach activities							x						

Selection of farm classification scheme

In order to ensure that the technical fiches that were developed under the Task 1 cover a range of mitigation and adaptation actions across different types of farming systems in Europe, the analysis and selection process for actions for fiche development adopted a farm typology based on the types used in the CAPRI Modelling System (see Britz and Witzke 2012, p195) farm categories after several classification schemes were reviewed. Two of the CAPRI categories (4: Specialist cattle-rearing and fattening (FT 42) and Cattle-dairying, rearing and fattening combined (FT 43)) were disaggregated into two sub-categories (low roughage and high roughage) so that the mitigation and adaptation operations better reflect the fundamental differences between these systems. The final categories used, and their relationship to the CAPRI farm categories are shown in Table 2. These categories were only used in relation to Task 1.

Table 2. Farm categories

Farm category	**CAPRI farm categories**
Cereal	Specialist cereals, oilseed and protein crops (FT 13)
Field cropping	General field cropping (FT 14) + Mixed cropping (FT 60)
Dairy	Specialist dairying (FT 41)
Cattle low roughage	Specialist cattle-rearing and fattening (FT 42)
	Cattle-dairying, rearing and fattening combined (FT 43)
Cattle high roughage	Specialist cattle-rearing and fattening (FT 42)
	Cattle-dairying, rearing and fattening combined (FT 43)
Sheep	Sheep, goats and other grazing livestock (FT 44)
Granivores	Specialist granivores (FT 50)
Mixed farms	Mixed livestock holdings (FT 7)
	Mixed crops-livestock (FT 8)
Vineyards	Specialist vineyards (FT 31)

Farm category	CAPRI farm categories
Fruits	Specialist fruit and citrus fruit (FT 32)
Olives	Specialist olives (FT 33)
Horticulture	Specialist horticulture (FT 20)
Not included in analysis	Various permanent crops combined (FT 34)
	Non-classifiable holdings'

Structure of the report

Chapter 1 provides the background and context to this report and outlines the aims and objectives of this study, as well as the structure of the report.

Chapter 2 presents the rationale and methodological approach for developing a subset of 25 technical fiches for new and innovative climate actions addressing climate change mitigation and adaptation. These fiches serve as guidance on key points of the selected actions such as the conditions likely to favour the operation, the likely mitigation/adaptation effect, any ancillary effects, but also explanations of the main cost elements likely to arise from the operation. While the fiches are presented in detail in Annex 1 to this report, the chapter gives a brief overview of all 25 actions.

Chapter 3 outlines the background and methodology for deriving reasonable combinations of measures, and a summary of the results.

Chapter 4 presents the methodology applied to identify existing 2007-2013 LEADER projects focusing on climate and to develop LEADER project factsheets, along with an overview of LEADER projects that were identified. This chapter also addresses what challenges exist to further promote climate action in LEADER post 2013 and gives an overview of the guidance for Managing Authorities.

Chapter 5 focuses on the opportunities and potential to strengthen the integration of climate change via joint actions under the Cooperation measure.

Chapter 6 discusses the green growth criteria and indicators which can be used to evaluate the contribution of combined RD measures to climate change mitigation and adaptation as well as to green growth objectives in line with the Europe 2020 strategy.

Chapter 7 details the consultation and outreach activities undertaken during the project. The ongoing consultation activities are explained, as well as the project workshop held in June 2014 in Brussels with RD practitioners and other stakeholders. Conclusions and observations from the workshop are presented in individual chapters.

The report also contains six **Annexes:**

- Annex 1 contains 25 technical fiches for new and innovative climate RD actions
- Annex 2 contains suggestions for combinations of measures for the different focus areas under Priority 4 and Priority 5 of RDPs.
- Annex 3 includes, best practice examples of 2007-2013 LEADER projects are presented which could serve as a basis for further incorporation of climate action into LEADER projects during the 2014-2020 period.

- In Annex 4 suggestions for promoting climate action into LEADER projects for the 2014-2020 programming period are presented
- Annex 5 provides examples of potential joint action topics
- Annex 6 contains the long list of LEADER climate action projects identified in Member States.

2. Technical Fiches for new and innovative climate actions

Background: Agriculture and climate change

Climate change presents a twin challenge for agriculture. On the one hand, it presents the need to reduce GHG emissions and, on the other hand, agriculture needs to adapt to a changing climatic environment.

Sources of agricultural GHG emissions

The major GHGs associated with agricultural production are:

- CH4 arising from the anaerobic decomposition of organic matter during enteric fermentation and manure management.
- N2O arising from the microbial transformation of N in soils and manures (during the application of manure and synthetic fertiliser to land and urine deposited by grazing animals).
- CO2 arising from energy use pre-farm, on-farm and post-farm and from changes in above and below ground carbon stocks arising from land use and land use change.

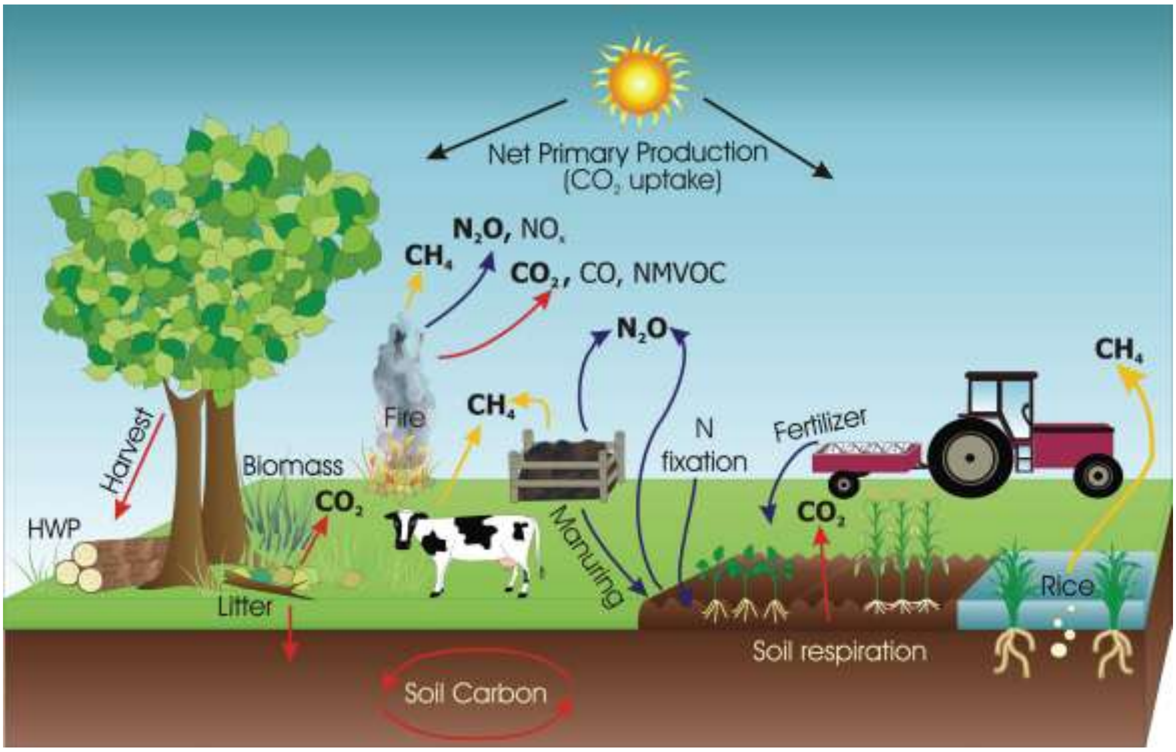

Figure 2: the main greenhouse gas emission sources, removals and processes in managed ecosystems (IPCC 2006, p16).

Within the EU in 2012, on-farm CH_4 and N_2O emissions accounted for 469MtCO2e, or approximately 10% of the EU28 total GHG emissions (EEA 2014, pxii). The contribution of the different emissions categories are given in Figure 3 below. It is important to note that this total does not include CO_2 emissions arising from fuel combustion on-farm (e.g. for field operations) or land use change on farm, or any emissions that occur off-farm (such as those arising from the production of inputs such as feed, energy and fertiliser).

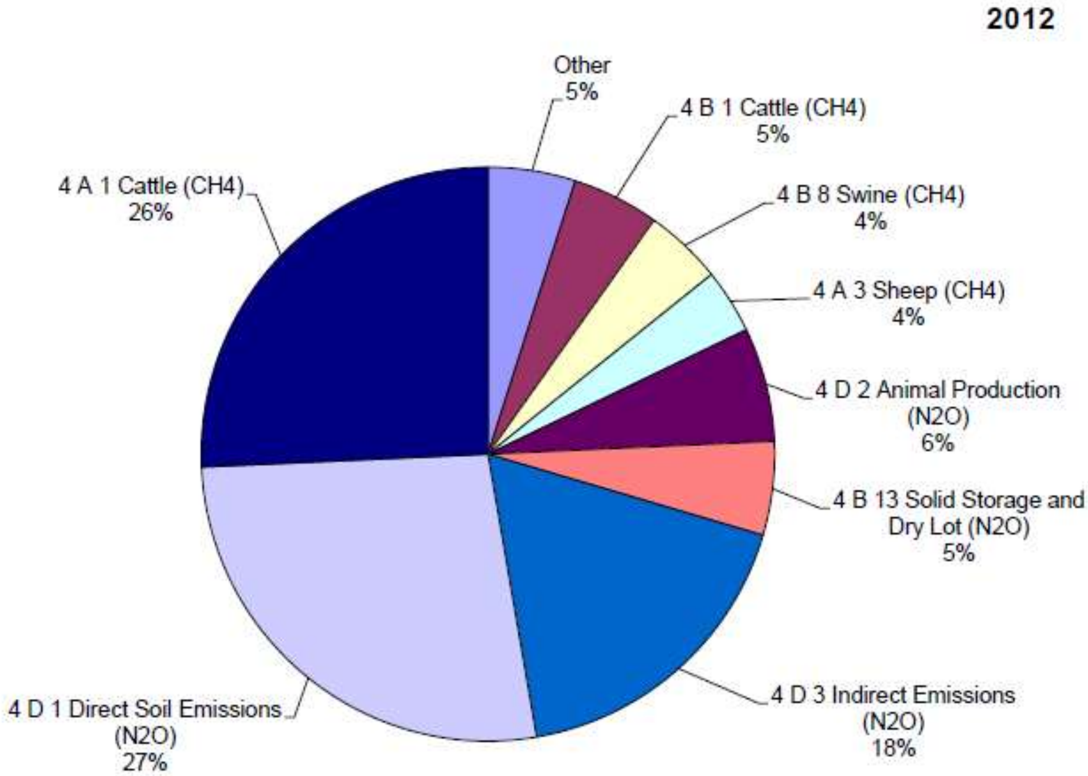

Figure 3: Contribution of different emissions sources to on-farm non-CO_2 agricultural GHG emissions in the EU28 in 2012 (EEA 2014b, p1175, http://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2014).

Greenhouse gas mitigation

Greenhouse gas mitigation involves the reduction of emissions at source or the enhancement of removal of greenhouse gases from the atmosphere into long term storage (see http://ec.europa.eu/clima/policies/forests/index_en.htm). As global demand for food is forecast to increase significantly over the next 30 years (see Alexandratos and Bruinsma, 2012). Therefore, the main (though not exclusive) focus in this work is on mitigation actions that can reduce emissions intensity (i.e. the $kgCO_2e/kg$ product) while either maintaining or increasing production. This focus is chosen in order to avoid the reduction of emissions via the reduction of production, and consequent displacement of production and emissions. While it is recognised that emissions intensity may also be reduced while reducing production, the complex consequential Life Cycle Assessment (LCA) required to quantify the net mitigation effect is beyond the scope of this project. It is also recognised that member states have commitments to reduce their total emissions, which means that any increase in the total emissions from one sector (even if accompanied by a decrease in the emissions intensity of that sector) would need to be offset by an emissions reduction elsewhere in the economy.

Adaptation to climate change

Adaptation to climate change has been described as "anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause, or taking advantage of opportunities that may arise" (see http://ec.europa.eu/clima/policies/adaptation/index_en.htm).

Agriculture needs to adapt to the direct effects (e.g. changes in temperature) and the indirect effects (e.g. increased volatility in feed prices) of a changing climate. The focus in this work is on the direct biophysical effects of climate change. The main impacts of climate change on agriculture are summarised by Hjerp et al. (2012, p34) as:

"Water scarcity is already being experienced in some areas of Europe and longer and more frequent droughts are anticipated in large parts of Southern Central and Eastern Europe, as well as parts of Northern Europe, with significant risks to crop yields. More arid conditions are likely to exacerbate soil degradation as a result of wind erosion and will also cause heat stress for livestock. There is less clarity about the likely changes in precipitation that might be experienced. The higher incidence of these types of extreme weather events (e.g. droughts, storms) is likely to severely disrupt crop production and increase the unpredictability and variability of crop yields. These higher temperatures and increased rainfall are also likely to lead to a noticeable increase in the incidence of disease, pests and pathogens, including the spread of invasive alien species."

Synergies between mitigation and adaptation

The fiches include actions targeting both mitigation (M1-M16) and adaptation (A1-A9). However, actions targeting mitigation often have adaptation effects and *vice versa*. These synergies are briefly explored in the fiches and summarised in Table 5.

Identifying new and innovative climate actions – method

In this study a distinction is made between actions (which are activities that can be undertaken on-farm, e.g. planting cover crops is an action) and operations (which refers to RDP operations that could be used to encourage uptake of an action, e.g. providing area-based payments for the sowing of cover crops in arable rotations).

The main aims of this task were to (a) identify a range of new and innovative RDP actions that have significant benefits in terms of mitigation and/or adaptation, and (b) create a suite of technical fiches describing a subset of 25 of these actions. The fiches are brief documents (typically 6-10 pages, see Annex 1), that provide an explanation of how a particular action (such as planting cover crops) could reduce GHG emissions or help to adapt to climate change, and an example of how the action could be translated into an RDP operation. They provide guidance on key points such as the conditions likely to favour the operation, the likely mitigation/adaptation effect, and any ancillary effects. They also provide brief explanations of the main cost elements likely to arise from the operation. Throughout the fiches, effort has been made to provide links to the evidence underpinning key assumptions.

When reading the fiches, it is important to keep in mind that:

- Mitigation of GHG and adaptation to climate change are complex processes. The fiches, which are overview summaries for communicating the main elements of the measures, simplify this complexity somewhat.

- The contents of the fiches are not prescriptive; they seek to provide inspiration and examples rather than detailed technical guidance.
- The scope of the 25 fiches is not exhaustive, and non-inclusion in the list does not imply a lack of mitigation/ adaptation potential.

The method used is summarised in Figure 4 and the individual steps are explained below.

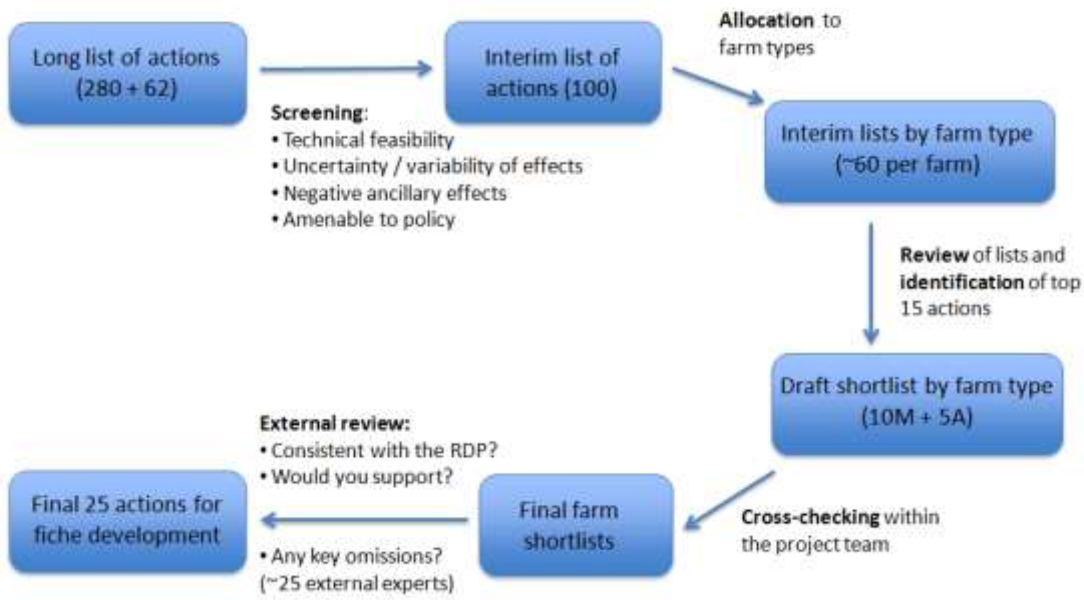

Figure 4: Overview of the method used to identify actions for the fiches (M=mitigation action, A=adaptation action)

Creation of a list of mitigation and adaptation actions

A long list of potential mitigation (N=280) and adaptation (N=62) actions was drawn up based on a review of existing evidence (see Annex 6 for the bibliography that was used in this process). The mitigation actions were screened by SRUC and actions that met the following criteria were removed:

- Actions unlikely to be technically feasible during the RDP period.
- Actions with a highly uncertain or variable mitigation/adaptation effect(s).
- Actions posing a high risk of negative ancillary effects.
- Actions not amenable to policy (e.g., difficult to verify), or facing legal barriers in the EU (e.g., GM, some feed additives and medicines)

The results of the screening were reviewed by Thünen Institute, and the remaining actions allocated to specific farm categories, to create the interim lists by farm type.

Conversion of actions into potential farm specific RDP operations

During this sub-task, members of the project team identified a short list of potential mitigation and adaptation operations for their subset of farm categories. In order to maintain a consistent approach, the task was structured, and detailed step-by-step guidance provided explaining how to:

- Review the lists of actions and add or remove actions as appropriate.
- Select the 10 actions that would make the best (in terms of their likely effect and their practical feasibility) mitigation operations, and the five actions that would make the best adaptation operations.
- Suggest potential RDP operations for the shortlisted actions.
- Answer a series of questions for the proposed operations, relating to their applicability, compatibility and potential ancillary impacts.

The findings were cross-checked and a short list of proposed operations for each farm type was then agreed on.

Review of short lists by external experts

A range of external experts was identified to provide feedback on the short lists. They were selected to cover a variety of agro-ecological zones, farm categories and sectoral perspectives (government, industry, NGO and research). The short lists were sent to the external experts along with guidance on the feedback required. The aim of the review was to identify any key omissions and to highlight potential issues with the proposed operations, notably:

- Inconsistency with the spirit and letter of the RDP
- Problems that may make the operations difficult for the experts to support (e.g. the possibility of low acceptability and uptake of the operations, challenges with monitoring compliance).

The 25 actions for which fiches were developed were identified based on the feedback received from the external experts combined with judgment from the study team (taking into account in particular mitigation potential, feasibility and reporting issues, and side-effects). The 25 actions and the main GHG emissions categories and climate change risks targeted by the fiches are shown in Table 3.

Table 3. The main GHG emissions categories and climate change risks targeted by the fiches

		Main emission categories affected											Main climate change risks								
		On-farm									Off-farm		(based on Iglesias et al. 2007)								
Fiche	Mitigation action	Enteric CH_4	Manure CH_4	Manure N_2O	Rice cultivation CH_4	Soil N_2O: applied N	Soil N_2O: grazing	Energy CO_2: other	Energy CO_2: fieldwork	CO_2 from soil carbon	Pre-farm emissions	Post-farm emissions	Decreased crop product'y	Pests, diseases, weeds	Crop quality decrease	Increased risk of floods	Water scarcity	Increased irrigation demand	Water quality deterioration	Soil erosion, salin'n, desert'n	Livestock conditions decline
M1	Extend the perennial phase of crop rotations					x		x		x						x				x	
M2	Use cover/catch crops and reduce bare fallow									x						x				x	
M3	Improved N efficiency					x					x		x		x				x		
M4	Precise N application					x					x		x		x				x		
M5	Bio N fixation in rotations and in grass mixes					x					x		x		x						
M6	No-till					x		x		x	x						x	x	x	x	
M7	Retain crop residues									x	x					x	x	x	x	x	
M8	Prevent/reduce soil compaction					x				x			x		x	x	x	x	x	x	
M9	Avoid drainage of wetlands/peatland conversion					x				x						x				x	
M10	High fat diet (dietary lipids)	x																			
M11	Precision and multi-phase feeding			x		x															
M12	Solar fodder dryers					x		x	x	x	x		x								x
M13	Behavioural change for energy efficiency							x	x		x										
M14	Climate proofing planned investments		x	x							x										
M15	Better livestock health planning	x				x	x	x	x		x			x							x
M16	Carbon audit	x	x	x	x	x	x	x	x	x	x										

Table 3 cont'd

		Main emission categories affected											Main climate change risks								
		On-farm									Off-farm		(based on Iglesias et al. 2007)								
Fiche	Adaptation action	Enteric CH_4	Manure CH_4	Manure N_2O	Rice cultivation CH_4	Soil N_2O: applied N	Soil N_2O: grazing	Energy CO_2: other	Energy CO_2: fieldwork	CO_2 from soil carbon	Pre-farm emissions	Post-farm emissions	Decreased crop productivity	Pests, diseases, weeds	Crop quality decrease	Increased risk of floods	Water scarcity	Increased irrigation demand	Water quality deterioration	Soil erosion, salin'n, desert'n	Livestock conditions decline
A1	Use of adapted crops					x			x	x			x	x	x		x	x	x	x	
A2	Cover crops/reducing bare fallow									x						x				x	
A3	Soil erosion control plan									x						x				x	
A4	Reduced tillage/minimum tillage					x		x		x	x						x	x	x	x	
A5	Optimising benefits of shelterbelts and hedges										x									x	x
A6	Optimising the adaptation benefits of drainage					x	x						x			x					
A7	Improved irrigation efficiency								x		x		X				x	x	x	x	
A8	On farm harvesting and storage of rainwater										x						x	x			
A9	Optimising greenhouse cultivation								x				x	x	x			x			

Structure of technical fiches

The 25 fiches are included in Annex 1. There are 16 mitigation fiches (demotes M1-M16) and nine adaptation fiches (denoted A1-A9). Each draft fiche was reviewed internally by a member of the project team (see Table 1 in Annex 1), before being reviewed by DG Climate Action (or their appointed experts) and then revised.

The contents of the fiches are summarised in Table 4. In the fiches a distinction is made between *actions* (which are activities that can be undertaken on-farm, e.g. planting cover crops is an action) and *operations* (which refers to RDP operations that could be used to encourage uptake of an action, e.g. providing area-based payments for the sowing of cover crops in arable rotations).

Table 4. Overview of the fiche contents

Section	Content
Summary	Summary of the intervention logic, brief description of the proposed operation and any key issues arising.
Regulatory requirements	Relationship between proposed operation and other regulatory requirements that have to be met (e.g., Nitrates Directive, GAECs), indication, where possible, of current uptake rates.
Description of the action	Brief explanation of the way in which the action leads to a reduction in GHG emissions or climate change risk.
Proposed general operation	Description of an example RDP operation that could be used to encourage uptake of the action.
Commitments, funding conditions and eligibility	Suggestions for criteria that may be used when defining eligible activities; appropriate timings and locations; synergies (both positive and negative) with operations in the other fiches.
Expected impacts on climate change on-farm	Quantification of abatement rate and/or qualitative assessment of adaptation benefits on farm. Off-farm GHG effects are included in ancillary effects. Explanation of factors influencing the abatement rate or adaptation benefits.
Ancillary effects	Description of potential ancillary effects (positive and negative) in terms of: off-farm GHG; production; adaptation; environment. Also highlight any potential maladaptation risks.
Guidance on costs and payment calculations	The private cost and savings - explanation of the main cost and savings elements. Classification of the CE - (1) negative cost, (2) no/low cost, (3) significant cost. Explanation of the main drivers of variation in costs. Costs are provided to illustrate the likely relative importance of the different cost elements. In practice, the actual costs will vary considerably depending on the specific context.
Control and verification	Explanation of how required undertakings could be verified. Potential result indicators are suggested and the extent to which the mitigation effect would be captured by National GHG Inventories is explained.
Barriers to implementation	Brief description of barriers to uptake and related key risks/uncertainties.

Section	Content
References	The fiches make reference, where feasible, to recent peer-reviewed evidence, supplemented by expert opinions

The actions outlined in the fiches can be applied individually or in combination. When applied in combination, actions can interact in a number of ways (see MacLeod *et al.* 2010). Positive synergies may arise through, e.g., shared costs or improved efficacy. Alternatively, negative synergies may arise if the actions are mutually exclusive or there is a risk of double funding. In addition, the abatement rates per ha or per animal may be reduced if two actions target the same emission source, or if one action reduces the total area or number of animals that can be targeted (for example, extending the perennial phase of rotations reduces the area on which cover crops can be planted). Potential synergies between actions should therefore be identified, where possible. While these synergies will depend on the specific details of the operations (e.g. when, where and how an action is to be undertaken), a summary of the potential synergies between the actions in the fiches is provided in Table 5.

Estimating the cost-effectiveness of adaptation operations is more complicated as the effects of adapting are not as readily quantified or converted into a common metric. In theory, the benefits of adaptation can be quantified and monetised; however, expressing the CE of the adaptation actions in a common metric is beyond the scope of the present study. The estimates of CE provide only a rough guide as CE can vary a great deal within and between countries.

Table 5. Summary of potential positive (+) and negative (-) synergies when combining actions[a] (according to the fiches), **and estimated cost-effectiveness of the mitigation actions** (note that this table refers to synergies between actions; synergies between RD measures are discussed in Chapter 3)

Fiche	Action	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	A1	A2	A3	A4	A5	A6	A7	A8	A9	CE[b]
M1	Extend the perennial phase		+/-														+	+	+/-	+							2/3
M2	Cover crops	+/-					+										+	+	+	+	+			-			3
M3	Improved N efficiency				+										+		+							+/-			1/2/3
M4	Precise N application			+			+/-			-					+		+				+/-						1/2/3
M5	Bio N fixation												+				+	+									3
M6	No-till		+		+/-			+		-				+			+	+									3
M7	Retain crop residues						+										+			+	+			+			1
M8	Soil compaction												+				+			+							2
M9	Avoid drainage of wetlands				-		-										+						-			-	1/2/3
M10	High fat diet											-				+/-	+										3
M11	Precision feeding										-				+/-	+/-	+										1/2
M12	Solar fodder dryers					+			+					+		+	+										2
M13	Energy efficiency						+						+		+		+							+	+	+	1
M14	Climate proofing investments			+	+							+/-		+		+	+								+/-	+/-	1/2/3
M15	Better livestock health										+/-	+/-	+		+		+										1/2
M16	Carbon audit	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	2/3
A1	Use of adapted crops	+	+			+	+										+			+	+			+		+	
A2	Cover crops	+/-	+														+			+							
A3	Soil erosion control plan	+	+					+	+								+	+	+		+	+	+				
A4	Reduced tillage		+		+/-			+									+			+							
A5	Shelterbelts and hedges																+	+		+							
A6	Optimising drainage									-							+			+							
A7	Improved irrigation efficiency		-	+/-				+						+			+	+								+	
A8	Rainwater harvesting													+	+/-		+									+	
A9	Optimising greenhouses									-				+	+/-		+	+						+	+		

A) This matrix provides a high level overview of potential interactions; in practice the extent to which actions interact is more complex and depends on the details of where, when and how they are implemented. **B)** (1) negative cost, (2) no/low cost, (3) significant cost

Insights from the Workshop

Background

A workshop was held in Brussels on the 17th of June 2014 (see Chapter 7 for further details). Two fiches were sent to participants prior to the workshop (one concerning adaptation and one on mitigation actions). During the workshop a presentation was given explaining the methodology used to select and develop the fiches, and two discussion groups were held. The topics addressed in the discussion groups are summarised below.

- GROUP 1: Technical Fiches – Brainstorming potential operations

The aim of this group was to improve the participants' understanding of the fiches, and awareness of: (a) the meaning of key terms used in the fiches, i.e.: measure, action, operation, abatement rate and cost-effectiveness; (b) the scope and content of the fiches, (c) the limitations of the fiches, (d) some of the questions likely to arise when they seek to develop their own operations from the fiches.

- GROUP 2: Technical Fiches – Identifying ways of improving the usefulness and uptake of the fiches

The aim of this group was to: (a) get feedback from the participants on the general content of the fiches, and (b) obtain insights into what might encourage, or prevent, RDP staff from using the fiches.

Summary of key points raised during the discussions

To what extent are climate change actions currently integrated into RDPs?

Moderate progress has been made in integrating climate change into the RDPs. Interest in including climate change has increased, partly as a result of its status as a cross-cutting theme. Climate change tends to be seen more as a secondary (i.e. indirect) benefit of other policies objectives (e.g. improving the environment through the Water Framework and Nitrates Directives, increasing productivity or encouraging innovation) rather than a primary policy goal. In terms of the EU priorities for rural development, priority 5 (promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy) tends to be used less frequently to introduce climate change than the other priorities: 1 (fostering knowledge transfer and innovation), 4 (restoring, enhancing and preserving ecosystems) and (to a lesser extent) 2 (enhancing farm viability and competitiveness). Where priority five is targeted, it tends to be more in terms of 5b and c (energy efficiency and renewables) rather than 5d (reducing GHG emissions).

What are the key barriers to integrating climate change actions into RDPs?

1. Verification and additionality

If mitigation or adaptation is cited as the primary reason for including an action, then the effect needs to be verifiable (i.e. it is not just the action that needs to be verified, but the outcome of the action). This is problematic as many actions do not have a readily measured mitigation/adaptation effect. This was cited as one of the reasons why RD programmers prefer to cite mitigation/adaptation effects as secondary benefits. Some participants had included actions with climate change mitigation as the primary effects but these had been objected to on the basis that the impact was not verifiable. This was seen as a particular problem with investments, though it potentially applies to many mitigation actions as most do not have a directly measurable effect. Verifying a sub-sample was proposed as a possible solution. Other approaches not involving direct verification of the effect would be to use an accredited carbon calculator to quantify the effect. Some previous experience already exists in France through the Energy Performance Plan in which an energy and climate audit was mandatory to get subsidies for investment. Other options would be to have a catalogue of approved actions or an expert panel approach (although concerns were raised that this may not be sufficiently transparent, and would be open to (accusations of) abuse.

Lack of reliable baselines against which to measure the additional climate change benefit can also be problematic. For example if a farm has planted cover crops in the past (for private benefit) it may not be straightforward to determine the additional uptake arising from an RDP operation.

2. Knowledge/attitudinal barriers

Lack of awareness (particularly amongst farmers) of the scale and rate at which climate change is taking place was cited as a barrier. Improved communication of the changing patterns of pest/disease prevalence was suggested as a way of illustrating the pace of change.

Lack of awareness of the opportunities for simultaneously reducing emissions and increasing profitability was also cited as a barrier. Improving industry understanding of the specific links between productivity, profitability and emissions intensity was cited as one of the keys to encouraging uptake of climate change actions, with the GHG Implementation Partnership[1] in Northern Ireland provided as an example of this in action.

Generally, co-benefits (of mitigation/adaptation actions) are numerous and could also be sometimes significant. It was suggested that they should also be put forward to convince farmers to implement the measure. Information and knowledge instruments could be quite relevant to disseminate these co-benefits. In some countries (i.e., Netherlands RDP) the major problem is the lack of information on these new/innovative technical operations rather than the amount of financial resources available to favour the adoption of these technologies. In addition, the creation of new markets for the production arising from "environmental" actions (e.g. biomass from cover crops) could help to convince farmers on the validity of these new proposals.

Lack of awareness (amongst policy staff and technical experts) of the potential climate change dimension of their own domain was cited as a potential barrier – e.g. the role that genetic resources can play in mitigation/adaptation is not always immediately apparent to geneticists.

3. Recognising the social benefits arising from implementing climate change actions

Reducing GHG emissions provides a benefit to society not always easily captured by the provider, i.e. it is a positive externality. Recognising (and, where possible, providing reward for) these benefits was suggested as a way of encouraging uptake.
Credit needs to be given (at a farmer and sectoral/policy level) when emissions are reduced, however the current national GHG inventories do not fully capture some mitigation effects (such as soil carbon sequestration).

[1] http://www.dardni.gov.uk/index/farming/climate-change-farming.htm

How could the content of the fiches be made more useful to RDP staff?

Discussion of the fiche contents was tempered by the fact that most participants had not studied the fiches in-depth prior to the workshop. However, many constructive suggestions were made during the discussions, which are summarised below.

- When possible, it would be helpful to get a national scientific literature of the GHG reductions or explain under which conditions the measure could be successful or not. Furthermore, it could be pointed out which regions/areas the mentioned abatement rates are appropriate.
- The rate of uptake in Europe could be indicated in the fiche. Quantitative indications, when available, could be helpful to understand if the measure is really new (which means innovative and then could get higher premium) or if it has already been implemented but need to be developed. It is important to highlight how many people are already implementing it and where. Also qualitative assessment of the rate of implementation could be useful, when other information is lacking.
- Clarification should be given that the costs in the fiches are provided to illustrate the relative importance of the different cost elements, rather than to give an absolute cost (which would vary considerably between systems, locations etc.). A better definition of the typology of investment (commercial vs. non-productive), characterised by different aid rates, could help to increase the adoption of these technologies, that in many cases do not have particularly significant private benefits.
- Recommending packages of mitigation/adaptation operations that exploit synergies would be helpful (but perhaps challenging). A matrix showing the interrelationships between fiches would provide a starting point.
- Providing packages of fiches on a thematic basis may make them more accessible e.g. fiches could be grouped that relate to key themes such as: soil health, nutrient management or improving water use efficiency (possibly illustrated with actual examples – see below).
- Linking the fiches to actual examples of actions being applied in practice could be a useful way of encouraging uptake, as it would provide reassurance that the action could be applied, and a way of learning from others' experience. It is also worth considering how use of the fiches may be monitored, and networking between people using the fiches could be facilitated in the future.

In general the fiches were welcomed by the participants and it is hoped that they will help to address some of the barriers to integrating climate change-specific actions into RDPs by raising awareness of how and why emissions arise and how mitigation and adaptation can work.

Concluding remarks

There are a wide range of potential mitigation and adaptation actions. A subset of 25 actions was selected to be developed into fiches. The scope of the 25 fiches is therefore not exhaustive, and non-inclusion in the list does not imply a lack of mitigation/ adaptation potential.

It should also be noted that the values of some key parameters, such as abatement rates, cost-effectiveness and likely uptake rates can be highly variable and difficult to quantify, and the values presented in the fiches should be seen as illustrative rather than definitive.

Feedback from stakeholders at the workshop highlighted potential barriers to the uptake of climate change actions arising from: lack of knowledge of the rate of the implications of climate change; lack of knowledge regarding the potential (win-win) benefits of climate change actions; and the difficulties of measuring and verifying (and therefore rewarding) the impact of actions. Improving understanding of the impacts could be achieved through more widespread and consistent use of carbon audits (Fiche M16). However, carbon audits should be seen a way of moving the process on rather than as panacea. Valid concerns were expressed during the workshop that measurement methods can be inconsistent and open to manipulation, however this risk can be minimised by keeping the measurements pre-competitive, and focussing on benchmarking within peer groups.

3. Combinations of rural development measures and thematic sub-programmes

Background

Rural development (RD) measures (i.e. measures at RDP article level) are no longer attributed to different axes, but rather to the different Union Priorities according to their expected contribution. This enables greater flexibility for the programming of RD measures (EC 2013a). Specific needs identified by the SWOT analysis, including those in relation to climate change mitigation and adaptation, can be addressed by combining measures or by using thematic sub-programmes (Art. 7 EAFRD Regulation). Through the combination, the RD support should be more targeted. The added value of the measure combination in comparison to a separate implementation of single measures needs to be justified (EC 2013a). The measures have to be complementary and should not incur excessive additional effort for programming and administration. However, some measures may exclude each other, for example where the combination may lead to double counting or overcompensation through double support. Task 3 in the project has examined how these new instruments can be employed to mainstream climate change mitigation and adaptation objectives into RDPs. Examples of practicable measure combinations with climate objective are identified that contribute to the achievement of the Union Priorities 4 and 5 (see Annex 2). Possibilities for reasonable appropriate combinations of measures are identified in close collaboration with Task 1 (Technical fiches), Task 2 (LEADER and Joint Action) and through consultation of EU Member State RD programmers . It is important to mention that it is difficult to evaluate the combinations or rank the combinations, as they are context specific. Their relevance and suitability depend on site-specific circumstances and conditions, policies, and farming practices and vary between beneficiaries.

The Union Priorities 4 and 5 and included focus areas are the following:

Priority 4: Restoring, preserving and enhancing ecosystems dependent on agriculture and forestry, with a focus on the following areas:

- restoring and preserving biodiversity, including in Natura 2000 areas and high nature value farming, and the state of European landscapes (with effects on climate objectives as a side effect);
- improving water management;
- improving soil management.

Priority 5: Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors, with a focus on the following areas:

- increasing efficiency in water use by agriculture;
- increasing efficiency in energy use in agriculture and food processing;
- facilitating the supply and use of renewable sources of energy, by-products, wastes, residues and other non-food raw material for purposes of the bio-economy;

- reducing nitrous oxide and methane emissions from agriculture;
- fostering carbon sequestration in agriculture and forestry.

All focus areas of the priorities 4 and 5 potentially relate to climate mitigation and/or adaptation.

Definitions for "combining measures"

The term "combining measures" is not defined in the EAFRD Regulation; however, reference to "combinations of measures" is made in the Working Paper of the European Commission "Guidelines for strategic programming for the period 2014-2020" (EC 2013a). According to these guidelines, combinations of measures are supposed to lead to a simplification for the administration and for the beneficiaries in the Member States. In theory all combinations are possible, if only they are compatible and complement each other. The complementarity needs to be justified. Implementation follows the rules of the single measures and the expenditure is assigned to the dominant measure. If co-financing rates differ between measures, the one of the dominant measure applies. The level of support should be determined by also considering specific income foregone and further costs from the combination. Commitments in respect to agri-environment-climate, organic farming and animal welfare measures can be combined (in case they are complementary and compatible). Integrated projects refer to a special case of measure combination, which always involves "Investment in physical assets" (Art. 17). In this case the implementation of the combination might lead to an increased support rate of additional 20% points (provided that the maximum combined support does not exceed 90%) (see Annex II of the EAFRD Regulation).

Different levels for "combining measures"

The combination of measures can occur at the level of the RD programme, within sub-programmes, at regional or local level and addressing single or multiple beneficiaries. The RD programmes offer a toolbox of complementary measures that in their entity can be understood as a loose "Combination of measures". This refers to the possibility of the beneficiaries to implement more than one measure out of the toolbox of an RD programme at the same time in case they do not exclude each other (e.g. to avoid double funding and undesired indirect effects such as leakage and deadweight). Such a combination of measures is an inherent characteristic of RDPs and was used in many member states during the 2007-2013 programme period, mostly in an informal, flexible way.

Different measures are combined in accordance with the RDP articles. These measures can for instance be programmed under "Article 17 Investments in physical assets" and "Article 28 Agri-environment-climate" and be combined with one-another. A new, specific case to organise such "toolboxes" are the Thematic sub-programmes (see below), a new programme format for grouping measures aiming at a specific objective, e.g. climate change mitigation and adaptation.

Combinations of measures can occur at the level of a single beneficiary, who has different commitments (i.e. realises several measures or operations). Such combinations might be obligatory (i.e. as a fixed "package") or voluntary. An example is the combination of "Article 15 Advisory services, farm management and farm relief services" with "Article 28 Agri-environment-climate". In this example, the effectiveness of agri-environment-climate measures can be improved through additional information transfer. Thus programme authorities are obligated to provide such information to beneficiaries of Article 28. This measure needs to be combined with advice ("Article 15 Advisory services, farm management and farm relief services"):

"Member States shall endeavour to ensure that persons undertaking to carry out operations under this measure are provided with the knowledge and information required to implement such operations. They may do so through, inter alia, commitment-related expert advice and/or by making support under this measure conditional on obtaining relevant training."

Another example, where an obligatory combination of measures would be reasonable, is the improvement of the manure management including stable, storage and application technologies and management. For this, a combination of measures ("Article 17 Investment in physical assets" and "Article 28 Agri-environment-climate") is useful in order to address the whole manure "chain". In this special case the obligatory combination is necessary because all ammonia emissions saved along the management chain (e.g. through investments into manure storage covers) can be lost again during manure application. Therefore, we would recommend an obligatory combination of measures related to manure management. As an alternative, support could be preferential for those beneficiaries addressing all stages of manure management on their farms.

Finally, at the regional or local level investments into infrastructure combined with farm-level measures can be useful. For example, the local investment in irrigation infrastructure could be combined with investment aid at single farm level in order to improve the adaptation to climate change. Also, the restoration of wetlands requires several activities at local and farm level, such as planning, advice, investment in the local water infrastructure (change of the drainage system), investment aid and agri-environment-climate measures at farm level. With a single measure, such complex changes at landscape level could not be achieved. Further, the combination of different measures addresses several actors with different needs that have to be included (multiple beneficiaries).

Thematic sub-programmes (TSP)

Thematic sub-programmes according to Art. 7 of the EAFRD Regulation are a new option to formally combine measures that address a specific need (e.g. related to young farmers, small farmers, mountain areas, short supply chains, women in rural areas, climate change mitigation and adaptation and biodiversity). Measures are programmed within a separate sub-programme, in order to better contribute to the achievement of the Union Priorities. The use of thematic sub-programmes needs to be justified and a specific SWOT analysis, a needs assessment, target identification and a separate indicator plan are required, which will not be included in the main indicator plan. The financial plan is covered by the main RDP financial programming. Thematic sub-programmes related to small farmers, short supply chains, climate change and biodiversity can receive higher support rates (increase by 10 percentage points). Management and implementation can be conducted by intermediate bodies designated by the Managing Authority.

Identifying combinations of measures and thematic sub-programmes – method

The method that was used in the project to identify the relevant combinations of measures and thematic sub-programmes is illustrated in Figure 5.

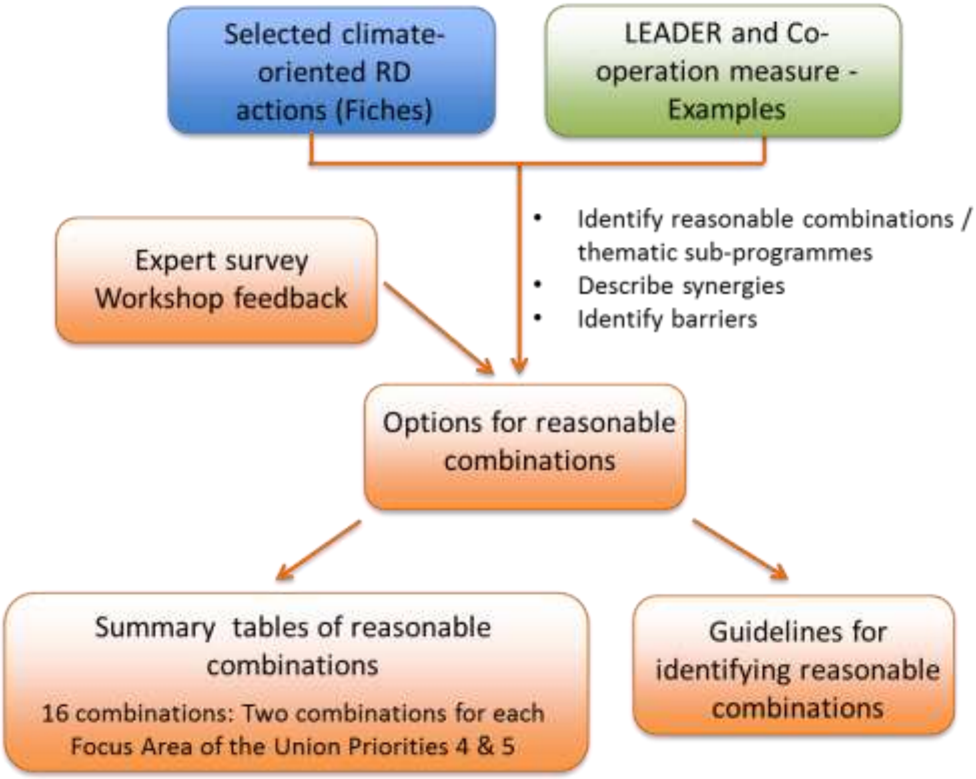

Figure 5: Overview of method for identifying relevant combinations of measures and thematic sub-programmes

In identifying the relevant combinations of measures and investigating options for thematic sub-programmes, the outputs of Technical Fiches and the work on LEADER projects was used. A questionnaire was developed and follow-up interviews were conducted with experts from RDP Managing Authorities in selected Member States. We sought to identify experiences from the 2007 – 2013 period and plans for 2014 – 2020 period. We received 10 questionnaires from six European member states (France, Germany, Hungary, Italy, Portugal, and UK (Northern Ireland, England)). However, some questionnaires were filled by several experts at the same time as they decided to bundle their expertise and responded on the questionnaire in collaboration with each other. Moreover, insights from other countries were obtained during the workshop.

As many experts were still busy with programming and many RDPs are in a preliminary state, only few responses to our questionnaire were received. We experienced that it was difficult for the interviewed experts to respond to the whole questionnaire as it considers two programme periods. Often they only had knowledge about one of these periods. However, we received responses from different MS that provide an overview on the experiences and status of combined measures in the RD programmes.

Opportunities for combinations of measures and thematic sub-programmes: Insights from the stakeholder consultation and the workshop

A questionnaire on appropriate combinations of climate-oriented RD measures was developed to gain insights into the experiences with the implementation of combined measures in the last period (2007-2013) as well as plans for the new programming period (2014-2020). The survey aimed to identify "real world" examples of combining measures. Further, during the project workshop, a group discussion on combined measures with the participants was organised. The aim was to present the approach of Task 3, including initial results from the stakeholder consultation and to gain feedback from practitioners. Participants provided feedback on the presented work and reported on the implementation of and experiences with measure combinations in their country's RD programmes. The discussion at the workshop confirmed the impressions obtained from the questionnaire results.

a) *Combinations of measures*

Programming period 2007 - 2013

Although a combination of some measures is considered useful in order to increase synergies, only few Managing Authorities have made experiences with the implementation of combined measures in an official way, which means by joint programming and implementation. Measures have been mostly programmed and implemented as single measures, not as obligatory measure combinations. In the programming period 2007 -2013 only few experiences with the implementation of combined measures exist, however not for climate related measures, as climate was not a priority in the last programming period. Several respondents mentioned that for some measures combinations were considered useful so that farmers were encouraged to implement additional measures jointly in order to use their synergies (see section *Possible combination of measures with a focus on climate change*, *Programming period 2007-2013*). Although land managers implemented several measures in the last programme period and combination may have been encouraged by advisory services, the measures were not particularly designed for combined implementation in the RDPs. A combined implementation was mentioned to be associated with increased workload for administrations.

In addition to combined implementation of two measures with different RD articles as laid down in the Guidelines for strategic programming (EC, 2013a), the combination of two or more operations under the same article was mentioned by some respondents of the questionnaire as having potential benefits. For instance this relates to the combination of Modernisation of livestock buildings and an Energy performance plan, where both operations belong to article 20 (b) (I), "Measure 121 Modernisation of agricultural holdings". This combination would increase the energy efficiency (Priority 5b) by considering the optimisation of energy use when planning the modernisation of livestock buildings.

Only a few Member States have experience with obligatory combinations of measures in the previous programme period. In Slovenia, agri-environment measures were made subject to participation in a RDP funded farm advisory service. Such obligatory combinations can pose risks to scheme performance, if advisory services are not available as required. Furthermore, the co-ordination of the funds for such combined measures requires more management capacities. For Hungary, a combination of agri-environment measures with public farm advice not funded from the RDP was reported.

Programming period 2014-2020

For the new programming period 2014-2020 it was mentioned that several measures are closely linked to each other and synergies exist and should be used (e.g. technical advice and training for other measures). However, these measures are mostly not implemented as formally combined measures in the sense of the Guidelines for Strategic Programming of the EC (EC 2013a). Voluntary and flexible implementation of combinations of measures is more common largely because obligatory combinations would complicate programming.

Nevertheless, in Northern Ireland (UK), an obligatory combination of investment in drainage with participation in agri-environment-climate measure is planned for the new programme period as a mechanism to avoid that all funds are used for the drainage investment.

b) Thematic Sub-programmes

Thematic sub-programmes with climate priority are not planned for any of the RDPs covered by the survey and represented by workshop participants. Reasons mentioned are that climate mitigation and adaptation measures are being embedded within the RDP scheme, rather than a stand-alone sub-programme. One respondent mentioned that two other thematic sub-programmes are planned in the national RDP (young farmers and short supply chains) on the background of political decisions to give priority to these areas. However, the programming is associated with a high additional administrative burden. As climate-related measures are implemented in the RDP, the administration did not consider it necessary to establish a third sub-programme with climate priority.

At the workshop, almost none of the experts saw the need to establish thematic sub-programmes due to the large additional burden to design a programme apart. In the on-going programming process, the administrations are already occupied with preparation of the new regular RDPs. In Italy, and in the next programme period also in France, several regional programmes are implemented which are adapted to the regional needs, so that there is no scope for additional sub-programmes. Even it was criticised that potentially multifunctional measures would be grouped into sub-programmes with only one objective. For example, measures for improving nutrient cycling in Finland are both addressing water quality and climate change mitigation.

All useful measure combinations described in this section (particularly section "Examples of combinations of measures with a focus on climate change" and Annex II) can be used in thematic-sub-programmes. The difference is that a 10% higher co-financing rate is attributed to thematic sub-programmes and that a specific budget is allocated to it. However, in the considered RD programmes, no examples of potential sub-programmes are suggested in this project. The associated additional work load and insufficient incentives impede the adoption of this new feature which should be reviewed for its additional benefits and necessity.

Examples of combinations of measures with a focus on climate change

Several examples for how measures with a focus on climate objectives can be combined were obtained from the questionnaires. These are presented in Table 6 and Table 7 below.

Table 6. Possible climate-focused combinations of measures from the programming period 2007-2013

Measure 1	Measure 2, 3…	Explanation
Agri-environment measures (214)	Slurry/manure management measures to improve the transport, storage and application of manure (e.g.121) Advisory services and training (111) Non-productive investments (216 and 227)	Agri-environment measures can be reasonably combined with several measures to increase their effectiveness. This could be investments in manure storage and application in order to cover the whole "manure chain". Also, combinations with training and advice or with non-productive investments can have synergies.
Investments in irrigation technologies (121)	Promotion of water use efficiency by farmers (111)	The combination of these measures increases the effectiveness of improved technologies by optimizing the water saving potential and support a targeted water use. Besides investment support the correct use of the new technologies is included.
Promotion of water use efficiency by farmers (111)	Legume rich pastures for carbon sequestration	This combination links the improvement of physical (technological) and human capital in farming with efficiency on the use of water (adaptation) and promotes carbon sequestration through the use of Permanent pastures rich in legumes. Therefore, climate mitigation and adaptation are considered from different starting points.

Table 7. Possible climate-focused combinations of measures planned for the programming period 2014 - 2020

Measure 1	Measure 2, 3…	Explanation
Land management Programme (Art. 28)	Farm business improvement scheme (Art. 17)	Capital support for drainage or advanced slurry spreading systems may be dependent on the applicant's participation in the Land Management Programme (either from the outset or later). This is to ensure that the capital investment is directed towards those who will derive most benefit from it, thus ensuring maximum impact of RDP support.
Business development groups (Art. 14)	EIP operational groups/ pilot projects/ demonstration projects (Art. 35) (see also Chapter 5)	This combination envisages that participants in Business Development Groups may develop into an EIP and then potentially take part in a Pilot project or Demonstration project. Such projects can address on-farm mitigation technologies or renewable energy.

Further examples for combining measures were identified in collaboration with the other Tasks of the projects related to LEADER projects and joint actions (see Chapter 4 and 5). A possible example for combined measure implementation related to joint action is the restoration of wetlands as it often requires a variety of activities, such as the extensification of land use, deconstruction of drainage systems, the rewetting of land (e.g. through extensive grazing) and land consolidation via purchase of land and/or leasing. Further the participation and collaboration of different actors such as Water and Land Associations, land owners (municipalities, forest authorities, Foundation for Nature Conservation, private owners), administration for agriculture, water and nature conservation is necessary.

Experiences with collective action for wetland restoration were obtained in the Eider valley in Germany. There, the Water and Land Association undertakes negotiations with land owners in order to purchase land. The land will be rewetted and drainage systems are deconstructed. Several farmers and land owners work together and use this land for collective extensive pasture management. Special breeds for selective grazing are used and thus enhance biodiversity (OECD, 2013b).

In principle, the LEADER instrument can also be combined with other RD measures. The screening of 2007 – 2013 LEADER projects (see in particular Annex 3) illustrates that some LEADER local action groups (LAGs) administered projects which drew on other RD measures to implement activities. In Italy, for example, the LAG coordinating the Est Sesia project provided a mobilising and animation role to improve the irrigation network whereby an Irrigation Association obtained funding through Measure 125a (water management and protection of irrigated land). In future, LAGs can continue to mobilise community-led projects which could also include climate actions such as carbon audits for farms, or establishment and management of shelterbelts and hedges (linked to recreational goals) (see also Annex 4).

Further possible combinations of measures including brief explanations which refer mainly to the Technical Fiches are presented in Annex 2.

Guidelines for how to identify effective measure combinations

The following box contains recommendations on how to identify potentially effective combinations. These guiding notes address the most important aspects that need to be considered when planning a combination of measures to enable its effective implementation.

Box 1: Guidelines for the identification of effective measure combinations

- *Identify the additional benefit of a combined implementation of measures for climate actions compared to single measures. The logic behind the combination has to be clearly defined.*
- *Measures have to be complementary. The synergies and expected benefits as well as potential barriers and disadvantages for measure combinations have to be considered.*
- *Define the adequate level for the measure combination (e.g. RD programme, sub-programmes, single or multiple beneficiaries, regional or local level).*
- *Decide on compulsory or voluntary measure packages: examine if it is more useful to establish the measure combination on a voluntary basis depending on the particular case or obligatory as a part of a "package". If two measures do not make sense as stand-alone measures, an obligatory combination is recommended. However, in some cases an obligation could decrease the acceptance and thereby the application of a measure. Voluntary combinations leave more flexibility and may be more suitable for differing conditions. In case of voluntary combinations, providing beneficiaries with the capacity for the selection of beneficial measure combinations would be essential (e.g. by training or use of carbon navigators).*
- *Assess the impacts on programming of the combined implementation of measures: If the combination is associated with high additional programming and administration efforts it might not be advisable to consider it (e.g. avoid double counting and exclude overcompensation or overlapping support).*
- *Reflect on capacities associated with a potentially higher uptake due to the combination of measures (e.g. advisory services, knowledge transfer, and training). The sufficient amount of service providers (e.g. public or private agencies) with adequate knowledge on measure combinations need to be available.*

Concluding remarks

In a wide sense, RDPs include a toolbox of measures which can be combined as needed. Combining measures according to the strict definition of the EU COM, as an obligatory “package”, or thematic sub-programmes require more administrative effort for programming and implementation. The Member State experts consulted see the need for programming complementary measures, but are reluctant to impose obligatory links between the measures, or to establish thematic sub-programmes. They prefer instead to keep combinations of commitments voluntary, so that beneficiaries have flexibility to choose appropriate measures.

Nevertheless, synergies and complementarities between measures can be realized also when measures are less strictly combined. For this, the design of the single measures should allow for more flexible and voluntary combinations, and the implementation of appropriate combinations should be explained and encouraged. It has to be considered that some measures do exclude each other and should not be combined with each other, e.g. in order to avoid the risk of double counting and double support.

Some measures, such as advice and training activities, can be reasonably combined with several other measures and should therefore always be considered for a combined implementation. Another key measure for climate change mitigation is the "Carbon audit", which provides an initial analysis of potential mitigation activities at farm level and can then be combined with several other measures.

4. Addressing climate action through the LEADER Instrument

Background

The 2014 – 2020 EARFD Regulation places an increased emphasis on flexibility, cooperation, innovation, and facilitating of action at a broader landscape level, beyond the individual farm holdings. This provides further opportunities to support coordinated climate actions and increase their effectiveness both for adaptation and mitigation, enhancing the provision of public goods and effective climate responses. Mutual learning and capacity building also arise as important benefits of cooperation.

The predicted impacts of climate change will meet differing existing capacities of EU Member States and regions to respond to these impacts, and there is also variation in opportunities across regions to contribute to mitigation in rural areas. The opportunities for collective action under the LEADER instrument and Cooperation measure, can be used to build capacities, collaborative initiatives and responses by rural communities, all of which can in turn contribute to climate abatement as well as increase resilience to climate change at community and regional levels. In this chapter, we examine how the LEADER instrument has been and can be further used to promote climate action, whereas chapter 5 examines opportunities for joint climate actions under the Cooperation measure.

The LEADER approach focuses on bottom-up community-led innovation through the development and implementation of local development strategies by local actors. The LEADER approach is well-established across Member States and has been proven to be effective in stimulating innovative activities. LEADER enables the development of joint initiatives and pilot type projects which are not possible under other RD measures, except for the Cooperation measure. The EAFRD Regulation stipulates that a minimum of 5% of RDP spending has to be allocated to LEADER. This approach thus represents an important instrument through which innovative climate action can be supported.

In the LEADER approach, Local Action Groups (LAGs) have the freedom to identify the key issues and how they wish to address them in their local development strategies (LDSs). The Managing Authorities set out the framework for the type of content that development strategies have to contain, conditions for operating LAGs, as well as the criteria for selecting LAGs which can receive LEADER funding. However, within this framework the LAGs have the flexibility to address local or regional problems that they deem most relevant in their context. The flexibility that local actors have in developing the LDS and projects means that the approach is less prescriptive than other RD measures such as the agri-environment-climate measure.

For the 2014 – 2020 period, the LEADER approach is situated as one element of the Community Led Local Development (CLLD) concept. In addition to LEADER LAGs, the Common Provisions Regulation (No. 1303/2013) sets out the possibility of local action groups linked to the other EU Funds, and there is potential for existing LEADER LAGs to act as local action groups within a broader, coordinated approach for the use of EU Funds.

In this chapter, we first outline the method for how existing climate focused projects for the 2007 – 2013 period were identified, followed by an overview of the main characteristics of the projects included in the 2007 -2013 LEADER project database (Annex 6) and selected best practice examples (Annex 3). We then examine the key challenges that need to be addressed to increase the role of climate action in LEADER in 2014-2020, and give an overview of the guidance that is contained in Annex 4.

Identifying climate-focused LEADER projects from 2007 – 2013 - method

In order to illustrate the opportunities for supporting climate action through the LEADER instrument, a screening of climate-focused LEADER projects in the 2007 – 2013 programming period was first undertaken. A project database of climate-focused LEADER projects was compiled. Drawing on this database, best practice examples were identified and described according to selected criteria (see Annex 3).

A comprehensive screening of LEADER projects at MS level was beyond the scope of this project due to limited resources as well as the fact that information on funded LEADER projects is often only partial and dispersed across many different information sources (for example, some MS have publicly available databases of best practice examples, while others do not, and where such databases exist they only present a selection of projects).

The overview of the method used to identify LEADER projects and to develop descriptions of LEADER best practice examples is summarized in Figure 6. The individual steps are explained below.

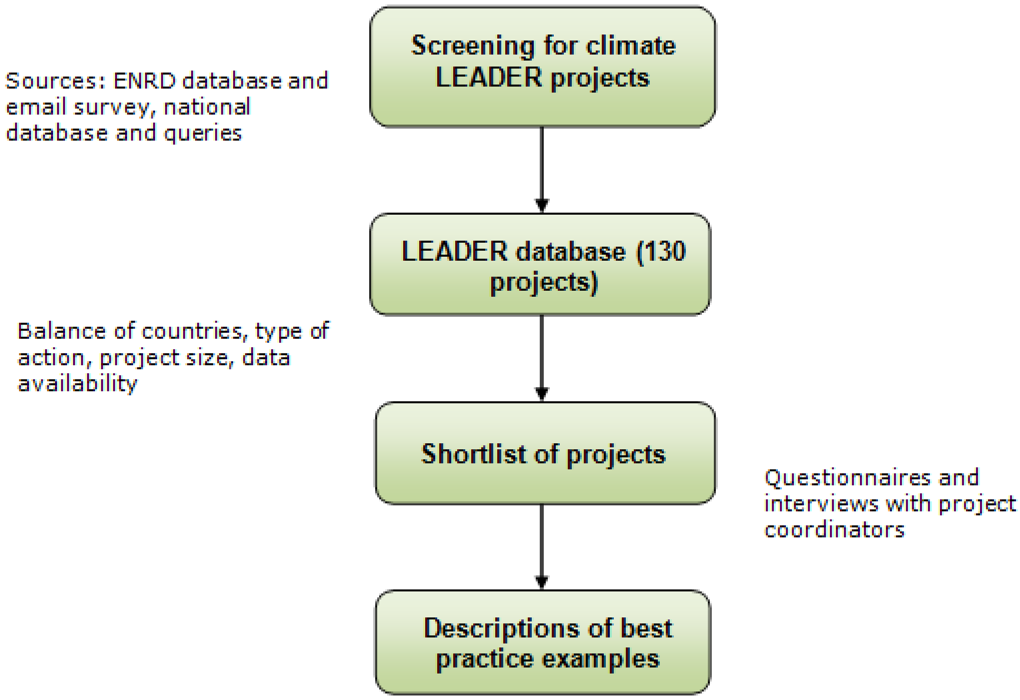

Figure 6: Overview of method for developing best practice LEADER examples

Screening for LEADER projects

In order to identify existing 2007 – 2013 LEADER projects, various information sources were used, including:

- Examples of best practice LEADER projects highlighted in the ENRD publications and project profiles available in the RDP database (http://enrd.ec.europa.eu/)
- National RDP / LEADER databases (e.g. Germany and Austria)

- Examples identified by the consortium partners and external experts in their respective countries (by consulting Managing Authorities, national rural development networks, and published materials)
- Email survey administered through the ENRD national contact points
- Inputs from participants at the project workshop

A project specific database of LEADER projects from 2007-2013 was compiled with short project profiles, and categorised according to focus areas relevant to climate change mitigation and adaptation. In this database, a total of 130 climate focused projects were included. The list of projects that were included in the database with some key characteristics of these projects (and contacts where available) can be found in Annex 6.

Shortlist of projects

From the long list of projects in the database, a shortlist was developed using the following criteria:

- Balance of country & agro-climatic zones
- Balance of categories of action (primary focus area)
- Balance of mitigation and adaptation, and different types of actions
- Data availability (clear contacts)
- Innovation aspects and range of types of activities supported
- Project size

Develop project descriptions

A questionnaire was developed to gather information on shortlisted projects. Some information on projects was available through project leaflets, or even websites; however, in many cases only very basic project characteristics were available so that the questionnaire was the primary source of information. Project coordinators were contacted and asked to fill out the questionnaire, and in most cases the questionnaires were followed up by phone interviews to clarify uncertainties or open questions.

An example of the Cheviot Futures project description was presented at the project workshop in Brussels where feedback was obtained on the content and presentation features.

Climate action in LEADER projects from 2007 – 2013

The LEADER climate action projects identified from the 2007 – 2013 programming period include 130 projects. The projects were compiled in a database and categorised according to thematic areas, country, project title, objectives, activities, mitigation and adaptation elements, and contact information. The thematic areas of the climate action projects include:

- Afforestation
- Agroforestry
- Capacity Building

- Energy Efficiency
- Forest Fire Prevention
- Forest Management
- Landscape / Resource Efficiency
- Nature Conservation
- Recycling
- Renewable Energy
- Tourism / Local Economy
- Water

Figure 7 below shows the distribution of projects across the thematic areas.

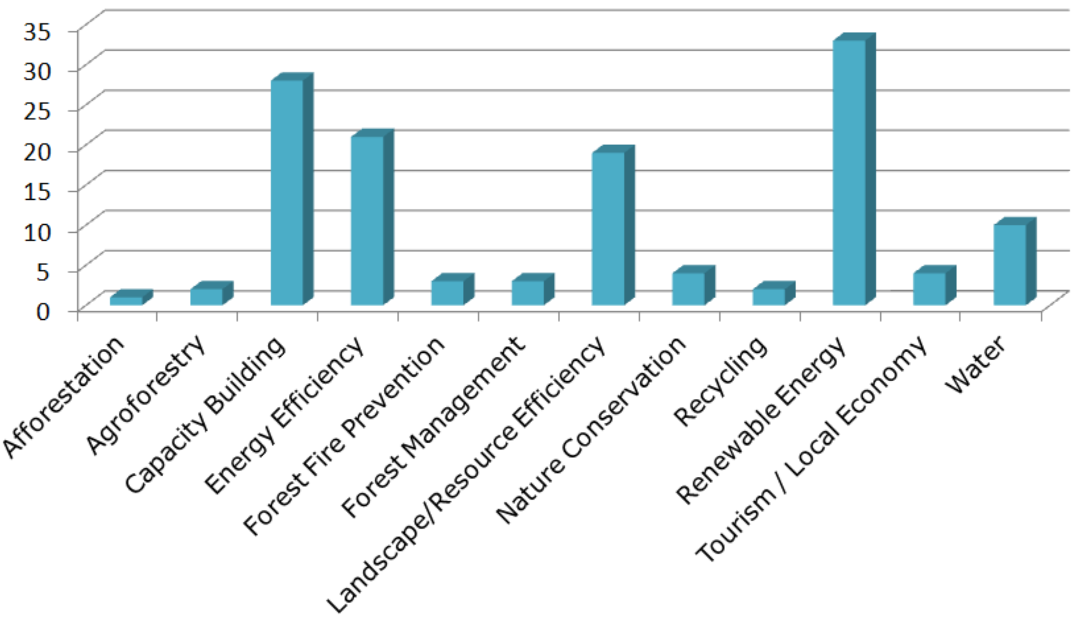

Figure 7: Number of LEADER projects in the database per thematic area

The identified climate action projects were distributed across the EU, although they were geographically spread unevenly amongst the Member States. There are fewer climate action projects within the Eastern European countries. Some countries are better represented due to assistance provided by in-country contacts and access to resources (brochures etc) available online. Figure 8 below shows the distribution of projects across the Member States.

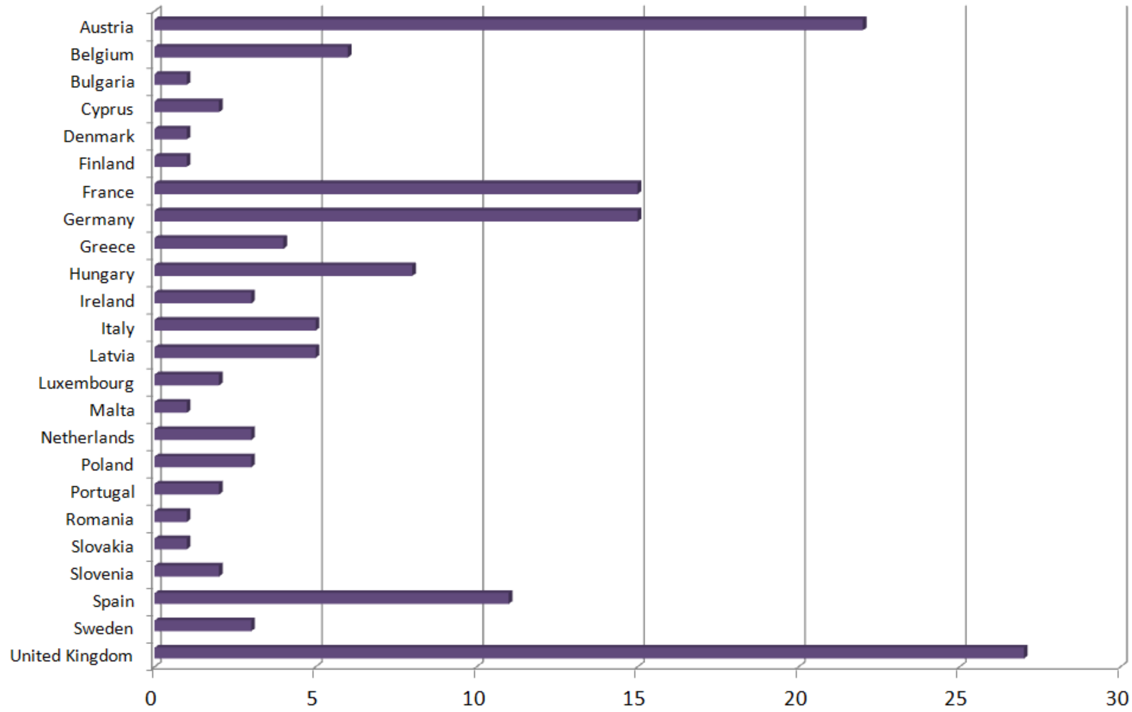

Figure 8: Distribution of LEADER projects in the database per Member State

The long list of projects in the LEADER database was narrowed down and 20 projects coordinators were contacted with questionnaires. Table 8 below lists the 14 LEADER projects for which detailed descriptions were prepared (see Annex 3), including the country where they were implemented and their thematic area.

Table 8. Best practice examples of LEADER climate action projects from 2007 – 2013 included in Annex 3

Thematic area	LEADER project	Country
Capacity Building	Carbon Buster Clusters Project	UK
Capacity Building	Cheviot Futures - United in a Changing Rural Landscape	UK
Renewable Energy – Agricultural Waste	CO_2 Recycling – Climate Protection through Soil, Humus, and Habitat Management	Austria
Capacity Building	Creating CSmart Organisations	UK
Renewable Energy	The Hungarian Virtual Micronetwork Balance Circle Cluster – "1 Village – 1 MW"	Hungary
Agroforestry	Zala Termálvölgye Association: Local Traditional Orchard Program for Sustainable Agriculture	Hungary
Water	Est Sesia – Maintenance works for the improvement of water infrastructures at Sartirana, Cavo Corsica	Italy
Forest Management	OFT "Forestry Organisation of the Territory"	Italy
Agroforestry	L'arbre en Champ – Agro-forestry Audit on	Joint Project –

Thematic area	LEADER project	Country
	the Farm and Mobilisation of Innovative Models	France and Belgium
Landscape / Resource Efficiency	Connection Runde – Integrating peat restoration and protection with river restoration in Southeast Drenthe	Netherlands
Renewable Energy – Solar Energy	Solar panels for farmers in Northeast Overijssel	Netherlands
Renewable Energy	Texel Energie	Netherlands
Energy Efficiency	Development of a local energy management for the LEADER region 'Westlausitz'	Germany
Renewable Energy	‘Shadows and Sun’ and ‘Catching the Sun’ – Improving the use of renewable energy	Slovenia

Questionnaires were sent to the various projects to gain more detailed information about the project’s development, implementation, and results. The topics covered in the questionnaires were:

- Project description and background
- Objectives and drivers
- Links to local development strategy(ies)
- Funding
- Outputs
- Benefits (including mitigation, adaptation, socio-economic, and other environmental benefits)
- Actors
- Success factors and barriers
- Project as initiator of future activities in the region

Completed questionnaires as well as additional project reports, evaluations, brochures, and project information were reviewed and individual project descriptions were drafted in the form of project factsheets. Annex 3 contains factsheets of LEADER projects which describe the above information for each best practice example.

Table 9. Overview of climate focused themes and activities in LEADER 2007-2013

Area	Examples of project activities
Renewable Energy	▪ Community emission reduction and/or renewable energy development plans ▪ Zero-carbon-footprint plans (potentially sector-specific, such as transport) ▪ Collective organisation of renewable energy supply and energy cooperatives ▪ Feasibility studies to determine local capacities and cost-benefit analyses ▪ Installation of new renewable energy systems ▪ Community biomass barter system (delivery of biomass to central location in exchange for alternate forms of compensation)

Area	Examples of project activities
	▪ Community renewable energy fund which is revenue generating and helps increase access to renewable energy systems for local stakeholders ▪ Collective biogas / biomass plant ▪ Reducing waste through alternative uses, e.g., biomass energy generation
Capacity Building	▪ Educational programmes on climate change for schools ▪ Carbon footprinting for businesses and organisations ▪ Carbon management action plans ▪ Community / stakeholder workshops for climate awareness raising ▪ Resilience planning ▪ Audits to determine where climate actions could lower emissions ▪ Site visits to demonstrate climate actions by local actors ▪ Support for future LEADER project developers in developing applications
Energy Efficiency	▪ Installing additional insulation in buildings ▪ Upgrading energy equipment (e.g., heat pumps) ▪ Analyses to identify carbon losses ▪ Community schemes to increase low-carbon behaviours (e.g., mobile phone scheme to promote car sharing) ▪ Substituting energy efficient light bulbs in all public buildings
Landscape/ Resource Efficiency	▪ Adaptation / resilience-building through land management planning ▪ Flood risk management plans ▪ Increasing coordination between local stakeholders for reduced landscape fragmentation and sustainable management ▪ Encouraged planting of traditional cultivars ▪ Restoration of peatlands / wetlands ▪ Native tree planting ▪ Enhancement of depleted agricultural soils for increased humus content and carbon sequestration potential
Water	▪ Irrigation infrastructure improvements ▪ Improvement of water availability and quality through improved landscape management (e.g., natural filtration through restored wetlands) ▪ Waste water storage in reservoirs or disposal in forests for filtration ▪ Feasibility study for how to raise groundwater table ▪ Capacity building for stakeholders to comply with WFD ▪ Small-scale financing for equipment, e.g., upgrade to drip irrigation systems ▪ Restoring riverbanks for improved water quality / reduced erosion
Nature Conservation	▪ Habitat restoration ▪ Reintroduction of hedges ▪ New equipment to improve the biological and ecological condition of lakes ▪ Encouraging stakeholders to visit nature sites to increase understanding and dedication to protection
Tourism/ Local	▪ Restoration of local resources to enhance recreational opportunities ▪ Revitalising rural areas for increased tourism as well as climate change

Area	**Examples of project activities**
Economy	response and resilience (energy efficiency / self-sufficiency as well as increased carbon sequestration potential) ▪ Revitalising rural areas to avoid abandonment and landscape degradation ▪ Implementation of collective food processing facilities for reduced external reliance (reduced emissions from local sourcing) ▪ Enhancing local markets through producer and area promotion ▪ Coordination of local supply chains for reduced emissions and enhanced production / sale potential
Afforestation	▪ Support in establishing new forest and determining appropriate composition according to local conditions
Agroforestry	▪ Training to increase uptake of agroforestry on farms ▪ Diversification of local farming businesses ▪ Increased carbon sequestration through above- and below-ground biomass
Forest Fire Prevention	▪ Wildfire prevention and response plans ▪ Network of infrastructure to aid with fire extinguishing ▪ Creation of fire barriers, new and restoration of old fire trails ▪ Separation of combustible forest materials ▪ Reconstruction of reservoirs to address increasing forest fire events
Forest Management	▪ Coordinated schemes to improve forest management and habitats ▪ Training programmes for forest owners to increase capacity and knowledge ▪ Community coordination to identify disease and prevent tree infection
Recycling	▪ Closing CO_2 cycles through reduced waste and reuse ▪ Feasibility studies to identify capacities for a recycling programme ▪ Green waste collection and composting ▪ Zero-waste planning for communities

As seen above, a wide range of different types of themes and projects are possible for integrating climate action into LEADER projects. Best practice examples of LEADER projects which include a climate action element exemplify these various project activities (see Annex 3). However, projects vary in terms of whether climate is the main focus of the project or a driving factor behind creation of the project, as opposed to one of several issues addressed by the project.

The best practice examples of Carbon Buster Clusters, Cheviot Futures, CSmart Organisations, 1 Village 1 MW, Solar Panels, Texel Energie, and Westlausitz all include climate as a key element in the project design. Carbon Buster Clusters and CSmart Organisations aimed at raising awareness and capacity on climate issues within the local populations, whether school children and the surrounding communities or local businesses in terms of lowering their carbon footprint / increasing their energy efficiency. Two Dutch projects, Solar Panels and Texel Energie, focused on renewable energy development within the local regions and were initiated in response to climate change issues. The Slovenian project targeted renewable energy uptake by the local population, utilising a collective working group format for the solar panel installation as well as raising awareness about the biomass potential in the region. Additionally, the 1 Village 1 MW project from Hungary involved multiple installations of new renewable energy equipment in order to increase the energy self-sufficiency of the local region, which was influenced by a long-term climate perspective. The Westlausitz project from Germany also aimed to increase energy self-sufficiency for the region, but rather through local energy efficiency plans, coordinated improvements for energy efficiency, and increased uptake of renewable energies. Finally, Cheviot Futures was a site-specific project developed in response to climate change in order to increase adaptation capacity and resilience for the local area.

In contrast, the best practice examples in Annex 3 also contain projects which integrate climate action as a side element. CO_2 Recycling specifically focuses on climate mitigation through reusing green waste, but a major element is also the use of compost made from such green waste for enhancement of the local soil humus quality. Additionally, the joint French and Belgian project L'arbre en Champ, OFT "Forestry Organisation of the Territory" project from Italy, and the Hungarian Local Traditional Orchard Programme contribute to climate change mitigation by the local area through agroforestry encouragement. These climate benefits are sought in addition to local economic benefits (e.g., fruit processing), environmental benefits (e.g., habitat restoration), and cultural/heritage benefits (e.g., re-establishment of the traditional mosaic landscape), as well as utilising a cooperative approach to landscape management and project implementation. The Est Sesia project from Italy contributes to climate adaptation through improved irrigation infrastructure in response to increasing water scarcity concerns, as well as the Connection Runde project from the Netherlands providing climate mitigation benefits through restoration of a peat stream. However, the additional focuses of the latter project were to improve the local natural resources and increase recreational use / opportunities associated with those resources, thereby improving the local quality of life.

The extent to which Member States and regions have already integrated climate action into LEADER differs widely. For example, in the UK, Germany, Austria, France, and the Netherlands there are many projects which have a specific climate action element. In other regions it is a less visible part of this approach. There is potential to learn from those who have already made valuable experiences, and the best practice examples (see Annex 3 as well as Annex 6) provide a useful starting point. In particular, the UK has many examples of successful capacity building projects to raise awareness about climate change. Germany and Austria both have many projects in which regional or community-based renewable energy plans have been developed. France provides good examples of natural resource management and/or restoration projects which could be used as models for future LEADER project development within this thematic area. In general, the search for climate action LEADER projects as well as the feedback received during the break-out LEADER session of the project workshop in Brussels indicated that LEADER projects in Eastern European countries do not integrate climate into the project objectives.

In addition to the above examples which demonstrate potential project aims and activities as well as the multiple different benefits resulting from projects which include climate objectives, there were key success factors identified for the best practice examples. Recognition of these factors in the design of future climate action LEADER projects would help to roll out or mainstream climate uptake under the LEADER programme. Key success factors for climate action LEADER projects from the 2007-2013 programming period included:

- Local stakeholder support through participation in project design and raising awareness of the multiple benefits available from climate action projects
- Staff dedicated to implementation of the project rather than strictly on a voluntary basis
- Elimination of administrative barriers
- Technical training available for implementation of the project activities as well as advice and support from local expert

Climate action in LEADER projects in 2014 – 2020

The range of LEADER projects that we identified for the 2007 – 2013 period and their different thematic areas illustrate the opportunities of the LEADER instrument for promoting climate activities. While it was not possible to estimate the share of climate action projects in the pool of all LEADER projects, the screening exercise showed that climate focused projects were more easily identified in a few countries where climate in LEADER seems to have a higher presence (e.g. UK, Germany, Austria). The geographic skewedness of the results is partially a reflection of how publicly visible climate focused-LEADER projects are. The discussion with practitioners at the Brussels workshop confirmed that climate topics did not feature strongly in LEADER in the previous programming period. This in turn suggests that there is still room to improve the presence of climate topics in the LEADER instrument.

In developing guidance on how climate action could be further supported through the LEADER instrument in the 2014 – 2020, we drew on the insights from the project database and the best practice examples. In addition, selected expert interviews were conducted to gather experiences from practitioners. The project workshop in Brussels offered an additional opportunity to discuss how to promote climate action in future LEADER implementation, highlighting a number of barriers as well as possible solutions for the 2014-2020 LEADER programming period.

Based on the interviews conducted with LEADER project coordinators, other experts, and feedback obtained from the workshop, the project identified significant challenges that need to be addressed in order to further develop climate activities in LEADER:

- Traditionally, the emphasis of LEADER projects has been on diversification of rural economies, creation of jobs, protection of natural heritage, and there was a perception among practitioners at the workshop that climate action is not a big issue for LEADER and may not fit well within this instrument. However, the best practice examples in Annex 3 illustrate that climate focused LEADER projects can have positive effects in terms of job creation, social and cultural heritage and natural heritage. The challenge is to elucidate more clearly the links between climate action and rural economies and the protection of local heritage.
- LEADER is designed to be a bottom-up programme responding to contextually specific local needs. The local action groups (LAGs) perform SWOT analyses, uncover local needs which are incorporated into their local development strategies (LDS), and LEADER projects are designed to address those needs. If climate is not identified as a priority need by the LAG, then the RDP does not force that issue to be included in the LDS. Additionally, the RDP sets objectives for the LEADER programme, but if climate is incorporated later after the LDS has been designed, it may be too late.
- There is a lack of a clear idea for how climate can be promoted through LEADER. In absence of climate action being an explicit objective of LDSs, climate action within LEADER projects only has the possibility to be a "side effect" rather than a priority focus.
- While it would be more effective for climate to be an explicit objective, the restrictions on delivering on this need to be recognised given the advanced stage of programming for RDPs 2014 – 2020, and complementary tools used (e.g. promotion, knowledge exchange). Member States have already begun the preparation phase for 2014-2020. Although the objectives for the national LEADER frameworks are already being determined, the objectives could be reviewed if there is a mid-term review of CAP, and options can be explored for

how to update the LEADER preparatory materials to incorporate climate dimensions.

- Because of the traditional focus on rural economies, quality of life and economic diversification, practitioners at the workshop stressed that there is also limited awareness or understanding among LAGs on how climate action can be done through LEADER. Increased awareness of opportunities for climate action through LEADER is required (including on 'how to do climate projects') and there is a need for climate action to be accepted and for LAGs to take ownership of climate challenges. Communicating the multiple benefits of climate action projects and establishing training and awareness raising for LAGs can increase climate action in LEADER projects.
- More broadly, an overall holistic shift is required from the top-down regulation in order to increase the visibility and priority given to climate issues in LEADER. Because the LEADER approach is focused on bottom-up action, Managing Authorities can only guide and encourage Local action groups (LAGs) while allowing the flexibility and autonomy of LAGs to respond to their context-specific challenges.
- A balance needs to be struck that respects the basic mandate and principles of LEADER yet enables better promotion of climate objectives. Since all RDP funding needs to contribute to the horizontal objectives of mitigation and adaptation this should in principle be implicit in LEADER mechanisms that are put in place. Managing Authorities have some tools at their disposal. Nonetheless, how to make effective use of these tools is a challenge.

Annex 4 outlines some ideas for how climate action could be further supported through the LEADER instrument. First, Managing Authorities could take a number of steps to support LAGs to address climate action in local development strategies and LEADER are presented:

- MAs can promote the inclusion of climate action in local development strategies by highlighting climate action as a thematic focus area in their national LEADER rules, setting quantitative targets for climate action (earmarking funds, establishing a reward system for LAGs addressing climate), as well as introducing climate proofing criteria for LDS and LEADER projects and monitor how climate action is addressed by projects.
- MAs can provide different forms of technical guidance for LAGs, specifically by disseminating examples of how climate action can be integrated in LDS objectives, and incorporating climate change topics in national training and experience sharing for LAGs.

Second, in terms of technical guidance, an especially relevant area to address is the contribution of climate action to rural economy and social development in rural areas. The MAs can demonstrate to LAGs how LEADER climate action can be an opportunity and also contribute to social development, and Annex 4 points to the main types of economic and social benefits from LEADER, as well as the types of indicators that can be used to monitor the benefits of LEADER projects.

Finally, Annex 4 also gives an overview of the types of topics which can be supported by LEADER in the future. What is innovative for a particular region and LAG depends on the already existing initiatives, resources, and conditions in the region. Given the disparity in how much climate topics have been addressed by LEADER so far in different MS, the choice of most appropriate topics will differ. There is, however, much room across the MS for LEADER to address systematically the planning and implementation of adaptation activities. It may also be easier for local communities to see how adaptation activities fit with the more traditional LEADER objectives of economic and social development. In terms of mitigation activities, in addition to topics of renewable energies and low carbon mobility concepts, energy efficiency, and capacity building for mitigation, there is potential to support newer topics such as those outlined in Annex 1 (Technical Fiches), in particular on carbon audits for farms and businesses, Shelterbelts and hedges (linked to recreational goals), and restoration of wetlands.

Concluding remarks

The LEADER approach has proven to be effective for stimulating bottom-up and innovative activities, and can contribute to climate actions as illustrated in this chapter as well as Annex 3, 4 and 6. Our review of LEADER projects from the 2007-2013 period indicates that LEADER has supported different types of climate actions, focusing more on capacity building, renewable energies, and energy efficiency. There has, however, been limited focus on explicit adaptation activities. The LEADER project factsheets also illustrate that climate action under LEADER have already delivered concrete benefits beyond climate mitigation and adaptation also for rural economies, social development and rural quality of life (see Annex 3 project factsheets). There is nonetheless further potential to increase climate action under LEADER, and several challenges that need to be addressed in realising the potential of LEADER for climate mitigation and adaptation. Managing Authorities can play an important role in increasing the role of climate action in local development strategies and LEADER projects by how they administer the LEADER instrument and by providing technical guidance to LAGs, and increasing experience sharing and knowledge exchange. LEADER can continue to mobilise low carbon initiatives in rural areas through capacity building for carbon consciousness among rural population and rural business and low carbon planning activities (including, for example, audits). It can directly also support the types of innovative actions outlined in Annex 1. In addition, more emphasis can be placed on adaptation activities under LEADER which can lead to increased awareness of climate change predictions, vulnerabilities, and adaptation options, contribute to establishing local strategies and action plans for adaptations, and select and support the implementation of adaptation options.

5. Climate Action under the Cooperation Measure

Background

The scope and ambition for joint actions have been expanded under the *Cooperation measure* (Article 35) for the 2014-2020 programming period. Joint actions are defined as involving at least two entities and the measure can also be combined with other measures. The joint actions can directly address mitigation and adaptation to climate change.

This Cooperation Measure offers the opportunity for setting-up cooperation groups but also for implementing projects. It offers the possibility for implementing pilot projects, and testing solutions to specific/localised problems. The Cooperation Measure can be used as a testing ground to analyse a specific climate-focused problem and identify mitigation and/or adaptation solutions by bringing together a range of stakeholders, including advisors, farmers, researchers, the industry, local communities, municipalities, and environmental agencies. The solutions can be tested on the ground, practical experience can be gained, and the solutions can then be applied broadly using other RD measures such as the agri-environment-climate measure.

Collective approaches to agri-environment and in particular climate issues, where several farmers cooperate in achieving a certain objective, have not been widely implemented until now (Franks and McGloin, 2007). However, these approaches have been recognised to offer a number of advantages for delivering environmental benefits, in particular for projects which require landscape level action such as development of green infrastructure or increasing flooding resilience (OECD 2013b). For example, in Tuscany, voluntary agreements between local government and a group of mountain farmers facilitated effective responses to increase resilience to flooding through better hydrogeological management and improvement of landscapes (Vanni 2013). The Farming for a Better Climate initiative in Scotland has facilitated effective knowledge exchange and problem solving for farm level mitigation through creation of farmer-led focus groups.

Joint actions enable opportunities to increase the scale and extent of climate mitigation and adaptation impacts through joint planning, design, and financing structures. There are risks associated with this implementation method though, such as issues regarding efficiency, transparency, and stakeholder participation, which need to be considered in order to design effective new and innovative operations (Davies et al. 2004).

For this task, a literature review was conducted, and practitioners were consulted at the workshop and through interviews. In this chapter, the process used to identify the potential climate topics that could be supported under the Cooperation Measure are explained, which includes our understanding of the differences and similarities between the LEADER and the Cooperation Measure. Moreover, an overview of the types of topics that can be supported under the Cooperation Measure is given.

Identifying potential climate-focused topics for joint actions

In Annex 5, we elaborate examples of climate focused topics that can be pursued through joint actions under the Cooperation Measure (Art.35).

The potential examples of joint actions were identified by drawing on the experiences in preparing technical fiches, the guidance on combinations of measures, as well as the work on LEADER projects. The topics for joint actions are being proposed that meet the following criteria:

- Are well suited to collective action
- There is a strong added value for climate mitigation and adaptation from pursuing the action through joint initiatives
- There is not yet sufficient experience or clarity on particular mitigation or adaptation measures so that the topic is not yet suitable for implementation, but rather needs to be first pursued through pilot projects

Five potential topics are elaborated in more details, including:

- Rationale and objectives for the joint action
- Potential actors
- Types of activities that can be supported
- Expected impact on mitigation and/or adaptation
- Combinations with other RDP measures

This list of potential topics needs to be seen as illustrative, rather than conclusive.

Demarcation between LEADER and the Cooperation Measure

To a certain degree, both the LEADER instrument and the Cooperation measure can support similar types of themes and activities. Both of these measures enable joint and collaborative activities, and the requirements in the EAFRD Regulation leave flexibility to Member States and regional / local communities to use these measures in the most relevant way given their contexts. The inherent flexibility built into the measures is a major strength of both measures. There are, nevertheless, some differences in the way the measures are set up, in particular their starting point. The starting point for LEADER are local development strategies and territorial cooperation, whereas the starting point for the Cooperation measure is co-operation that is more sector-specific or thematically narrow.

The LEADER approach is traditionally focused on territorial (and within a given territory cross-sectoral) or inter-territorial cooperation, and projects need to respond directly to local development strategies. Since the Cooperation Measure does not require a direct link with a territorial development strategy, it in a way allows more flexibility for climate action. If LDS do not incorporate climate action as explicit objectives, the Cooperation Measure can in principle be used in place. However, this requires that the Member State approach to implementing the Cooperation Measure incorporates a climate focus.

The range of project sizes that can be supported by LEADER is significant. LEADER could support very small projects, for example with size of less than 10,000 Euros and lasting only a couple of months, to large projects (for example, 400,000 Euros) and lasting over several years. In principle, there is no lower limit for joint actions under the Cooperation Measure, so very small projects could also be supported, although the types of actors that may have access to LEADER (through local communities) may not be able as easily able to access Cooperation Measure funding.

Due to its traditional focus, LEADER can be applied well for capacity building for communities and for cross-sectoral initiatives which have a direct link to economic development and rural quality of life. In terms of underutilised yet highly relevant topics, LEADER is particularly well suited for capacity building for adaptation at local community level since climate impacts have significant implications for economic development across sectors.

The Cooperation Measure can be effectively used for actions explicitly focusing on climate mitigation through improved resource efficiency or landscape level projects addressing both mitigation and adaptation, which can also have a strong link to economic development and quality of life (e.g. through provision of opportunities for tourism). The Cooperation Measure is well suited for pilot projects for agri-environment-climate schemes, or the development of climate audit tools for farms which can be applied across the whole country. These may otherwise be more difficult to tie to a particular LDS. The Cooperation Measure also appears more suitable for linking research and practice on specific, narrower, in particular on agri-environment-climate approaches and resource efficiency enabling the testing and transfer of possible solutions, technical approaches, which may not yet be suitable to be funded under the other RD measures. The Cooperation Measure can be used to set up collective actions for delivery of environmental services at landscape level which have a climate focus or component and projects focusing on resource efficiency.

The two measures could be combined. The LAGs can apply for joint action funding to implement their objectives. Moreover, existing LEADER networks (including existing LAGs) can be used strategically to reduce the administrative effort and increase the stakeholder buy-in needed to develop joint actions. This is particularly relevant for joint actions aimed at delivering environmental and climate services at landscape level (whether included in or independent from local development strategies). These projects which target issues potentially spanning multiple LAG areas and requiring coordinated rather than isolated responses could build on the organisational network already mobilised by LEADER.

Testing and implementing new and collective methods for climate actions

Examples of the types of joint actions that can address climate objectives include:

- Establishment of cooperatives for sharing of equipment that facilitates improved nitrogen or soil management
- Climate action networks which facilitate peer-to-peer learning and exchange of information
- Establishment and operation of operational groups of European Innovation Partnership (EIP) for agricultural productivity and sustainability focusing on climate topics

Five examples of joint actions which have the potential to address key areas climate mitigation and/or adaptation needs and opportunities are also explained in more detail. These include:

- EIP operational group: Testing of regionally appropriate ‘payment by result’ schemes for N-efficiency
- EIP operational group: Development and/or improvement of regionally appropriate climate audit tools

- EIP operational group: Testing of innovative contracts for voluntary schemes to develop expansion tanks to store water for dry periods or to provide natural retention in case of heavy rains
- Climate action networks
- EIP operational group: Develop a methodology for farm resilience plans for particular farm types/sectors, focussing on risks that farmers are currently underprepared for

Equally well, joint actions could also deal with issues such as:

- Pilot projects focusing on the development and implementation of wetland restoration concepts and collective projects either through establishing cooperatives, or other types of partnerships between public and private actors
- How to adjust fertilisation without affecting yield quality (e.g. remove 'late quality fertilisation with nitrogen' for bread wheat)
- Screening and options to improve herd health status
- Building design for adaptation
- Development and transfer into practice of adapted crop varieties,
- Events and activities which aim to increase awareness or adaptive capacity of farmers to deal with climate change, including for example, the inclusion of virtual learning platforms such as those targeting young farmers.

These examples of joint actions are related to the actions outlined in the Technical Fiches (Annex 1), yet the focus is on testing and developing new, or thus far unexamined or open aspects or questions. As in the case of LEADER, what is new will depend on the regional circumstances and conditions. Such cooperation actions bring in a degree of flexibility in the design of specific solutions and schemes, so that these could be better tailored to regional and farm conditions, and thus the stakeholder buy-in can also be increased. The joint actions can also enable the testing of performance of developed measures and schemes so that feedback from users can be incorporated and effectiveness increased. The success of the joint action projects can be also increased if, where possible, they build on continuity with already existing initiatives.

Participants at the workshop saw the Cooperation Measure as a tool that can be more easily applied than the LEADER instrument in terms of direct support for climate action, in particular if climate activities are presented as contributing to resource efficiency in the agricultural sector. Greenhouse gas emissions from this perspective are presented as a wasted resource. The operational groups under the EIP can frame climate issues in terms of the logic of efficiency and productivity of the production system rather than it being framed as a separate issue. This makes climate objectives more concrete and understandable to the farming sector. Benefits of climate action to farmers can be more directly demonstrated.

The workshop participants also stressed that climate mitigation and adaptation issues can be approached by the EIP operational groups as part of a broader question 'How do we farm sustainably in the future'. And in particular, the possibility to test concrete ideas, demonstrate concrete benefits and find ways to implement actions presents a valuable space through which farmers can be convinced of the impact and effectiveness of proposed solutions, also because they are able to be involved in the collective approach and be part of designing the solutions.

The Cooperation Measure can be used to identify practical needs for research, and enhance uptake of results at farm level (incl. for example demonstration sites and projects) – develop pilot initiatives on 'interactive knowledge creation' around climate change topics (incl. through climate networks).

Concluding remarks

Joint actions under the Cooperation Measure offer the opportunity for setting-up cooperation groups to test and implement innovative collective projects. As a testing ground for locally specific and appropriate solutions, joint actions can be used to develop solutions related to emission reduction or climate adaptation which can later be rolled-out more broadly through other RD measures. The Cooperation Measure is also a very useful instrument to support collective landscape level solutions, where the added value of joint action is significant and required (for example, in the case of wetland restoration). Where feasible and relevant, the existing LEADER networks and LAGs could be built on strategically to increase the feasibility of joint actions at landscape level.

6. Indicators and criteria – green growth

Background

The aim of Task 4 was to review existing criteria and indicators (OECD, European Commission) which can be used to evaluate the contribution of combined RD measures to climate change mitigation and adaptation as well as to objectives of green growth that are in line with the Europe 2020 strategy. In this context, the term "combined RD measures" also refers to all measures of a RD programme related to the relevant EU priorities 4 and 5, which in a wider sense can be understood as a broad combination of measures.

Box 2: Green growth

The idea of green growth or green economy has been formulated by different international organisations (i.e. UNEP, UNDP, World Bank, OECD and the European Environmental Agency). Although their definitions vary, green growth or green economy essentially focuses on three objectives (EEA 2014a):

- Improving resource-use efficiency
- Maintaining ecosystem resilience
- Enhancing social equity

Green growth represents a concept to support the transition to an economy that experiences growth while at the same time fosters sustainable and inclusive development (ESCAP et al. 2012; EEA 2014a). It moves away from the short-term thinking that costs associated with sustainable development impair economic growth, but instead emphasizes long-term benefits (EEA 2014a). As green growth has key focus on improved resource-use efficiency, it closely relates to the concept of a circular economy, which basically comprises recycling and re-use of physical and material resources (EC 2014).

Criteria for evaluating the contribution to climate protection and green growth

In order to evaluate the contribution of measures and measure combinations to climate protection effects and green growth, a number of criteria need to be considered.

- As the European Union aims at achieving a low carbon economy, the **GHG emission abatement potential** or the actual reduction of GHG emissions plays an important role for the evaluation of measure combinations.
- **Cost effectiveness** is a key criterion in order to evaluate the contribution of measure combinations to green growth. It relates the associated costs with the achievable reduction in emissions. Many climate change measures are associated with net private cost (i.e. the costs to the farmer are greater than the benefits they receive) but a net social benefit (i.e. the total benefits to the farmer and to society (including the environmental improvement) outweigh the total costs).

- **Ancillary effects** (e.g. social benefits) give an indication on such net social benefits. Multi-functional measures are particularly beneficial from a social perspective, as they contribute to multiple aims (e.g. Technical Fiches M4 and M14 where the operations both contribute to a reduction in GHG emissions and ammonia emissions) and thus contribute to an inclusive and sustainable economy.
- As green growth can only be achieved in the long run, the **durability of the impacts** of the measure combinations is very important. If these measures are supported (e.g. by RDPs), it should be taken care that the positive effects are not reversible when the support phases out.
- Especially when reducing GHG emissions, **displacement effects** need to be considered. Associated decreases in production might lead to leakage effects as production increases elsewhere in order to satisfy the unchanged demand.

Although single measures and measure combinations need to fulfil the above criteria in order to contribute to GHG mitigation and green growth, the actual evaluation of their contribution is difficult. The causal relationships between measures at the micro scale and green growth effects on the macro scale (national/sectoral level) cannot be identified easily (further discussed below).

For GHG mitigation measures, the link to green growth is the objective to reach higher resource efficiency (e.g. less N fertiliser input per tonne of output) and reduced emissions (e.g. less GHG emissions per tonne of output). In the case of climate change adaptation, the relevance for green growth is the aim to maintain productivity of land-based production systems and to limit negative impacts of extreme weather events. While for the evaluation of GHG mitigation measures, the challenge is how to quantify net effects on global GHG emissions, for climate change adaptation the assessment of climate change impacts with and without adaptation measures is crucial.

Indicators

Methods and criteria for indicators selection

In order to identify relevant indicators a literature review was conducted, focusing on the indicators of the EU's Common Monitoring and Evaluation Framework (CMEF) and the Green Growth indicators of the OECD (2011, 2013).

Box 3: CMEF indicator definitions for the CAP post 2013 (EC 2012)

Context indicators

- *"provide information on relevant aspects of the general contextual trends that are likely to have an influence on the performance of the policy, e.g. GDP per capita, rate of unemployment."*

Output indicators

- *"measure activities directly realised within policy interventions as the first step towards realising the immediate aim of the intervention. They are measured in physical or monetary units, e.g. number of farmers supported by young farmer scheme, number of farm holdings supported by investment measure, number of Ha supported with the basic payment".*

Result indicators

- *"measure the direct and immediate effects of the intervention providing information on changes in, for example, the behaviour, capacity or performance of direct beneficiaries. They are measured in physical or monetary terms e.g. share of direct payments in farm income, percentage of UAA under management contracts preserving soil."*

Impact indicators

- *"refer to the benefits of the intervention beyond the immediate effects on its direct beneficiaries and evaluations are normally used to identify their net effects (i.e. subtracting effects that cannot be attributed to the intervention and taking into account indirect effects), e.g. total factor productivity in agriculture, rural employment rate compared to rest of economy. Impact indicators are common for Pillar I and Pillar II."*

Appropriate indicators were selected considering the following criteria:

- The focus is on result and impact indicators, as we are interested in evaluating the impact of RDP measure combinations and the impact of the whole RD programme
- Indicators need to measure the impact on climate change mitigation or adaptation
- With respect to Green Growth, indicators should focus on:
    - Mitigation: (changes in)resource efficiency and GHG emissions
    - Adaptation: (changes in) productivity
- Indicators need to comply with the SMART-criteria (ENRD, 2012)
    - Specific
    - Measurable
    - Available/achievable in a cost-effective way
    - Relevant for the programme
    - Available in a timely manner

Evaluation and monitoring of the CAP in the EU is mainly based on output, result and impact indicators. Depending on the degree of aggregation, indicators can be used to evaluate different levels of the CAP. Output indicators reflect the activity directly related to the implementation of the specific measures (e.g. number of beneficiaries, hectares or amount of public support of a specific operation or RD measure). Due to their focus on the activity itself, output indicators can be used to describe the overall implementation and acceptance of an operation, measure or the whole programme, but they do not indicate whether a measure successfully meets the related targets. These output indicators are mainly used for monitoring the implementation of RD programmes and are thus excluded from the compilation.

Result and impact indicators

In contrast to output indicators, result indicators measure the direct and immediate effects of measure implementation. Different result indicators are used for the two pillars of the CAP. For the evaluation of the RDP, they relate to the different Union Priorities and Focus Areas. For the priorities 2-6, a few result indicators that are easy to capture and monitor are defined as target indicators (this can also include combinations of several result indicators) that need to be quantified ex-ante. Table 10 specifies result indicators that can be drawn on for the evaluation of the contribution of RD measure combinations to the Union Priorities. Many of these result indicators can be used for the monitoring of different operations and are recommended in the Technical Fiches (See Annex 1).

Table 10: Result indicators for the Union Priorities 4 and 5 (Evaluation Expert Committee 2013; EC 2012) and related Technical Actions that can be evaluated by the different indicators

Union Priority and Focus Area	Result indicator	Fiches
P4 A Restoring, preserving and enhancing biodiversity, including in NATURA 2000 areas, areas facing natural or other specific constraints and high nature value farming, and the state of European landscapes	Absolute area and % of forest or other wooded area under management contracts supporting biodiversity	
	Absolute area and % of agricultural land under management contracts supporting biodiversity and/or landscapes	
P4 B Improving water management, including fertiliser and pesticide management	Absolute area and % of agricultural land under management contracts improving water management	A7
	Absolute area and % of forestry land under management contracts to improve water management	
P4 C Preventing soil erosion and improving soil management	Absolute area (ha) and % of agricultural land under management contracts improving soil management and or preventing soil erosion	M1, M2, M6, M8, A2, A3, A5
	Absolute area (ha) and % of forestry land under management contracts to improve soil management and or preventing soil erosion	A5
P5 A Increasing efficiency in water use by agriculture	Total water savings in m^3	
	% of irrigated land switching to more efficient irrigation system	
	Increase in efficiency of water use in agriculture in RDP supported projects (output/m^3 water used)	A7, A8

Union Priority and Focus Area	Result indicator	Fiches
P5 B Increasing efficiency in energy use in agriculture and food processing	Tonnes of oil equivalent saved per volume of outputs	
	Total investment in energy savings and efficiency (€)	
	Increase in efficiency of energy use in agriculture and food-processing in RDP supported projects (output/MJ energy used)	M13
P5 C Facilitating the supply and use of renewable sources of energy, of by-products, wastes, residues and other non-food raw material for purposes of the bioeconomy	Total investment in renewable energy production (€)	
	Renewable energy produced from supported projects (Tonnes of oil equivalent)	M12
P5 D Reducing greenhouse gas and ammonia emissions from agriculture	LU concerned by investments in live-stock management in view of reducing GHG and/or ammonia emissions	M3, M4, M11, 12, M14
	% of agricultural land under management contracts targeting reduction of GHG and/or ammonia emissions	M3, M4, M14
	Reduced emissions of methane and nitrous oxide (measured in CO_2 equivalent)	M3, M4, M10, 11, M14
	Reduced ammonia emissions (measured in CO_2 equivalent)	M3, M4, M14
	Tonnes of CO_2-eq. saved from RDP supported projects, expressed as annual savings per project, aggregated across projects	
P5 E Fostering carbon conservation and sequestration in agriculture and forestry	Absolute area (ha) and % of agricultural and forest land under management contracts contributing to carbon sequestration	M1, M2, M6, A3, A5

The result indicators are suited to evaluate the effects and contribution of measures and operations to the climate objectives of the Union Priorities 4 and 5. However, they can only evaluate the impacts on Green Growth to a limited extent, since they rarely consider impacts on economy or society.

Impact indicators are used to evaluate the programme impact on a more aggregated scale. They describe effects in relation to wider effects of the implemented programme, such as net GHG emissions from the agricultural sector as a whole. They are used to evaluate the contribution of the whole CAP (first and second pillar) to the different objectives. Table 11 shows a subset of such indicators. With regard to environmental effects, this includes especially the effects of greening and cross compliance.

Table 11. Impact indicators for the evaluation of first and second pillar of the CAP (EC 2013b)

Indicator	Definition
GHG emissions from agriculture	Net GHG emissions from agriculture including agricultural soils
Water abstraction in agriculture	Volume of water which is applied to soils for irrigation purposes
Soil organic matter	Organic carbon content in soils
Soil erosion	a Estimated rate of soil loss by water erosion b Estimated agricultural area or share of estimated agricultural areas affected by a certain rate of soil erosion by water
Rural employment rate	Employed persons aged 15-64 and 20-64 as a share of the total population of the same age groups in thinly populated areas (used as proxy for rural areas)
Degree of rural poverty	Share of population at risk of poverty or social exclusion in thinly populated areas (used as proxy for rural areas).
Rural GDP per capita	GDP per capita in predominantly rural regions, in PPS (purchasing power standard)

As the impact indicators are more general they could as well be used on a sectoral or national level. In addition to the monitoring of GHG emissions and resource state (estimated rate of soil loss by water erosion, organic carbon content in soils) and use (water abstraction in agriculture), they also link to socio-economic aspects such as employment, income and poverty in rural areas (see the last three indicators in Table 11) and can thus be used to evaluate the contribution of RD programmes to green growth objectives.

In order to be able to derive meaningful information from these result and impact indicators, their values need to be compared over different points in time (which might be difficult because of data availability) since they mostly only display absolute numbers. Indicators that relate different information such as GDP and net GHG emissions and thus express efficiencies would be suited better to evaluate the contribution to climate change mitigation/ adaptation and green growth.

Green growth indicators

During the evaluation of measures/ programmes, cost effectiveness poses a key criterion. Most climate change mitigation or adaptation measures are associated with substantial costs and might thus have negative effects on economic growth, at least in the short-term. A green economy, however, takes into account that over-exploitation of resources leads to welfare losses in the long run. Thus, a sustainable and efficient use of resources is necessary in order to maintain economic growth.

Some climate change measures have a net private cost (i.e. the costs to the farmer are greater than the benefits they receive) but a net social benefit (i.e. the total benefits to the farmer and to society, including the environmental improvement, outweigh the total costs). Multi-functional measures can be particularly beneficial from a social perspective, as they contribute to multiple aims (e.g. Technical Fiches M4 and M14 where the operations both contribute to a reduction in GHG emissions and ammonia emissions). Without public support (such as the RDP), underinvestment in these socially beneficial measures is likely to occur.

RD programmes promote innovation (e.g. through the EIP) and support rural development and the initial use of innovative measures/operations until the innovation is well-established and a new level of development is reached. When the innovative measure or operation has become the standard procedure, the support through RD programmes should be terminated. This is the case especially for measures/operations that relate to innovative technologies (e.g. M4 Precise N-application, M14 Climate proofing planned investments, A7 Improved irrigation efficiency). As the European Union aims at becoming a “smart, sustainable and inclusive economy” (EC 2010), it promotes green growth, which includes increased resource efficiency and a low carbon economy. Thus the RD measures and combinations shall also be evaluated in relation to their contribution to Green Growth.

The Green Growth indicators of the OECD, are even more aggregated than the CMEF impact indicators and also focus on macroeconomic effects at the sectoral or national level (Table 12).

Table 12. Green growth indicators of the OECD (OECD 2011, 2013)

Indicator
Production based CO_2 productivity (GDP per unit of energy related CO_2 emitted)
Demand based CO_2 productivity (Real income per unit of energy-related CO_2 emitted)
Energy productivity (GDP per unit of Total primary energy supply (TPES))
Energy intensity per sector
Share of renewable energy (of TPES in electricity production)
Demand based material productivity (Real income per unit of materials consumed)
Production based (domestic) material productivity (GDP per unit of materials consumed Biotic materials: food, other biomass Abiotic materials: metallic minerals, industrial minerals)
Waste generation intensity and recovery ratios (by sector, per unit of GDP or value added, per capita)
Nutrient balance in agriculture (N,P) (per agricultural land area and change in agricultural output)
Water productivity (Value added per unit of water consumed, by sector)
Land resources: land cover conversions and cover changes from natural state to artificial state (Land use: state and changes)
Soil resources: degree of topsoil losses on agricultural land, on other land (Agricultural land area affected by water erosion, by class of erosion)

In addition to increased resource efficiency and reducing GHG emissions, Green Growth also focuses on socio-economic aspects such as economic growth, productivity, labour markets, education and income. However, as the contribution of the agricultural sector to these aspects is rather small in relation to other sectors in most EU Member States, potential impacts will not be significant at a macroeconomic scale. Thus, for evaluating climate-relevant overall impacts of RD programmes and the CAP only indicators are proposed that directly relate to reducing GHG emissions and improved resource efficiency. These indicators should be applied to the agricultural and land use sector, its productivity and GHG emissions.

So depending on the level on which impacts shall be evaluated, different types of indicators need to be utilised. It is difficult to evaluate effects of single operations/measures (or combinations) on a sectoral or national scale, as their impact cannot be easily separated from other influences. Further, these effects will be hardly visible on a national scale, since the contribution of the agricultural sector to economic or social issues will be rather small in comparison to that of other sectors (e.g. industrial sector). Here result indicators are suited better. However, currently many EU result and impact indicators are represented by absolute numbers (e.g. "Reduced nitrous oxide and ammonia emissions" or "Total investments into renewable energies"). These indicators would become much more meaningful if they –like the green growth indicators- relate these absolute numbers to a reference and would thus be able to express efficiencies (e.g. output per unit of CO_{2e} emitted). The green growth indicators are especially suited for the evaluation at a sectoral or national level and are thus very general. For the evaluation of measures/operations they need to become more specific (e.g. not based on the GDP, but on farm outputs). N-efficiency for example could be measured at farm level in order to get an indication on how sustainably fertiliser is used on farm. However, if such indicators (adapted result and green growth indicators) are used at a local/farm scale, it is important to consider that the results cannot easily be scaled up to a sectoral/national level.

Limitations of indicator use

A number of potential indicators have been identified that could measure green growth (Table 11 and Table 12). However, their explanatory power might be limited. A main problem relates to the availability and accessibility of appropriate data. More data needs to be gathered and integrated in physical accounts in order to allow for the setting up of a more complete statistical base. In order to combine economic and environmental data, the OECD (2011, 2013) suggests using the System of Environmental-Economic Accounting (SEEA) of the United Nations in order to be able to derive reasonable Green Growth indicators. SEEA is a statistical framework, which consists of physical and monetary accounts and thus interrelate economic and environmental data. SEEA approaches allow for the analysis of national and sectoral indicators for resource efficiency and GHG emission intensity, related to the total output of commodities. Such indicators at the macro-economic level can be compared with indicators for specific GHG emissions per unit of output at the micro level, which are based on life cycle assessments of specific products.

For a detailed analysis of the state and improvement of the GHG emission intensity, the quality of the data needs to be improved. Amounts of GHG emissions for example can be estimated using different approaches (Tier 1, 2 or 3 methodology, representing increased level of detail and national specificity). The applied GHG reporting methodologies vary in their level of detail and ability to depict improvements of technologies and management. Another important point for quantifying climate mitigation impacts is the consideration of leakage effects and the assessment of net mitigation effects. The mere reduction of production activities and the related decrease of GHG may not necessarily provide net GHG mitigation effects at global level. The displacement of production activities may results in increasing GHG emissions elsewhere at global level. Thus, substitution and displacement effects as well as foreign trade balances in order to control for effects at international level have to be considered. Many indicators applied at national level are not appropriate to depict global leakage effects and are thus not really useful for the evaluation of the contribution to Green Growth at macro-economic and global level. For a broader analysis, in the terms of life cycle assessments, a system expansion is required in order to consider effects at the global level.

Leakage effects at global level cannot be measured exactly, but must be estimated on the basis of quantitative modelling. For the assessment of overall effects of mitigation policies, Pérez Domínguez et al. (2012) quantified the overall effects on the foreign trade balance of the EU using the CAPRI model and specific emission intensities per unit of traded agricultural commodities for different world regions. Osterburg et al. (2013) used a similar approach for the evaluation of mitigation scenarios for the German farm sector. They quantified cumulated GHG emissions (i.e. farm sector and upstream emissions), cumulated energy inputs and farm land requirements, mainly on the basis of the German situation, considering commodity imports and exports and their respective specific average emissions, energy and land requirements. Using such approaches, simultaneous changes of production, trade balances, productivity, input use and emissions can be evaluated. They should be used to assess impacts of major changes at sectoral and global level.

The contribution of the CAP and RD programmes to overall GHG mitigation can be based on estimates of gross GHG mitigation effects of the single measures plus their impacts on production and resource productivity. Challenges for the evaluation of adaptation to climate change are how to quantify climate change impacts without adaptation measures. For this, modelling methodologies for quantitative assessment of climate change impacts and effects of adaptation measures are required.

Concluding remarks

In order to evaluate the contribution of RDP measures/operations to climate change mitigation/adaptation and green growth, GHG abatement potential, the cost effectiveness, ancillary effects, the durability of effects and possible displacement effects of measures and measure combinations should be considered. Result and impact indicators for RD programmes provide a useful entry point for the evaluation of the contribution to climate change mitigation and adaptation. The result indicators are more specific and can be used for measuring the impact of operations outlined in different technical fiches. Impact indicators are less specific and evaluate the contribution of the whole CAP programme. Especially indicators that relate to resource efficiency (e.g. output/m^3 water used, N-efficiency, etc.) provide useful information on the impacts, as they relate impacts to a reference and thus allow for comparisons. The evaluation of the contribution to green growth based on quantitative indicators however remains difficult. Existing indicators are very general and were intended for the evaluation on a sectoral or national level. The impacts of single measures (measure combinations) cannot be separated from other influences and might not even be visible on a national scale. The green growth indicators of the OECD can be adapted in order to evaluate a less aggregated level, however then leakage effects cannot be considered. In order to account for leakage effects, quantitative modelling needs to be conducted.

7. Consultation and outreach tools

Introduction

Experts and practitioners in the area of rural development, agriculture and climate change were consulted at different points during the project in order to gain insights from practical experiences, on-the-ground implementation, success factors and barriers, as well as to validate preliminary project results. These consultations enabled the project team to take into account sectoral and regional perspectives, and provided an additional layer of quality control. Previous chapters in the report outline how the consultations fed into the results of different tasks. In this chapter, an overall overview of the consultations and the project workshop is given, complemented with a summary of the outreach tools produced by the project.

Consultation with practitioners and project workshop

Ongoing consultations with practitioners

An Advisory Board was established at the beginning of the project with representatives from a range of Member States. The Advisory Board provided support to the consortium with Tasks 1 – 3, and on occasion with ad-hoc queries. In addition, each task identified relevant experts that could support with more specific requests. The ongoing consultations were carried out over E-mail or as phone interviews.

Technical experts were involved extensively in the shortlisting process under Task 1, reviewing potential new and innovative mitigation and adaptation actions and helping to prioritise those which should be promoted through RDPs. In Task 2 practitioners were consulted to identify and present examples of climate focused LEADER projects, gain insights into the current implementation of LEADER and community-led climate actions, as well as options for new concepts for LEADER and Joint Actions. Under Task 3, Managing Authorities were consulted using a questionnaire to obtain information on their experiences with combinations of measures and thematic sub-programmers, and to help identify most relevant potential combinations of measures. In Task 4, practitioners were not contacted separately, but instead contributed with feedback during the workshop.

Project workshop

Under Task 5, a one-day workshop was organised in Brussels on 17 June 2014 where preliminary project results were presented, and feedback was sought from RD Managing Authorities and other relevant stakeholders. The target group for the workshop were practitioners involved directly in the design and implementation of RDPs. In addition, some stakeholders working at the intersection of agriculture and climate change also participated. Over 40 participants attended the workshop.

A website was created where resources were made available to participants prior to the workshop, including:

- An overview of the 25 technical fiches, and full-length sample fiches
- An example of a LEADER project factsheet and list of short-listed LEADER projects

- Preliminary ideas for new concepts to further support climate action through LEADER and Joint Actions
- An information sheet regarding combinations of measures and thematic sub-programmes
- Questions for small-group discussions
- List of participants
- Workshop agenda

The workshop participants were invited to read through the materials prior to the workshop in order to contribute ideas and critical commentary.

The workshop was structured in three parts. First, general context for the project was given and task leaders introduced the methodology and preliminary findings for each task. Secondly, four 25-minute group discussions were held using the World Café discussion format. The workshop participants rotated across four different groups covering the following themes:

- Technical fiches – brainstorming potential operations
- Technical fiches – identifying ways of improving the usefulness and uptake of the fiches
- LEADER projects and Joint Actions
- Combinations of measures and thematic sub-programmes

A moderator and note-taker in each discussion group facilitated the discussion and recorded participant feedback. Lively discussions yielded numerous comments, suggestions, and experiences. Finally, the workshop concluded with a plenary session where group discussions were summarised and key take-away messages were agreed upon.

Following the workshop, all 25 technical fiches were made available on the workshop website. Participants were invited to provide written feedback on specific fiches and further links to LEADER and joint action initiatives.

Outreach tools

The project developed technical guidance for RD Managing Authorities to effectively integrate mitigation and adaptation operations into Rural Development Programmes. This technical guidance is composed of the different annexes to this report which can be read as stand-alone documents or in combination with the final report.

In order to disseminate project outputs to Managing Authorities and other relevant RD practitioners involved in the design and implementation of RDPs (e.g., ministries, environmental and farming organisations), different outreach tools are made available. These outreach tools provide an overview of the project and enable access and efficient use of the technical guidance. The tools include:

- A project workshop **website** where the preliminary technical guidance and tools were made available prior to the workshop
- A project **leaflet** (highlighting the need and opportunities for integrating climate action in RDPs and introducing technical guidance)

- A project **brochure**, outlining in 10 pages the key findings of the project and introducing the technical guidance
- A scientific article (to be submitted for peer-review upon completion of the project)

The project was also introduced at the Good Practice Workshop “Climate change mitigation and adaptation in RDPs – assessing the scope and measuring the outcomes” organised by the ENRD in Larnaca, Cyprus, in February 2014. Participants at the workshop were invited to become involved in project activities as external experts. Moreover, preliminary results, focusing on the methodology and the content of the 25 technical fiches, were presented at the meeting of the Working Group 5 "Implementation of the LULUCF Decision and policy development of the land use, land use change and forestry sector" under the Climate Change Committee. This meeting took place in May 2014.

Concluding remarks

The technical guidance developed by the project can offer valuable information and inspiration to Managing Authorities and other RD practitioners on how to integrate climate action in Rural Development Programmes. It is hoped that the guidance will stimulate further targeted action on climate change, as well as trigger exchange of experiences and knowledge around the issue. The technical guidance will be disseminated through appropriate channels beyond the lifespan of the project, drawing on the network of experts and practitioners who were involved in the project activities.

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Glossary

Adaptation

Adaptation is defined by the IPCC as the 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.' It can be understood as the process of managing climate risks.

Adaptive capacity (in relation to climate change impacts)

The ability to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Abatement rate

This is the rate at which greenhouse gas emissions are reduced. Abatement rates can be expressed in variety of units, depending on the context and approach, such as: % change in total emissions, % change in emissions intensity, reduction in kgCO2e/ha or in kgCO2e/head.

Climate Mainstreaming

The process of ensuring that climate concerns and responses are integrated in relevant policies, plans and programmes at different levels of governance. In the context of this study, the focus is on Rural Development Programmes.

Life cycle assessment (LCA)

Life cycle assessment is a technique for assessing the environmental aspects and potential impacts associated with a product, process, or service, by: (a) Compiling an inventory of relevant energy and material inputs and environmental releases; (b) Evaluating the potential environmental impacts associated with identified inputs and releases, and (c) Interpreting the results to help with more informed decision making. (http://www.epa.gov/nrmrl/std/lca/lca.html)

Mitigation

Mitigation can refer to the reduction in total greenhouse gas emissions or the reduction in emissions intensity (i.e. the kgCO_2-e/kg product). In this study it is defined as a reduction in emissions intensity while either maintaining or increasing production.

Rural development measure

Rural development measure is defined as a "set of operations contributing to one or more of the Union priorities for rural development" and corresponding to Articles 14 – 46 of the EAFRD Regulation (Art. 2(c)). The EAFRD Regulation (Art. 2) defines an **operation** according to the definition provided in the Common Provision Regulation (Art. 2(9)), which states an operation is "a project, contract, action or group of projects selected by the managing authorities of the programmes concerned, or under their responsibility, that contributes to the objectives of a priority or priorities; in the context of financial instruments, an operation is constituted by the financial contributions from a programme to financial instruments and the subsequent financial support provided by those financial instruments." In the context of this proposal, we understand operations in a slightly more restricted sense to mean the technical or non-technical actions at the basic / disaggregated level of activity. A distinction can be made between technical operations (specific farming practices, installation of specific technologies), and non-technical operations (e.g., provision of farm advice, dissemination actions).

Sub-measures

Sub-measures are specific, programmed measures to be implemented in Member States and regions. They can include single operations as well as coherent categories of operations that have a clear common focus and whose effect is increased if they are implemented at the same time. For example, this is particularly relevant for the agri-environment-climate measure of the EAFRD Regulation (Art. 28) where numerous different types of operations can be implemented. However, sub-measures can also refer to other measures (e.g., provision of climate-oriented advice with explicit climate objectives).

In designing climate operations as part of rural development measures, Member States must define a number of different parameters. The aspects that are of major importance are discussed below.

Eligibility criteria

Such criteria allow for definition of the addressed beneficiaries, as well as targeted land. Eligibility criteria thus help to target the measures, focussing on beneficiaries or areas most appropriate for the positive performance of the respective measure. As a new eligibility feature of the new EAFRD, group contracts for agri-environment and climate payments can be used for groups of farmers or groups of farmers and other land managers. Further, the definition of eligible land in Pillar 1 and Pillar 2 of the CAP will change. Eligibility criteria for RD measures have to be clearly defined to allow for yes/no decisions. Beneficiaries have to fulfil all eligibility criteria without exemption. Eligibility criteria are not remunerated for through RD payments, and not meeting eligibility means a 100 % reduction of RD support. In contrast, non-compliance with commitments leads to payments reductions which are proportional to severity, extent, duration and intention. Thus, eligibility criteria should be easy to understand and to verify, and clearly distinguished from commitments.

Commitments

The commitments to be complied with are the core element for many measures such as agri-environment and climate measures. They describe the additional requirements beyond the baseline which contribute to the intended effect of the measure. Commitments have to be easy to understand and to control, and must be essential for the effect of the respective measure. Often, several specific commitments have to be combined to reach the intended effects with high probability.

Calculations of the payments

Payments shall compensate for additional cost and income foregone resulting from the commitments or payments granted on the basis of standard cost. For the agri-environment and climate payments, also transaction costs can be covered. According to EAFRD Regulation Article 62(2), Member States have to ensure that the relevant calculations are adequate and accurate and established in advance. For the calculations, specific requirements have to be fulfilled. Agri-environment and climate payments should be differentiated with regard to regional conditions and production practices, and the application of flat-rate payments has to be justified by the Member States.

Payment by result (output or result-oriented measures)

Payments to beneficiaries based on the results achieved instead of additional cost and income foregone can be an efficient way to implement agri-environment and climate measures. However, the calculation of payments has to be based on assumed commitments leading to the respective result.

Targeting

Targeting means focusing measures on those beneficiaries or land areas where best measure performance is expected. Targeting can be realised through eligibility criteria, through bidding systems (auctions, tenders) or ranking of RD applications. Approaches based on auctions or ranking require an excess of applicants compared to the budget to be allocated. Targeting can restrict RD measures to selected areas (environmental zone, land use type, soil type etc.) or towards specific farm types.

Selection of operations

Article 49 allows RDP Managing Authorities to establish selection criteria for operations for the allocation of limited RD funds. For example, calls for tender can be used to select most cost-efficient offers in terms of targeting and claimed payments.

Controllability

Member States need to ensure that all RD measures are verifiable and controllable under Article 62(1) of the EAFRD Regulation (2013). The Managing Authority and the paying agency have to provide an ex ante assessment of the verifiability and controllability of the planned RD measures. This means that control of commitments has to be feasible and based on objective criteria easy to verify. Also, verification of eligibility criteria has to be feasible and unambiguous. Especially for measures improving input efficiency, e.g. nitrogen fertiliser, these requirements are a challenge. For area-related RD payments, inaccurate size of the contract area is a main source of high error rates. This is true especially on marginal grassland. Guidance how to keep the risk of such errors low is therefore of special importance.

Monitoring and evaluation

For climate protection and adaptation measures, there are few experiences how to define and quantify result and impact indicators. For climate protection, the definition of target indicators (e.g. land related versus product output related change of GHG emissions) and of system boundaries is crucial. As results and impacts cannot be directly measured in most cases, calculation methods have to be established which should be in line with the national GHG accounting systems of the Member States.

Vulnerability

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Mainstreaming climate change into rural development policy post 2013 – Annex 1

Technical Fiches

This Annex 1 is part of the Technical Guidance produced in the project "Mainstreaming climate change into rural development policy post 2013".

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Table of Contents

Introduction to the Technical Fiches

This Annex contains 16 fiches for mitigation actions (M1-M16) and 9 fiches for adaptation actions (A1-A9) – see Table A1-1. The fiches are summary documents (typically 6-10 pages), that provide an explanation of how a particular action (such as planting cover crops) could reduce GHG emissions or help adapt to climate change, and an example of how the action could be translated into an RDP operation. The fiches provide guidance on key points such as the conditions likely to favour the operation, the likely mitigation/adaptation effect, and any ancillary effects. They also provide brief explanations of the main cost elements likely to arise from the operation. Throughout the fiches, effort has been made to provide links to the evidence underpinning key assumptions.

The method used to select the actions for the fiches is explained in Chapter 2 of the main report. The following caveats should be borne in mind when using the fiches:

- Mitigation of GHG and adaptation to climate are complex processes. The fiches, which are short documents written within strict time constraints, by necessity, simplify this complexity somewhat.
- The contents of each are not prescriptive; they seek to provide inspiration and examples rather than detailed technical guidance.
- The scope of the 25 fiches is not exhaustive, and non-inclusion in the list does not imply a lack of mitigation/ adaptation potential.

Table A1-1 Fiche lead authors and internal reviewers
(M = mitigation action, A = adaptation action)

Fiche	Action	Lead	Internal reviewer
M1	Extend the perennial phase of crop rotations	AKI	SRUC
M2	Use cover/catch crops and reduce bare fallow	SRUC	SRUC
M3	Improved N efficiency	TI	Solagro
M4	Precise N application	TI	SRUC
M5	Biological N fixation in rotations and in grass mixes	SRUC	INEA
M6	No-till	INEA	TI
M7	Retain crop residues	SRUC	AKI
M8	Loosen compacted soils / Prevent soil compaction	SRUC	TI
M9	Avoid drainage of wetlands / conversion of peatlands	TI	SRUC
M10	High fat diet (dietary lipids)	SRUC	Solagro
M11	Precision and multi-phase feeding	SRUC	SRUC
M12	Solar fodder dryers	Solagro	SRUC
M13	Behavioural change towards better energy efficiency	SRUC	Solagro
M14	Climate proofing planned investments	TI	SRUC
M15	Better livestock health planning	SRUC	SRUC
M16	Carbon audit	Solagro	SRUC
A1	Use of adapted crops	Solagro	SRUC
A2	Cover crops/reducing bare fallow	SRUC	INEA
A3	Soil erosion control plan	AKI	SRUC

A4	Reduced tillage/minimum tillage	SRUC	AKI
A5	Optimising adaptation benefits of shelterbelts and hedges	SRUC	SRUC
A6	Optimising the adaptation benefits of drainage	SRUC	TI
A7	Improved irrigation efficiency	INEA	SRUC
A8	On farm harvesting and storage of rainwater	SRUC	INEA
A9	Optimising greenhouse cultivation	SRUC	AKI

Table A1-2 Structure of the fiches

Section	**Content**
Summary	Summary of the intervention logic, brief description of the proposed action and operation and any key issues arising.
Regulatory requirements	Relationship between proposed operation and other regulatory requirements that have to be met (e.g., Nitrates Directive, GAECs), indication, where possible, of current uptake rates.
Description of the action	Brief explanation of the way in which the action leads to a reduction in GHG emissions or climate change risk.
Proposed general operation	Description of an example RDP operation that could be used to encourage uptake of the action.
Commitments, funding conditions and eligibility	Suggestions for criteria that may be used when defining eligible activities; appropriate timings and locations; synergies (both positive and negative) with operations in the other fiches.
Expected impacts on farm-level GHG emissions	Quantification of abatement rate and/or qualitative assessment of adaptation benefits on farm. Off-farm GHG effects are included in ancillary effects. Explanation of factors influencing the abatement rate or adaptation benefits.
Ancillary effects	Description of potential ancillary effects (positive and negative) in terms of: off-farm GHG; production; adaptation; environment. Also highlight any potential maladaptation risks.
Guidance on costs and payment calculations	The private cost and savings - explanation of the main cost and savings elements. Classification of the CE - (1) negative cost, (2) no/low cost, (3) significant cost. Explanation of the main drivers of variation in costs. Costs are provided to illustrate the likely relative importance of the different cost elements. In practice, the actual costs will vary considerably depending on the specific context.
Control and verification	Explanation of how the required undertakings could be verified. Potential result indicators are suggested and the extent to which the mitigation effect would be captured by National GHG Inventories is explained.
Barriers to implementation	Brief description of barriers to uptake and related key risks/uncertainties.
References	The fiches make reference, as far as possible to recent peer-reviewed evidence, supplemented by expert opinions

Fiche M1: Extend the perennial phase of crop rotations - MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	36 (a) (iv); 39	214: Agri-environmental payments
2014-2020	28	Agri-environment-climate

Summary

Area based payments for growing perennial crops is proposed. Benefits include:

- Reduced GHG emissions (direct N_2O and CO_2 from fertiliser manufacture)
- Reduced energy use in agriculture (less field operations)
- Sequester soil C

Regulatory requirements that have to be met

There are no specific policy requirements that farmers must meet or measures to support the extended use of perennial crops in European agricultural systems. However, in the details of current agri-environment payments, there are requirements suitable to be met by perennial crops, although not necessary in explicit form.

General description of the action and operation

Incorporating 1–3 years of a perennial crop (often alfalfa or grass hay) into annual crop rotations diversifies the rotation and can also sequester soil C, although it may be difficult to separate the impact of crop changes from tillage-reduction effects[1]. In the US it is estimated that incorporating 1–3 years of a perennial crop such as alfalfa or grass hay into annual crop rotations captures soil C at an average rate of 0.5t CO_2 ha^{-1} yr^{-1} (range from 0 to 1.2). Reduced need for fertiliser N, fewer field operations, and some N_2O emission reductions result in an estimated net GHG mitigation of 0.7t CO_2e ha^{-1} yr^{-1} for including perennials in annual rotations. Since U.S. data are somewhat limited, these estimates are supplemented by research from Canada (e.g., Gregorich *et al.*, 2001; Hutchinson *et al.*, 2007; VandenBygaart *et al.*, 2003). There is certainly CO_2 release during the switch from perennial phase to arable one, but the degree varies according to local conditions, therefore it is advisable to prepare good practice instructions or other advice that takes local conditions into account.

Compared with annual crops, perennials (especially grasses) tend to allocate a relatively high proportion of C underground and have a greater number of days per year of active plant primary productivity, resulting in more potential biomass production and soil organic carbon (SOC) storage. They can also generate more total evapotranspiration, drying soils, and lowering soil C decomposition rates (Paustian *et al.*, 2000). Therefore, while good for maintaining SOC, in the long run this can be problematic in dry climates with rain-fed agriculture, as high water demand could lead to low-yielding annual crops in following seasons (Paustian *et al.*, 1997, 2000). For irrigated cropland, the impact on water requirements (and associated energy and GHGs) will also need to be considered, while in more humid regions, these considerations are unimportant.

In general, altered crop rotations have a limited effect on N_2O and CH_4 fluxes (Johnson *et al.*, 2010; Omonode *et al.*, 2007), although increases in plant cover (and deeper

[1] Inclusion of perennial crops is most often associated with fewer tillage operations, since seedbed preparation is dramatically reduced, and management generally does not involve growing-season tillage for weed control.

root development) over a longer period of time throughout the year will scavenge mineral N and reduce N losses, with possible N_2O emission reductions as well (Delgado *et al.*, 2007; Robertson *et al.*, 2000). In contrast to annual crops, perennial crops (particularly where these include a leguminous species) have similar or lower fertiliser N requirements, and legumes, in particular, not only require less fertiliser N but also tend to reduce N_2O emissions. Rochette *et al.* (2004) found that N_2O emissions with legume crops are much lower than would be estimated from calculations of N additions through fixation. For alfalfa and soybean, an average of 0.48% ± 0.33% and 0.39% ± 0.27%, respectively, of fixed N was emitted as N_2O versus the assumed 1.25% from the IPCC Tier I factor that is used for fertiliser and other N additions. Even with much higher soil mineral N concentrations under legume crops (compared with timothy grass), the N_2O emissions with legume crops were similar to that with the grass. With less seed-bed preparation and typically lower fuel requirements for harvest, the process-related GHG emissions are lower during the perennial crop portion of such an adapted rotation. For example, California cost-studies find that fuel costs for grain corn are three times that of alfalfa hay (Frate *et al.*, 2008; Mueller *et al.*, 2008).

At the farm or field level, multiple activities on the land interact with one another to affect the biogeochemical cycling of carbon (C), nitrogen (N), and other elements, affecting soil C storage and other GHG emissions. Some intensively managed grasslands (those receiving large fertiliser additions and in the absence of legumes) can be significant sources of non-CO_2 GHGs (Flechard *et al.* 2007). One activity may enhance or be additive to the GHG mitigation potential of another, or trade-offs can occur where one activity reduces or eliminates the benefits of another. (Sparks 2012.) The overall effect of the extended use of perennial crops- ceteris paribus – may very well depend on the utilisation. Also, the switch back from perennial to annual crops needs attention. Soil temperature was a driving factor affecting CO_2 flux, which accounted for approximately 59% in variation of CO_2 flux. It was concluded that less intensive tillage, such as no-till or strip tillage, along with careful irrigation management will reduce soil CO_2 evolution from land being converted from perennial forages to annual crops (Jabro *et al.*, 2008).

Perennial crops can mitigate GHG emissions in five main ways:

1. Sequestering C to soil
2. Reducing direct emissions from N fertilisers
3. Reducing the CO_2e emissions from fertiliser manufacture
4. Reduction in N leaching
5. Reduction in the amount of N that needs to be applied to the following crop.

Proposed general operation

In order to achieve mitigation via the extended use of perennial crops in the crop rotation the following operation is proposed:

- Provision of area-based payments for the incorporation of perennial crops in arable rotations to improve long run mitigation.

Under the measure, perennial crops are established and kept in production for certain minimum duration and/or share of land cultivated. The programming authorities (PA) have to provide specific guidelines in relation to perennial production (establishment, nutrient-, disease insect- management) in order to guarantee efficiency and acceptable cost-benefit ratio.

Commitents, funding conditions and eligibility
When developing a specific operation, PA should provide detailed conditions. Guiding principles are set out below.

Activities
In case of arable areas, perennial crops should be incorporated in the rotation in a deliberate way in order to utilise positive and minimise possible negative effects of the perennial crop. Two activities should be distinguished: establishment and management. PA should specify a minimum seed sowing rate to provide a sufficiently dense canopy.

Timing and duration
PA should provide species specific advice on operation timing (either time slots or restricting periods) and durations for the specific crop required to keep in production based on the national recommendation systems. In general, perennial crops are kept in the rotation based on economics, therefore it vary site-to-site and farm-to-farm. Inclusion of perennial crops also decreases flexibility.

Location
PA should define the areas within which the operation is available, taking into account the following points:

- Establishment of perennial crops is widely applicable on different soil types in arable rotations. Requirements for successful establishments should be set. Preference towards erosion threatened areas should be applied.
- In case the perennial crop is utilised by grazing, appropriate measures should be in place (e.g. stocking density) in order to avoid any unwanted impact.

Synergies - Incompatible operations and recommended combinations
This measure might overlap with measures aiming to reduce erosion, especially in case of sloping areas. Moreover, for certain species it might overlap with bioenergy incentives in case perennial bioenergy is subsidised.

Expected impacts on farm-level GHG emissions
The climate change impact of the operation depends on the crop planted and the way it is utilised (e.g. forage vs. bioenergy; mowing vs. grazing). Indirect effects should also be considered.

The main on-farm mitigation effects of perennial crops are reduced or avoided nitrous oxide emissions and C sequestration (see Table 1).

Table 1. Abatement rates for perennial crops

Mitigation effect	**Abatement rate**	**Source**
Reduced need for fertiliser N, fewer field operations, and some N_2O emission reductions	Net GHG mitigation of 0.7t CO_2e ha-1 yr-1	Sparks (ed.) 2012.
C Sequestration	Miscanthus: 826 ± 26 g C m^{-2} / 3.5 yr, Switchgrass: 798 ± 27 g C m^{-2} / 3.5 yr	Anderson-Teixeira *et al.*, 2013 Sparks (ed.) 2012.

Mitigation effect	Abatement rate	Source
	Avg.: 0 to 1.2 CO_2 ha^{-1} yr^{-1}	
N_2O emissions* (direct and indirect) linked to mineral fertilisers	Grain legumes in arable systems: 1,706 / 1,100 kgCO_2e/year Legumes on grassland: 283 / 170 kg CO_2e/year	Pellerin *et al.*, 2013
N_2O emissions* (direct) linked to the legume	Grain legumes in arable systems: -1,191 / -77 kgCO_2e/year Legumes on grassland: 0 kgCO_2e/year	Pellerin *et al.*, 2013
Direct CO_2 emissions* (diesel)	Grain legumes in arable systems: 21 kg CO_2e/year Legumes on grassland: 1.36 kgCO_2e/year	Pellerin *et al.*, 2013
Induced CO_2 emissions (upstream)	Grain legumes in arable systems: 947 kg CO_2e/year Legumes on grassland: 156 kg CO_2e/year	Pellerin *et al.*, 2013

Ancillary effects

Table 2. Ancillary effects of the operation

Positive effects		**Source**
Off-farm water quality	Extensive root system directly helps to filter water, while lower pesticide and fertiliser rate helps to achieve better water quality.	Sparks (ed.) 2012.
Reduce erosion	Perennial grasses and trees provide year-round cover, extensive rooting systems and an increased level of raindrop interception, which collectively contributes to reduced erosion and run-off losses	Sparks (2012); Thompson and Luckman, 1993; Meyer *et al.*, 1995; Kort *et al.*, 1998; Pimentel and Kounang, 1998; Dabney *et al.*, 1999; Self-Davis *et al.*, 2003).
Adaptation	Perennial crops can provide significant adaptation benefits, by decreasing soil erosion and increasing soil water retention capacity.	
Environment	Create high value habitats and increase biodiversity, decrease environmental load from nutrients and pesticides	
Negative effects		
Off-farm GHG	In case the following crop is not “matching” with the perennial, it might induce increased pesticide use.	
Production	Depends on the utilisation of the perennial crop, it might result displacement effect.	
Adaptation	No significant effects.	
Environment	Significant water use, in case water demanding species are used.	

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is reversible (shift back to annual cropping system).

Guidance on costs and payment calculations

Establishment
The establishment of perennial crops depends on the site conditions and operations required to sowing preparation and management activities during establishment. Field should be carefully selected and soil test should be required.

Maintenance
The maintenance of perennial crops includes:

- nutrient management (fertiliser and/or manure)
- weed/disease/insect management
- harvest management

Input savings
Savings may be made from reduced synthetic fertiliser application rates and related operation, and savings related to tillage.
The cost-effectiveness vary between (2) and (3) [to Kuhlman and Linderhof, 2014].

According to Kuhlman and Linderhof (2014), considering two common legume-supported agricultural systems - faba bean/wheat(1) and grass/clover (2) – that was studied, the estimated cost (€/ha) to farmers is €50(1) - €400(2). On the other hand, the expected benefit brought by reduction of GHG is 1.975(1) and 1.347(2) t CO_{2e}.

The main driver of variation in cost-effectiveness is likely to be the loss of income as a result of alternative land uses (row crops).

Control and Verification
Compliance could be verified in a number of ways:

1. Integrated into current monitoring programmes.
2. Via remote sensing or aerial photography (Pellerin *et al.* 2013, p47)

Potential result indicators
P4B (agriculture): % of agricultural land under management contracts improving fertiliser management

P4C (agriculture): % of agricultural land under management contracts improving soil management and/or preventing soil erosion (ha)

P5E: % of agricultural and forest land under management contracts to foster carbon sequestration/conservation

Extent to which the mitigation effect would be captured by National GHG Inventories
N_2O reduction from reduced rates of fertiliser application would be captured by current inventories.

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	Source
Lack of machinery	result of stakeholder consultation
Disease/pest risk	Cox *et al.* 2005
Lack of market/utilisation potential (no livestock and/or bioenergy option)	result of stakeholder consultation

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Fiche M2: Cover crops/reducing bare fallow - MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	36 (a) (iv)	214: Agri-environmental payments
2014-2020	28(1)	Agri-environment-climate

Summary

Cover crops can mitigate GHG emissions in four main ways:

- Increase of soil organic carbon content
- Decrease soil erosion during the fallow period
- Reduction in N leaching
- Reduction in the amount of N that needs to be applied to the following crop.

The RDP could achieve GHG mitigation by encouraging uptake of cover crops through the provision of area-based payments for the sowing of cover crops in arable rotations during the fallow period. Cover crops need to be carefully targeted in order to achieve cost-effective mitigation. This operation is unlikely to be cost-effective in areas where cultivation costs are high, or where there is a risk of yield penalties through use of the cover crop. Potential barriers to the uptake of this operation are cover crops include the risk of negative affect on yield of following crop and concerns about herbicide use and resistance.

Regulatory requirement that have to be met

Existing policy incentives for cover crops include the Nitrates Directive (specifically the use of catch crops) and the Rural Development Programmes (for example, in England payments are available for cover cropping under the agri-environment Higher Level Scheme). Despite these incentives, low rates of use of cover crops in some member states (MSs) indicates potential to increase uptake.

General description of the action and operation

A cover crop is a fast growing crop grown at the same time as, or between plantings of, a main crop. They provide a variety of benefits, notably: reduce soil erosion, improved soil structure, N fixation, weed suppression and insect habitat provision (Lu *et al.* 2000). Catch crops are a type of cover crop grown for the purpose of scavenging surplus N remaining after harvest of the main crop, and thereby reducing the rate at which N is lost from the soil.

Cover crops can be grown following the early harvest of main summer crops such as cereals or horticultural crops (typically in June/July), and in the autumn during the break between a summer/autumn harvested crop and a following spring crop. An alternative is to under-sow spring crops with a cover crop that will be in place to take up nutrients and provide vegetation cover once the spring crop has been harvested. The establishment of a temporary cover or catch crop can provide green cover over winter using crops such as grass, winter rye, winter barley or mustard (Wiltshire *et al.* 2014).

"The principal loss pathway for carbon within a tillage system is the extended fallow period, during which time there is no uptake of CO_2, whilst ploughing affects the recalcitrant C pools (Willems *et al.*, 2011). Cover crops are traditionally used to reduce leached N emissions to groundwater during the fallow period. However, winter cover has also been observed to reduce net soil CO_2 emissions, due to the fact that there is net photosynthetic uptake of CO_2 by the cover crop (Ceschia *et al.*, 2010)." Schulte *et al.* (2012)

Cover crops can mitigate GHG emissions in four main ways:

- Increase of soil organic carbon content
- Decrease soil erosion during the fallow period
- Reduction in N leaching
- Reduction in the amount of N that needs to be applied to the following crop.

Proposed general operation
In order to achieve mitigation via the use of cover crops, the following operation is proposed:

Provision of area-based payments for the sowing of cover crops in arable rotations during the fallow period (and potentially, if verifiable, reduction of N application to following crop).

Other potential cover crop operations include (a) the planting of permanent or temporary green cover in orchards and vineyards and (b) buffer strips. However Pellerin *et al.* (2013, p47) found planting in orchards to have a much smaller abatement potential than including cover crops in arable rotations in France due to the relatively small area under orchards and vineyards. Buffer strips are expensive as a stand alone option (Pellerin *et al.* 2013) but may be more cost-effective as part of a soil erosion control plan (see Fiche A3).

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
Planting of cover crops in arable rotations during the fallow period.

PA should provide a list of eligible rotations and cover crops, based on local agronomic expertise. In general suitable cover crops will be fast growing with good N uptake characteristics, such as mustard (Sinepsis alba) (Schulte *et al.* 2012, p19).

PA should specify a minimum seed sowing rate to provide a sufficiently dense canopy.

No fertiliser (synthetic or organic) should be applied to the cover crop.

Timing and duration
PA should define the appropriate period of planting and the minimum and maximum length of the cover crop period. Autumn sown cover crops should be established early to enable uptake of N before the onset of winter. For some cover crops it may be beneficial to set a date by which the cover crop should be destroyed, in order to negate the impacts on spring production.

The presumption is that cover crops will have to be used during each year of the RDP, although exemption criteria may be provided to enable suspension of the operation on farms under specified conditions (e.g. rainfall beyond certain thresholds).

Location
PA should define the areas within which the operation is available, taking into account the following points (based on Wiltshire *et al.* (2014):

- Cover crops are widely applicable on different soil types in arable rotations; however, they are best suited to light soils types, due to the spring ploughing requirement, and light-textured free-draining soils to enable preparation of a good seedbed for the succeeding crop.
- Cover crops are more suitable where there is a relatively high spring rainfall as the cover crop will deplete soil moisture reserves and, hence, where there is insufficient rainfall, the main crop can suffer (Dabney et al., 2001).
- Cooler soil temperatures under cover crop residues can retard early growth of subsequent crops grown near the cold end of their range of adaptation (Dabney et al., 2001).

Synergies - Incompatible operations and recommended combinations
Hristov *et al.* (2013, p100) note that "Interactions with other soil conservation practices are significant (tillage system, for example) and must be considered when the goal of cover cropping is reducing whole-farm GHG emissions." Related actions include:

M1 Extend the perennial phase of crop rotations
A2 Cover crops (adaptation)
A3 Soil erosion control plan
A7 Improved efficiency of irrigation

Expected impacts on farm-level GHG emissions
The main on-farm mitigation effect of cover crops is via enhanced soil carbon storage (see Table 1). They can also reduce N_2O emissions through the uptake of nitrate and ammonium, but the uncertainty regarding this effect led this mitigation effect to be excluded from the mitigation calculations in the French MACC (Pellerin *et al.* 2013, p44). Small reductions in N_2O can also arise if the cover crops lead to a reduction in the amount of synthetic fertiliser applied, but these are likely to be offset by the small increase in diesel used for cultivation of the cover crop.

Table 1. Abatement rates for cover crops sown during the fallow period of arable rotations

Mitigation effect	**Abatement rate**	**Source**
Increased soil C	0.874+/- 0.393 tCO_2e/ha/yr	Pellerin *et al.* (2013) (based on Justes *et al.* 2012)
	1tCO_2e/ha/yr	Schulte *et al.* (2012)
	"small, but significant increase in SOC"	Kirk *et al.* (2012)
	1.75tCO_2e/ha/yr	Posthumus *et al.* (2013)
Reduce direct and indirect N>N_2O EFs	Highly variable	Pellerin *et al.* (2013)
	0.49tCO_2e/ha/yr	Schulte *et al.* (2012)
	Leached N reduced by 30kgN/ha = 0.11tCO_2e/ha	Cameron *et al.* (2002) (cited in O'Hara 2003)
Reduce amount of applied N	0.06tCO_2e/ha/yr	Pellerin *et al.* (2013)
Fieldwork CO_2 – increased diesel use	-0.062tCO_2e/ha/yr	Pellerin *et al.* (2013)

Ancillary effects

Table 2. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG	Reduction in emissions arising from fertiliser manufacture if synthetic fertiliser application is reduced	Pellerin *et al.* (2013, p45)
Production	No significant effect	
Adaptation	Cover crops can provide significant adaptation benefits, by decreasing soil erosion and increasing soil water retention capacity	See Fiche A2 for further details
Environment	Improved water quality via reduced runoff	Schulte *et al.* (2012, p39) Kirk *et al.* (2012, p36) Wiltshire *et al.* (2014, p23)
Negative effects		
Off-farm GHG	No significant effects	
Production	Potential loss of production if they lead to switching from winter to spring cultivation.	Wiltshire *et al.* (2014, p24)
Adaptation	No significant effects, if the operation is applied in areas with suitable soils and adequate rainfall.	
Environment	Increased herbicide use	Schulte *et al.* (2012) Wiltshire *et al.* (2014, p23)

Safeguards against maladaptation

No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations

No significant one-off costs arising from the operation are predicted. Recurring costs arise from seed purchase and additional fieldwork for cultivation and destruction/incorporation of the cover crop. Savings may be made from reduced synthetic fertiliser application rates (see Table 3).

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Reduced fertiliser purchase CC planting and destruction	(€41/ha/yr) €160/tCO_2e	Pellerin *et al.* (2013)
Purchase of seed and fuel costs associated with cultivation of the crop	€71.20/ha/yr ~€50/tCO_2e	Schulte *et al.* (2012)
Seed (£55/ha/yr) Cultivation/drilling (£60/ha/yr) Incorporating crop residues (£25/ha/yr)	€165/ha/yr	Posthumus *et al.* (2013)

The cost-effectiveness is categorised as being in category 3, significant cost.

The main driver of variation in cost-effectiveness is likely to be the cost of the cover crop cultivation and incorporation, which will depend on the efficiency of cultivation. This operation is unlikely to be cost-effective in areas where cultivation costs are high, or where there is a risk of yield penalties through use of the cover crop. Given the limited private benefits of cover crops, payments are likely to need to offset a significant proportion of the farmers' costs of implementing the operation. These costs will vary depending on, for example, the particular cover crop, but should be sufficient to meet seed purchase costs and most, if not all, of the costs of planting and incorporating the cover crop. Payments should not provide compensation for lost production.

Control and Verification
Compliance could be verified in a number of ways:

- Integrated into current monitoring programmes (if they coincide with the cover crop cultivation timing).
- Via provision of proof of purchase of cover crop seeds
- Via remote sensing or aerial photography (Pellerin et al. 2013, p47)

Potential result indicators
P4C % of agricultural land under management contracts improving soil management and/or preventing soil erosion (ha)

P5E % of agricultural and forest land under management contracts to foster carbon sequestration/conservation

Extent to which the mitigation effect would be captured by National GHG Inventories
Changes in soil carbon stocks would require specific soil C emissions factors and would not be captured in most current approaches. N_2O reduction from reduced rates of conversion of applied N to N_2O, could be captured with a tier 2 approach if EFs for N losses under cover crops could be derived and verified. N_2O from reduced N application could be captured under T1 if cover crops lead to a reduction in total N application, and reduction in N due to cover crop could be established. Off-farm changes in emissions would not be captured.

Identified implementation challenges and barriers
Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Establishment of cover crop coincides with busy period in the farming calendar Reduces time to establish the following crop	Kirk *et al.* (2012, p34) Wiltshire *et al.* (2014, p21)
Cost of seed and cultivation	Kirk *et al.* (2012, p34), Wiltshire *et al.* (2014, p21)
Risk of damage to soil from establishing or destroying the cover crop in wet conditions	Kirk *et al.* (2012, p34)
Risk of negative affect on yield of following crop	Wiltshire *et al.* (2014, p21)
Concerns about herbicide use and resistance	Wiltshire *et al.* (2014, p21)
Lack of suitable land	Wiltshire *et al.* (2014, p21)
Other key risks/uncertainties	
Effect on N_2O emissions uncertain	Pellerin *et al.* (2013, p44) Kirk *et al.* (2012, p33)

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Fiche M3: Improved N efficiency - MITIGATION

Proposed RDP article and measure:

	Article	Measure
2007-2013	36 (a) (iv) 20 (a) (iv)	214: Agri-environmental payments 114 Farm advisory services 111 Vocational training and information actions
2014-2020	28 14 15	Agri-environment-climate Knowledge transfer and information actions Advisory services, farm management and farm relief services

Summary
Improved N efficiency was selected as a GHG mitigation measure as it reduces N surpluses and the use and production of mineral fertiliser while maintaining yield levels. Improved N efficiency reduces direct N_2O emissions from fertilized soils, indirect N_2O emissions that occur by the release of NH_3 and $NO_3^-$and upstream emissions of the production and transport of mineral fertilisers. The proposed operation is a result-oriented approach to improve N efficiency by providing payments when N-surpluses are reduced below a defined threeshold. As farmers are responsible for the selection, implementation and control of the management changes, it is a flexible operation and enables a learning process of the farmers. The monitoring and implementation of this operation is associated with an increased workload for farmers and managing authorities, however the cost of reduced N fertiliser application and positive environmental effects could make this an attractive operation. It should be combined with advisory services and training.

Regulatory requirements that have to be met
The regulatory law is defined by requirements of Nitrates Directive and related national legislation, which regulates the good agricultural practice of nitrogen fertilisation (Flessa *et al.*, 2012). However, requirements vary between Member States, and while some Member States apply codes of good agricultural practice according to Nitrates Directive in their whole territory, others limit it to selected “nitrate vulnerable zones”.

Further important regulations are the Water Framework Directive (WFD) and the EU NEC (National emission ceilings) Directive (Osterburg *et al.*, 2013). Changes of the baseline may occur in line with amendments of the action plans according to Nitrates Directive, and the implementation of WFD. These changes have to be considered when designing the operation.

General description of the action and operation
“N use efficiency” is the ratio of the amount of N in the harvested product and the amount of N that was introduced into the production system (relation of N-output to N-input). The objective of this measure is to increase N use efficiency (in brief: N efficiency) by reducing the mineral fertiliser application and reduction of N surpluses while maintaining yield levels. An improved N efficiency means that a larger share of the N fertiliser is used by the plants. Thereby the N input per unit of output is decreased. Yield decline needs to be prevented in order to avoid indirect land use changes which would decrease the emission reduction potential (Flessa *et al.*, 2012).
Improved N efficiency has the effect to reduce direct N_2O emissions from fertilized soils and indirect N_2O emissions that occur by the release of NH_3 and NO_3^- as well as to reduce upstream emissions of the production and transport of mineral fertilisers. The amount of direct and indirect emissions depend on the amount of N applied, the

type of fertiliser or manure, respectively, and a variety of factors related to site-specific, climatic, plant production, technical and management conditions (Osterburg *et al.*, 2013). An improved N efficiency means also decreased N farm surplus (assuming equal N output). While the N use efficiency of mineral fertilisers is comparatively high under good management conditions, organic fertilisers such as manure tend to show lower efficiencies due to higher gaseous losses and the fraction of organic N which is not immediately available for plant growth.

This action focuses on improving N efficiency by optimising the amount of fertiliser applied and factors that are influencing it while at the same time maintaining the yield level. This allows the saving on non-productive nitrogen, e.g. by reducing N fertiliser application and avoiding indirect effects by keeping yields at the same level. The optimisation of applied N is enabled by improved fertilisation planning as well as improved N application technology, amounts, and timing. Further, the setting of more realistic yield targets for the various arable crops (in view of the yields actually obtained) allows better adjustment of fertilisation and is a strong lever for mitigation (see Pellerin *et al.*, 2013, p27).

Fertiliser planning means to specify the fertiliser demand by plants and nutrient availability in order to optimise it. This is supported by farm data analysis and testing of soil and farmyard manure samples. This includes analysis of nutrient content of farmyard manure and other organic fertilisers as well as of the mineral N content in the soil and nutrient contents of plants and the calculation and interpretation of the farm N balance, including parcel-specific balances. Actions which can be performed in order to improve N efficiency are the use of appropriate types of fertilisers, better timing of application and according to the nutrient contents of plants, using measurements and technologies for precision application (Flessa *et al.*, 2012). For improving the fertiliser application technology see the *Fiche M4 Precise N application*.

N-efficiency might also be improved by the use of controlled-release fertilisers that are matching nutrient release with crop demand. NO_3 leaching and N_2O losses are thereby decreased (Weiske 2006; Flessa *et al.*, 2012). This is a promising technology but not mature enough for widespread recommendation via RDPs at the moment. Further pilot studies are recommended in the hope that these may be included in future RDPs.

Voluntary measures with the objective to improve N efficiency are:

- Improved fertilisation planning
- Result-oriented approaches
- Investment support (see Fiche Precise N application and Climate proof planned investments)

As the impacts of the different measures interfere with each other, it is difficult to clearly attribute impacts to the single measures. Also the total impact of the cumulated measures is associated with uncertainties. However, a reduction of N balances by 20 kg N per ha seems to be a realistic objective for comparatively intensive conditions of German agriculture (Flessa *et al.* 2012), with even higher reductions in intensive livestock systems. A recent French study about mitigation potential related to nitrogen fertilisation also conclude to an average rate reduction of 20 kg N/ha, which is 10 to 20% of the total amount, without impacting crop yields (Pellerin *et al.*, 2013, p27).

Proposed general operation
In order to achieve mitigation via the improvement of N efficiency, the following operation is proposed:

Payment by result approach to improve N efficiency by providing payments when N-surpluses are reduced to a certain amount

The reference level for the N balance could be either

- a legally defined maximum level of the N surplus,
- a typical surplus level in farms compliant with the codes of good farming practice,
- a surplus level derived from a standard calculation based on minimum N efficiencies for mineral and organic N inputs
- or the farm specific starting level at the beginning of the measure.

The data basis to measure the result should be an average over two or three years, as the performance of N efficiency varies depending on weather conditions.

The aim of this operation is to improve N efficiency by reducing the mineral fertiliser application and N surpluses. Farmers receive a premium if they agree voluntarily to reduce N surpluses to a lower level than defined by a reference level. In the case of Germany the Fertiliser Ordinance implementing Nitrates Directive limits N surplus to 60 kg N/ha/year on a three-years average. Each year farm balances have to be calculated. In this case, the limit for a voluntary agreement could be 40 kg N/ha/year (Flessa *et al.*, 2012). Such agri-environment measures have been applied in three German regions in the EAFRD (European Agricultural Fund for Rural Development) period 2007-2013.

Result-oriented approaches provide an incentive to achieve a target value of environmental outcomes. In comparison, action-oriented approaches are paying the farmer to not perform specific management practices with detrimental effects to the environment, or to adopt beneficial practices. Result-oriented approaches are often seen to be able to deliver better environmental outcomes than action-oriented approaches as it is a cooperative approach that allows farmers to incorporate existing knowledge and to develop further skills in a learning process. Further, as the payment depends on the outcomes, farmers are encouraged to perform activities only, but to achieve measurable results (Burton and Schwarz, 2013).

As the farmer is responsible for the selection, implementation and control of the measures he is more actively involved than in action-oriented measures were these tasks are mainly done by the managing authority. In case the target value is not reached, the farmer is able by himself to adapt and select appropriate measures in the following year. This allows a greater flexibility and enables a learning process how to improve N efficiency (Osterburg and Schmidt, 2008).

This operation should be accompanied by technical advice and/or training operations in order to identify weaknesses and potentials of the farms and to identify where additional knowledge or improved management and technologies are necessary (e.g. fertilisation planning, optimisation of fertiliser application, calibration of sprayers- see *Fiche M4 Precise N application*) (Osterburg and Schmidt, 2008; Flessa *et al.*, 2012; Osterburg *et al.* 2013). This operation could be further developed to improve efficiency to promote the reduction of losses during the management of farmyard manure (Flessa *et al.* 2012).

Operations aiming to reduce N surpluses exist in some states of Germany (Lower-Saxony (pilot project), Saxony-Anhalt, Thuringia and Brandenburg) since 2009/2010. They have potential to be further developed for livestock farms and the whole farm level. Therefore, further requirements for farm management should be specified that are to some extend integrated in good agricultural practices, such as documentation of farm and plot balances, data at farm level about purchases and sales, additional indicators, e.g. soil samples of the plots, farmyard manure and feed samples as well as samples of urea in milk (Flessa *et al.*, 2012).

Commitments, funding conditions and eligibility (description of the operation)

No specific management conditions are necessary besides to consistently provide data for nitrogen accounting on input and output at farm level in order to allow a documentation of the N balance surplus and to calculate N efficiency (utilisation) (Osterburg *et al.*, 2008).

Eligible activities

The performance of N efficiency should be evaluated at the level of the whole farm, and not on a single parcel basis, in order to avoid displacement effects within the farm. Instead of detailed prescriptions, farm specific N management adaptations should be undertaken. A reliable and consistent nutrient accounting system is necessary. It is recommended to elaborate a fertiliser plan (using EDV technique) on parcel level to have an overview over the on farm N management and to detect possibilities to reduce fertiliser input. Further, analysis of soil mineral N in spring should be assessed to take N reserves into account, for maize, sugar beet and vegetables in the late spring. Analysis of the slurry before spreading enables to know the N content and to determine the amount of fertiliser needed. To improve the acceptance this measure has to be supported by technical advice, at least in the beginning (Osterburg *et al.*, 2008).

Timing and duration

No timing restrictions exist. When deciding about the duration of the commitments (5, 7 or more years), it has to be considered that the measurement of results is based on the average of farm balances over several years, and such balances are calculated ex-post.

Location

All farms are suitable for this operation. However, the focus of this result-oriented approach should be on farms with potentially high N surplus, e.g. on livestock farms, particularly in target areas of the Water Framework Directive (WFD) and in intensive livestock farming regions, where it is necessary to reduce N surplus.

Synergies - Incompatible operations and recommended combinations

This operation should not be combined with other operations targeting to reduce N surpluses, e.g. action-oriented measures, as this would lead to double funding (e.g. M4 Precise N application, M14 Climate proof planned investments*)*. A compatible combination could be with M16 Carbon audit, as an initial analysis and advice.

Expected impacts on farm-level GHG emissions

The mitigation effect of improved N efficiency is positive. GHG emissions, in particular direct and indirect N_2O, develop through the application of N fertilisers as well as during the production of synthetic fertilisers. Reducing the amount of fertiliser applied through improved fertiliser planning, e.g. by the improvement of the accounting and use of N from farmyard manure leads to emissions savings. Therefore, also the application of N mineral fertiliser can be reduced resulting in a further reduction on GHG emissions.

Improved N-efficiency contributes to GHG abatement as:

- It reduces ammonia emissions and thus indirect N2O emissions.
- Less fertiliser is needed, which saves emissions from the production of synthetic N

Table 1. Abatement rates for improved N efficiency

Mitigation effect	**Abatement rate**	**Source**
Abatement rates of reduced N input		
Reduction of GHG emissions by saving 1 kg of non-utilised nitrogen from N fertilisation	17.5 kg CO_2e/kg N Including direct and indirect N_2O emissions and emissions from synthetic fertiliser production(12.5 g N_2O-N/kg N 6.1 kg CO_2e/kg N)	Flessa *et al.* 2012 Based on IPCC, 1996 (emission coefficients)
Reduce the nitrogen rate (19.7 kg/ha)	Unitary abatement potential (direct + indirect N_2O, upstream CO_2 and N_2O emissions from manufacture) = 299 to 331 kg CO_2e/ha (about 16 kgCO_2e/kg N)	Pellerin *et al.*, 2013 (p28)
Potential reductions of N input		
Improved fertiliser planning (reduce amount of applied N)	Expert interviews: Saving potential of 40 kg N/ha N-surplus and 20 kg N/ha of mineral N content in soil in autumn (Lower Saxony, Germany) Saving potential of 20 kgN/ha for French farms	Osterburg *et al.* 2007 Pellerin *et al.*, 2013

Ancillary effects

Table 2. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG	Reduction in emissions arising from fertiliser manufacture if synthetic fertiliser application is reduced	Flessa *et al.* 2012
Production	No shift in production level as yields shall be maintained while increasing N use efficiency	Pellerin *et al.*, 2013; Osterburg *et al.* 2013
Adaptation	-	
Environment	Reduced risk of nitrate leaching Positive environmental impacts, e.g. on biodiversity and improved water quality via reduced/more suited N application (reduced pollution, eutrophication and acidification)	Schulte *et al.* 2012 Flessa *et al.* 2012 Osterburg *et al.* 2013
Negative effects		
Off-farm GHG	No significant effects	
Production	No significant effects	
Adaptation	-	
Environment	No significant effects Increased export of organic N fertilisers can lead to displacement effects which can be	Schulte *et al.* 2012 Osterburg *et al.*

	avoided depending on the design of the measure (e.g. considering minimum N efficiencies for mineral and organic N inputs)	2008

Safeguards against maladaptation
When N efficiency is improved and yields are maintained no leakage effects occur. A decline of yields would lead to a shift of emissions to other production sites (Flessa *et al.*, 2012).

Coefficients for N-efficiency are calculated separately for mineral and organic N to allow for a documentation of efficiency improvements independent from structural changes, e.g. a reduction of livestock which would lead almost automatically to lower N surplus (Osterburg *et al.*, 2008).

Guidance on costs and payment calculations
The EU requires agri-environmental measure payments to be calculated based on additional cost and income foregone, considering the legal baseline. Payments by result do not require defined actions on which such calculations could be based on, thus they do not fit into the standard EAFRD approach. In order to be able to pay incentives based on results, the payment can be fixed via tendering, or (as is the case in the German programmes) in addition to the result component, activities such as participation in training sessions, detailed documentation of fertilisation and balances (beyond legal requirements), regular testing of soils, manure and plant etc. can be remunerated.

For this operation, costs arise for the additional time of the farmer for accounting N balances and fertiliser planning. Savings may be made from reduced synthetic fertiliser application rates (see Table 3). If this operation is combined with technical advice born by the farmer, the cost for this activity needs to be considered as well.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Cost of nutrient analysis and technical advice When 50 % of the recommendations are implemented	1 – 5 €/ ha/ year (0.15 and 0.75 €/kg N reduced)	Interwies *et al.* 2004
N balance: N reduced/ Cost-effectiveness Improved fertilisation management	30 kg N/ ha (2.7 €/kg N)	Osterburg *et al.* 2007
Reduce the nitrogen rate (19.7 kg/ha)	Management tool: 9.3 €/ha Savings of mineral nitrogen purchased: (18 €/ha) ⇨ Gain of (8.7 €/ha) Transaction cost: -18€/ha/yr ⇨ 9.3 €/ha/yr	Pellerin *et al.*, 2013 p28 & 85
N efficiency calculation (calculation of the N balance of	€706 per farm/year (1 day's work of a consultant,€529,	Crabtree *et al.*, 2008[2]

2 The cost of this publication was originally expressed in British pounds. For the calculation of the cost in Euro, the conversion rate £0.85 = 1 € was used.

the farm)	and cost of information provision by the farmer €176 €2.35 per ha/year	
Use fertiliser rate 10 % below the recommended rate for arable crops (loss in gross margin: €75 per ha; costs saved: €18 per ha)	€57.4 per ha	Crabtree *et al.*, 2008

The cost-effectiveness is categorised as being in category (1) negative cost or (2) no or low cost depending on the reference situation and required activities. Negative cost means that farmers show irrational behaviour when "over-fertilising" their crops. However, for many farmers it is not clear how far fertilisation could be reduced without losing yield technological, and fertilisation is often planned for optimal weather conditions while weather in reality varies within a wide range. Considering the need for incentive payments for changes of the management, and the transaction cost for advice and control, even category 3, significant cost, may occur from the perspective of the total cost of operation.

The GHG-abatement cost related to the reduction of N-surplus is relatively low. Sometimes it is possible that the abatement costs are higher than the additional cost. In recent years, N prices increased strongly which contributes to the improvement of the cost-effectiveness. Additional workload or necessary investments could however increase the cost. Further, in needs to be considered that the improvement of N-efficiency also contributes to other environmental objectives such as water quality and biodiversity. Therefore, the cost should not be attributed solely to climate mitigation (Osterburg *et al.*, 2013). When distributing the cost between different environmental objectives, the cost-effectiveness of the operation is increased.

Control and Verification

The effectiveness of the operation is verified by calculating the farm gate balance or with an area-based balance. The monitoring of these balances enables to proof if the targets are achieved (Flessa *et al.*, 2012). The three-year average of the N balances in the years before the participation or the planned participation provides the reference levels for N use efficiency (calculated separately for organic and mineral fertilisers) (Osterburg *et al.*, 2008).

As farmers are implementing the required analysis and calculating the nutrient balances by themselves increased requirements for controlling the results occur. Controls can be based on proofing the farmers activities regarding improved N efficiency such as participation in obligatory training courses, implementation of Nmin and manure analyses and the presence of own testing equipment and documentation. Further, a plausibility check on nutrient accounting is necessary. The verification of N balances is not possible at 100%, but adequate plausibility checks through different control approaches (e.g. control balances for completeness, correctness, plausibility of yields and N inputs and N test results of the parcel diary) which are complemented by training and advice can show the effectiveness of this operation (Osterburg and Techen, 2011).

Potential result indicators

% of agricultural land under contracts to reduce the N surplus to a certain amount which is lower than the regulative law (ha)

Amount of N input reduced (in metric tonnes)

P5 D "Reducing greenhouse gas and ammonia emissions from agriculture"

- Target indicator:
    - LU concerned by investments in livestock management in view of reducing GHG and/or ammonia emissions
    - % of agricultural land under management contracts targeting reduction of GHG and/or ammonia emissions
- Complementary result indicators:
    - Reduced emissions of methane and nitrous oxide (measured in CO_2 equivalent)
    - Reduced ammonia emissions (measured in CO_2 equivalent)

Source: EU (2013) Draft target indicator fiches for Pillar II + complementary result indicators. Working document. Evaluation Expert Committee 18/9/2013, Rural Development Committee meeting on 19/09/2013.

Extent to which the mitigation effect would be captured by National GHG Inventories
The reduction of direct and indirect N_2O emissions that are related to decreased fertiliser application is captured in the national GHG inventories (IPCC). Emission reductions related to fertiliser production is captured for the national fertiliser production but not credited for the agricultural sector. However, effects on fertiliser imports are not depicted in the national GHG accounts. Improved N efficiency relating to increased yields without the reduction of N-fertiliser is not causing reductions of GHG emission but of emissions per unit of output. These changes of efficiency are not captured in the national GHG inventories (Flessa *et al.*, 2012).

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Result-oriented approach more risky than action oriented approach as farmers are only rewarded if the desired effect on N use efficiency is achieved.	Osterburg *et al.*, 2008
A reliable and consistent nutrient accounting system is necessary.	Osterburg *et al.*, 2008
Leakage effects: for participants with low N balances it is beneficial to participate	

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Fiche M4: Precise N-application - MITIGATION

Proposed RDP article and measure:

	Article	Measure
2007-2013	26	121 Modernisation of agricultural holdings
2014-2020	17	Investments in physical assets

Summary

Precise N-application may be achieved by supporting the use of more efficient and specialised technologies (e.g. more efficient machineries and equipment). The three proposed operations promote this through 1) financial support for the purchase of site-specific fertilisation and precise fertiliser application technologies, 2) the financial support for hiring contractors that use these technologies and 3) the calibration of fertiliser spreaders. All three actions/operations mainly reduce NH_3 and thus indirect N_2O emissions and reduce N-excess on the field. Thus, less fertiliser is needed and emissions from the production of synthetic fertiliser are reduced as well. There are substantial costs for the purchase of technology. However, the saved amounts of mineral fertiliser partly or even over-compensate these costs. Still, investment support is a reasonable measure in order to promote technological change, as high initial investment costs might discourage framers from switching to more efficient technologies. In addition, the operations do not only promote emissions reduction, they also have a number of positive ancillary effects (e.g. reduced eutrophication and biodiversity loss, reduction of odour emissions, possible promotion of further technological change and innovation).

Regulatory requirements that have to be met

On EU level the EU NEC (National Emission Ceilings) Directive, which restricts emissions of nitrogen oxides and NH_3 and the Nitrates Directive need to be complied with. These specifications are implemented in national regulations (e.g. the fertiliser ordinance in Germany). In addition, the EU technological norms for agricultural machinery (Norm DIN EN 13406) need to be considered when defining norms for different RDP operations. As the technological state differs between the Member States, the operations should be adapted to current technological situation in the Member State and requirements should be designed as top-ups to existing national regulations in order to avoid deadweight effects (i.e. avoid supporting beneficiaries that would also have invested into more efficient technologies without support incentives). The uptake of these operations could promote technological development in some Member States.

General description of the action and operation

The precise application of nitrogen considers plant requirements and site conditions while aiming at an efficient use of N-fertilisers in order to avoid excess amounts of nitrogen and related emissions. In addition to N_2O emissions, N-application mainly causes NH_3 emissions and thereby also contributes to indirect N_2O emissions. Several aspects contribute to a precise N-application. The identification of plant specific needs via yield potential maps, (optical) sensor technology and the use of plant growth models and artificial neural networks allows for the determination of the appropriate amount of fertiliser and thus site-specific application of nitrogen. As the yield map approach does not always provide accurate predictions (Blackmore *et al.* 2003), Ehlert and Thöle (2008) recommend to combine these maps with a sensor approach. As the spectral signature of plants changes if they experience stress, the sensor approach can be used to measure different plant growth parameters (e.g. via optical measurements) and identify their specific needs. Plant growth models and artificial neural networks are then applied to interpret these measurements and help to derive management recommendations (e.g. for fertilisation). Site-specific N-application and precision farming can best deploy their potential on heterogeneous fields (Flessa *et al.* 2012).

The application process as such can also be improved in order to reduce emissions. Immediate incorporation of urea containing fertiliser (e.g. via injection) is proven to significantly reduce ammonia emissions (Velthof *et al.* 2003; Liu *et al.* 2006; Schmidthalter *et al.* 2010). Furthermore, a precise calibration of fertiliser spreaders reduces N-losses. According to the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN) (2008), a variation coefficient of 15% of fertiliser distribution leads to a 10% increase in N-losses and an 8% increase in nitrate leaching in comparison to a "perfect" distribution. An ideal coefficient of variation should stay below 10%. Although the same principles apply to synthetic fertilisers and farm yard manure, it should be discerned between them as different technologies are needed. The technology for site specific N-application is only suited for mineral fertiliser so far (Flessa *et al.* 2012).

In order to reduce emissions due to the application of farmyard manure and digestates, broadcast spreading techniques should be replaced by more accurate ones such as the use of trailing hoses/shoes. The higher precision of these technologies also allows for the application of manure into the growing crops. Injection is also an efficient technique in order to reduce NH_3 emissions, but it might increase N_2O emissions (Boeckx and Van Cleemput 2001; Rühling *et al.* 2005; Webb *et al.* 2010; Weiske and Michel 2007; Wulf *et al.* 2002). Further research is necessary. Overall, GHG emissions of injection and trailing hose application do not differ much, if mineral fertiliser production is considered as well (Flessa *et al.* 2012). In contrast to injection, trailing hose/shoe application does not cause increased direct N_2O emissions. High losses of NH_3, however, reduce the fertiliser value of manure and thus additional mineral fertiliser is needed. However, as the higher NH_3 losses with the trailing hose and the associated reduction in fertiliser value need to be replaced by mineral fertiliser, there is no big difference between the GHG emissions of both techniques (Flessa *et al.* 2012). As described in the operation fiche "Increase N-efficiency", precise N-application also relates to fertiliser type and the right timing for fertilisation.
In order to avoid ineffective investments, farms should incorporate efficient N-application into an overall strategy for manure handling and fertilisation (Flessa *et al.* 2012). Here precise N-application plays an important role, since emissions saved during previous manure handling can be released during application (Weiske *et al.* 2006).

Proposed general operations
In order to achieve mitigation via precise N-application, the following operations are proposed:

1) Investments in precise N-application technology
   a) Financial support for the acquisition of the site specific fertilisation technology (using a GPS systems can help to save inputs such as fertilisers, fuel and reduces N-excess on the fields).
   b) Financial support towards buying fertiliser spreaders, which have a low coefficient of variation (synthetic fertilisers and farm yard manure) (e.g. place N in the soil via injection)
2) Financial support for hiring contractors who are using these techniques
3) Financial support for the calibration of spreaders

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
Operation 1) The Programming Authorities (PA) should formulate a list of eligible technologies that can be supported according to the state of technology in their country. It is important to consider the current state of technology, in order to avoid deadweight effects.
For site-specific fertilisation (1a), only sensor and modelling /artificial neural network approaches are supported. The map approach is only supported in combination with a sensor approach, as the fertilisation based on yield maps alone is no reliable option for reducing GHG emissions (Flessa *et al.* 2012). It cannot be used with farm yard manure/slurry.
The list mentioned above should also specify eligible coefficients of variation for fertiliser spreaders (1b).
Recommended coefficients of variation:

- for synthetic fertiliser spreaders: less than 10% (NLWKN 2008)
- Trailing hose: 5 – 10% (manure) (Flessa *et al.* 2012)
- Broadcast spreading: the EU norm DIN EN 13406 requests a maximal coefficient of variation of less than 30%. However, a coefficient of less than 10% (manure) (Flessa *et al.* 2012) is possible. The coefficient of variation can be improved by replacing splash plates by trailing hoses or improved broadcast technologies (to be used only in combination with immediate incorporation of manure into the soil).
- For manure tankers the classifications presented in Table 1 are developed by Frick (1999). Only spreaders that are classified as very good shall be supported.

Table 1 Classification of coefficients of variation for manure spreaders (Frick 1999)

Coefficient of variation (manure tankers)	**Classification (Frick 1999)**
<10%	Very good
10 – 15%	Good
15 – 20%	*Satisfactory*
20 – 30%	*Insufficient*
> 30%	*Unsatisfactory*

Real performance of spreading machinery is unknown throughout the EU, and EU norms have to be complied with on a voluntary basis. To establish an objective basis for investment aid, variation coefficients of each type of agricultural spreading machine should be evaluated according to the existing EU norms by independent authorities, and results should be published.

As the variation of emissions between the different application technologies is smaller than between different amounts of manure produced, the size of farm/amount of manure produced should be taken into account (Weiske 2006; Weiske *et al.* 2006). PA should define a threshold for minimum farm size/ manure production amount in order for farms to be able to get support for new technology. If the threshold is not reached, cross-farm solutions should be considered e.g. the hiring of contractors (see operation 2).

Operation 2) The hiring of contractors can only be supported, if they also comply with the technological standards defined for operation 1.
Operation 3) Calibration is always an option to improve fertilisation. However, calibration should be part of good farming practice to be recommended through technical advice. It can be promoted by financially supporting the hiring of contractors that do the calibration. Another option would relate to technical advice on how to calibrate their spreaders (Fiche for "Improved N-efficiency").

Timing and duration
Existing banning periods and soil conditions (frozen, snow-covered, and waterlogged) have to be considered according to legal requirements implementing Nitrates Directive. In order to reach a high uptake of improved spreading technology, investment aid could be offered for a limited period, during a transition time until obligatory requirements are introduced.

Location
Operation 1a) Site-specific fertilisation should especially be applied to heterogeneous fields. Their occurrence depends on different types of landscapes and soil conditions.
Operation 1b) Trailing hose and trailing shoes are less manoeuvrable and are only of limited use on slopes (KTBL 2011).

Synergies - Incompatible operations and recommended combinations
As the use of optimised fertilisation technology also reduces the amount of N application, it should not be combined with other measures that are evaluated according to the reduction of N-excess on the field in order to avoid double funding (Flessa *et al.* 2012).

As all emissions from manure that are saved due to other mitigation operations can be emitted during N-application, they should be combined with a precise N-application. This relates especially to:
M 14 Climate proofing planned investments (e.g. covering of manure and digestate storages)

Expected impacts on farm-level GHG emissions
Precise N-application contributes to GHG abatement as:

- It reduces ammonia emissions and thus indirect N2O emissions.
- Less fertiliser is needed, which saves direct N2O emissions and emissions from the production of synthetic N

Because of a more precise application and incorporation of fertiliser into the soil, direct N_2O emissions might increase.

Operation 1a) The abatement potential (CO_2e/ha) of site specific fertilisation differs with respect to the approach:

- sensor approach: mean: -315 CO2e/ha, range:-368 CO2e/ha – 123 CO2e/ha (mean with weighted median according to the number of experiments; Ehlert und Thöle 2008; Werner et al. 2008, Maidl 2009, Wagner et al. 2005)
- plant growth model: -26 CO2e/ha (Link et al. 2008),
- artificial neural network: -621 CO2e/ha (Wagner et al. 2005, Werner et al. 2008)

Operation 1b) According to the the results of the flow-based FARM GHG Model (Olesen *et al.* 2004) the application with trailing hose and the use of injection reduce farm GHG emissions (CO_2e/kg milk) for conventional farms (incl. indirect gaseous emissions and saved emissions from reduced synthetic N-production) by 0.7%, and 3.2% respectively compared to broadcasting (Weiske *et al.* 2006). Table 2 displays possible CO_2e savings that can be attained by using different application techniques instead of broad cast application. The CO_2e were estimated based on NH_3 emissions from manure application (based on KTBL 2011). Although more precise application also reduces direct N_2O emissions from the soil and indirect N_2O emissions from leaching, the calculation was only based on the NH3 emissions. Due to less ammonia emissions the fertiliser value of manure increases and less mineral fertiliser is needed. The saving of the upstream emissions for fertiliser production makes up a main share of the abatement potential. The data was calculated according to the assumption that the whole amount of N in the manure that is saved due to ammonia emission reduction replaces N of synthetic fertiliser. In reality this might not be the case, however, the emission savings due to reduced direct N_2O emissions more than cancel this effect. In case cattle manure is used, abatement rates are higher as cattle manure is less fluid and does not infiltrate into the soil as fast as pig manure.

Table 2 Estimated CO_2e abatement potentials of different manure application techniques (Reference technology: broadcast spreading) (calculations based on KTBL 2011).

		Cattle manure	**Pig manure**
Technology	**Saved CO_2e from:**	**kg CO_2e /m^3**	
Trailing hose	NH_3 reduction	2.39	1.92
	Synthetic N production	1.48	1.48
	Sum	**3.87**	**3.40**
Trailing shoe	NH_3 reduction	4.84	3.90
	Synthetic N production	3.00	3.00
	Sum	**7.84**	**6.90**
Injection	NH_3 reduction	7.25	5.85
	Synthetic N production	4.51	4.51
	Sum	**11.76**	**10.36**

Operation 2) as the used technologies are the same as in 1a +b, similar effects are expected when contractors are engaged.

Operation 3) no quantitative assessments exist for calibration.

Ancillary effects

Table 3 Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG	Reduction in emissions arising from fertiliser manufacture if less synthetic fertiliser is needed.	Flessa *et al.* 2012
Production	Due to higher fertiliser values and optimised spreaders, productivity is increased. More precise application of farm yard manure leads to a lower contamination of crops and high quality of products.	Flessa *et al.* 2012. Weiske *et al.* 2006
Adaptation		

Positive effects		**Source**
Environment	Reduced NH_3 emissions reduce eutrophication of water bodies and preserves biodiversity, reduction of odour emissions due to incorporation.	Flessa *et al.* 2012 p. 181 Weiske *et al.* 2006
other	Operations might induce further technical development and innovation.	
Negative effects		
Off-farm GHG		
Production		
Adaptation		
Environment		
other	Possible deadweight effects, greater costs for additional storage (in case less manure is applied).	

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations
One-off costs arising from the operation:
Operation 1a+b) Machine costs: purchase of technology/equipment, maybe machines with more tractive force are needed (Weiske 2006)
Operation 1a) Here the focus is on the sensor approach (Rösch *et al.* 2005):

- Data collection: 5,800 -26,000 €;
- Application technology: several thousand euros;
- Navigation technology (not absolutely necessary): 15,000 – 25,000 €

Recurring costs:
Operation 1a+b) Operating costs might be higher: increased cost for labour (-> more time consuming) and higher fuel demand (Weiske 2006). A more efficient geometry, however, might reduce fuel demand, negative costs result from reduced costs for fertiliser purchase and potentially higher yields.

Operation 1b) see table 4

Table 4 Cost for manure application in relation to application technique and amount of manure application and conserved N (figures in brackets are savings) (synthetic N price: 0.9 €/kg N) (KTBL 2011).

Amount of manure application (m^3 $year^{-1}$)	1,000	3,000	10,000	100,000	Pig manure	Cattle manure
	Cost for manure application (€/m^3 of manure applied)				**Credit for conserved N (€/m^3)**	
Broadcast spreading (reference)	6.61	4.31	3.04	2.49	-	-
Trailing hose	8.76	5.08	3.38	2.57	(0.27)	(0.23)

Trailing shoe	9.68	5.87	4.11	-	(0.45)	(0.45)
Injection	9.97	6.16	4.37	2.89	(0.68)	(0.54)

Costs for manure application decrease with increasing amounts of applied manure irrespectively of the used technology. Thus, cross-farm solutions would be more efficient, if the amounts of manure applied are too small. Broadcast spreading is the cheapest technology for application. However, less fertiliser is needed using more precise technologies. As pig manure flows more easily, it infiltrates into the soil much faster than cattle manure and thus conserves even more N (KTBL 2011).

Operation 2) As contractors better use the full capacities of the applied technologies, the costs are lower than for small farms and small amounts of manure applied. The costs are similar to those in operation 1, where huge amounts of manure are applied.

Operation 3) Costs for fertiliser calibration are included in Table 5. The calibration of a spreader by a contractor costs 210 € on average, which results in about 1.69 € per ha. Due to the more efficient use of fertiliser in comparison with spreaders that are not calibrated, 18.1 € per ha can be saved. This leads to a net benefit of 16.2 € per ha.

Table 5: Costs of fertiliser calibration (Crabtree *et al.* 2008), £ converted to € (1€ = 0.85£) (figures in brackets are savings)

	Mean	**Range**
Cost per spreader (€)	210	217 – 377
Cost (€ per ha)	1.69	0.24 – 6.22
Benefits (€ per ha)	(18.1)	(1.76) – (57.6)
Net benefit (€ per ha)	**16.7**	**-0.02 – 57.4**

Cost effectiveness:
The variation in cost-effectiveness depends on the reference case, the necessary investments into technology and the size of the agricultural area/ amount of fertiliser that needs to be applied. This operation is unlikely to be cost-effective in areas where technology standards are high already. Cost of the measure should not be attributed only to climate protection, but also to other environmental benefits, e.g. water quality.

Operation 1a) Category 3: significant cost (Abatement costs (Lower Saxony) 51 -327 €/t CO_2e, costs depend on the necessary capital investment, the size of arable land (Osterburg *et al.* 2013))

Operation 1b): the cost category depends on the degree of utilisation of the machines (Table 6 and 7). Thus for small amounts of manure costs are relatively high (category 3), for medium amounts (10,000 m^3 of manure) costs for some technology are in category 2 and for 100,000 m^3 costs are even negative (category 1). As NH_3 reduction also contributes to cleaner air, the abatement costs need to be allocated between the climate targets and the clean air targets. Here the costs were evenly distributed between both targets (50% allocation) in order to account for the multifunctional effects of NH_3 reduction.

More precise manure application technologies are only profitable where huge amounts of manure are applied. Thus the purchase should only be supported in case enough manure is applied (e.g. via cross-farm solutions and co-operation between farmers).

Table 6 Abatement costs for different manure application techniques in relation to amount of cattle manure applied (Reference technique: broadcast spreading) (figures in brackets are savings) (calculations based on KTBL 2011).

Cattle		Amount of manure application (m^3)				
		1000	3000	10000	30000	100000
Technology	**Abatement cost**	**€/t CO_2e**				
Trailing hose	Total cost	487.3	137.3	28.5	(24.1)	(40.1)
	50% allocation to climate aim	243.7	68.7	14.2	(12.1)	(20.1)
Trailing shoe	Abatement cost	332.9	141.0	79.1	58.4	
	50% allocation to climate aim	166.4	70.5	39.5	29.2	
Injection	Abatement cost	227.5	99.4	55.3	67.8	(23.8)
	50% allocation to climate aim	113.7	49.7	27.6	33.9	(11.9)

Table 7 Abatement costs for different manure application techniques in relation to amount of cattle manure applied (Reference technique: broadcast spreading, synthetic N price: 0.9 €/kg) (calculations based on KTBL 2011).

Pig		Amount of manure application (m^3)				
		1000	3000	10000	30000	100000
Technology	**Abatement cost**	**€/t CO_2e**				
Trailing hose	Total cost	542.7	144.7	20.6	(38.0)	56.9)
	50% allocation to climate aim	271.3	72.4	10.3	(19.0)	(28.5)
Trailing shoe	Abatement cost	378.6	160.6	89.9	66.3	
	50% allocation to climate aim	189.3	80.3	45.0	33.2	
Injection	Abatement cost	272.3	126.3	76.2	90.5	(13.6)
	50% allocation to climate aim	95.0	75.9	35.7	41.5	(8.3)

Operation 2) Cost effectiveness assumed similar as in operation 1. In general, contractors would utilise the capacities of their machines better and thus abatement costs probably belong to category 1 or 2.

Operation 3) Category 1: negative costs. Money can be saved as less fertiliser is needed.

Control and Verification
Compliance could be verified in a number of ways:

- Operation 1, 2) Via provision of proof of purchase of machines/ contracts with contractors for such machines, and submission of documentation about fertiliser planning including documentation stemming from the application of the computerised sensing and distributing system.
- Operation 3) Certificates for machine calibration.
- Operation 3) Random inspection of spreaders and their coefficients of variation, proof via certificates of contractors or result tables of the calibration tests.

Potential result indicators
P5 D "Reducing greenhouse gas and ammonia emissions from agriculture"

- Target indicators:
  - LU concerned by investments in live-stock management in view of reducing GHG and/or ammonia emissions
  - % of agricultural land under management contracts targeting reduction of GHG and/or ammonia emissions
- Complementary result indicators:
  - Reduced emissions of methane and nitrous oxide (measured in CO_2 equivalent)
  - Reduced ammonia emissions (measured in CO_2 equivalent)

P2 A "Improving the economic performance of all farms and facilitating farm restructuring and modernisation, notably with a view to increase market participation and orientation as well as agricultural diversification":

- Target indicator: % of agriculture holdings with RDP support for investments in restructuring
- Complementary result indicator: Change in Agricultural output on supported farms/ AWU

Extent to which the mitigation effect would be captured by National GHG Inventories
Ammonia emissions and indirect N_2O emissions from the application of farm yard manure are included. NH_3 emissions are reported under the National Emission Ceilings Directive 2001/81/EC, and depending on the national accounting systems, these emissions are included into the GHG accounts. If this is the case and activity rates (such as the share of emission-reduced slurry application) are part of farm surveys, different application techniques can be differentiated and credited against the GHG reduction aims. Reduced synthetic fertiliser purchase are captured in the inventory, as well as saved upstream emissions from reduced production, but the latter not under source category 4 "Agriculture" (Flessa *et al.* 2012).

Identified implementation challenges and barriers

Table 6: Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Complexity of site specific fertilising technology	
Not enough trained personnel for site specific fertilisation technology	
Lack of information and knowledge about possible techniques and solutions	
Capital costs for site specific fertilisation technology	
Other key risks/uncertainties	
Uncertainty relating to the increased N_2O emissions following injection	Flessa *et al.* 2012

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Fiche M5: Biological N fixation in rotations and in grass mixes - MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	36 (a) (iv)	214: Agri-environmental payments
2014-2020	28(1)	Agri-environment-climate

Summary
Area based payments for grain and forage based legume production are proposed. Benefits include:

- Reduced GHG emissions (direct N_2O and CO_2 from fertiliser manufacture).
- Reduced energy use in agriculture.
- Increased protein security in Europe.
- Reduced land use change (tropical deforestation) outside Europe.

Regulatory requirements that have to be met
There are no mandatory policies or specifications of good farming practice to support the use of nitrogen fixing crops in European agricultural systems.

General description of the action and operation
Nitrogen (N) fixing crops belong to the family *Leguminosae* and are commonly described as legumes. They form symbiotic relationships with bacteria in the soil that allows them to fix atmospheric N and use this in place of N provided by synthetic fertilisers. Leguminous crops are able to fix in excess of 300 kg N/ha/y making the N input comparable with quantities of synthetic N applied to many crops. Legumes also provide other benefits which include the provision of N to subsequent crops, their value as a break crop in arable rotations (suppressing the incidence of weeds and diseases), and potential biodiversity benefits (Rees *et al.* 2014; Bues *et al.* 2013).

N fixing crops fall into two main categories; the grain legumes which includes peas, beans and soya, and the forage legumes which include clover and alfalfa. Although these crops differ significantly in their role within farming systems and geographical distribution, their contribution to N inputs into agricultural systems is important.

Forage legumes form a major source of protein for ruminants, and therefore, provide an important link between crop and livestock farming systems, providing an opportunity to increase the recycling of nutrients within a farming enterprise and therefore minimise nutrient losses (Luscher *et al.* 2014). Mixed farming systems have historically been dependent on locally produced forages, thereby reducing the need for long distance transport which is rarely economically viable or environmentally sustainable. The use of legume based forage systems predates the use of N fertilisers to produce forage crops, but is still practiced extensively in organic rotations. Due to increasing costs of fertiliser N, there is some evidence to suggest that such rotations are becoming more widespread in conventional farming.

Grain legume production in Europe has declined significantly in recent decades, with the area under production of Faba bean being now only around 10 % of levels in the early 1960s (FAO 2012). Most grain legumes consumed in Europe are used as livestock feeds. Although European production of grain legumes has reduced, consumption has increased though imports of mostly South American soya. There is a perception amongst farmers that grain legume production is less profitable than the production of cereals. Although this is the case in some areas, a recent analysis has shown that in some regions of Europe, current market conditions make it profitable to produce grain legume crops if the full range of benefits is taken account of.

Legumes can mitigate GHG emissions in four main ways:

- Reducing direct emissions from N fertilisers
- Reducing the CO2e emissions from fertiliser manufacture
- Reduction in N leaching
- Reduction in the amount of N that needs to be applied to the following crop.

Proposed general operation
It should be considered that legume crops will enter as equivalent measures of greening. In order to achieve mitigation via the use of legumes, the following operation is proposed:

The hectare premium (such as existed until recently in the CAP for peas, field beans and sweet lupins) appears to be the most effective in increasing the area under grain legumes – although even so it cannot reverse the decline that has taken place in recent years. It leads to a small increase in farmers' incomes (although achieved by arable farmers at the expense of livestock farms).

For forage legumes, an area-based payment is proposed, where the forage is cultivated for a minimum of one year as a part of an arable rotation or long term grassland. Payments would be conditional on maintaining at least 25% of the grass/legume mixture as a legume, and on using N application rates that are lower than those for grass only forages.

Commitments, funding conditions and eligibility
When developing a specific operation, Managing Authorities (MA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities

1. *Grain legumes*

- Planting of legumes should take place within normal arable rotations (and reduction of N application to following crop applied)
- PA should provide a list of eligible rotations and legumes, based on local agronomic expertise. In general, suitable legumes will be suited to the local climate (Rees et al. 2014).
- No fertiliser (synthetic or organic) should be applied to the grain legume crop.

2. *Forage Legumes*

- Planting of forage legumes should take place as part of the normal sequence of pasture cultivation and reseeding
- PA should specify a minimum seed-sowing rate to provide a sufficiently dense canopy.
- Reduced fertiliser (synthetic or organic) should be applied to the forage legume crop (relative to a grass only crop).

Timing and duration
MA should define the appropriate period of planting and the minimum and maximum length of legume cultivation.

MA should provide advice on N fertiliser application rates to forage legumes and fertiliser recommendations to crops following grain legumes on the basis of national recommendation systems.

Location
MA should define the areas within which the operation is available (Nitrate Vulnerable Areas should be the most eligible areas), taking into account the following points (based on Rees *et al.* (2014):

- Legume cultivation is widely applicable on different soil types in arable and grassland rotations; however, they are best suited to light soils types with moderate to high pH and P status.
- The residues left by legume crops can result in rapid losses of N, so it is important to ensure that ground is not left fallow following the incorporation of legume residues.

Incompatible operations
None anticipated

Expected impacts on farm-level GHG emissions
The main on-farm mitigation effect of legumes is via reduced or avoided nitrous oxide emissions (see Table 1). These effects would apply where grain legumes replace cereals or other arable crops in a rotation. There is also an indirect benefit in terms of GHG mitigation through avoided tropical deforestation (and carbon emissions) in regions such as Brazil. The inclusion of legumes in rotations has also been shown to allow carryover of residual N to subsequent crops, thereby reducing the fertiliser requirement of subsequent crops and associated N_2O emissions (Buses *et al.* 2013).

Table 1. Abatement rates for cover crops sown during the fallow period of arable rotations

Mitigation effect	Abatement rate	Source
Reduce direct and indirect N>N_2O EFs	Highly variable	
	Grain legumes 1.04 tCO_2e/ha/yr	Pellerin *et al.* (2013)
	Forage legumes 0.17 tCO_2e/ha/yr (0.6-2.7 tCO_2e/ha/yr)	Pellerin *et al.* (2013)

Ancillary effects
Table 2. Ancillary effects of the operation

Positive effects		Source
Off-farm GHG	Reduction in emissions arising from fertiliser manufacture if synthetic fertiliser application is reduced	Pellerin *et al.* (2013, p45)
Production	No significant effect	
Adaptation	When used as cover crops, they can provide significant adaptation benefits, by	See Fiche M2 for further details

Positive effects		Source
	decreasing soil erosion and increasing soil water retention capacity	
Environment	Improved water quality via reduced leaching of nitrate	(Nemecek *et al.* 2008)
Negative effects		
Off-farm GHG	No significant effects	
Production	Greater yield variability in response to weather variability	Rees *et al.* 2014
Adaptation	No significant effects, if the operation is applied in areas with suitable soils and adequate rainfall.	
Environment	Potential N loss by leaching if residues left on bare soils	(Jensen *et al.* 2010)

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations
No significant one-off costs arising from the operation are predicted.

Savings may be made from reduced synthetic fertiliser application rates (see Table 3).

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	Total cost	Source
Reduced fertiliser purchase	(€19-31/ha/yr)	Pellerin *et al.* (2013)
Purchase of seed and fuel costs associated with cultivation of the crop	€71.20/ha/yr ~€50/tCO_2e	Schulte *et al.* (2012)
Seed (€66/ha/yr) Cultivation/drilling (£60/ha/yr)	€126/ha/yr	Posthumus *et al.* (2013)

The cost-effectiveness is categorised as being in category 3, significant cost.

The main driver of variation in cost-effectiveness is likely to be the potential yield and income loss of an alternative crop, which will depend on climate, soils and agronomy. This operation is unlikely to be cost-effective in areas where there is an unfavourable climate.

Given the limited private benefits of legume crops, payments are likely to need to offset a significant proportion of the farmer’s costs of implementing the operation. These costs will vary depending on, for example, the particular legume, but should be sufficient to meet seed purchase costs and most, if not all, of the perceived yield penalty.

Control and Verification
Compliance could be verified in a number of ways:

- Integrated into current monitoring programmes.
- Via provision of proof of purchase of legume seeds and fertilisers
- Via remote sensing or aerial photography (Pellerin *et al.* 2013, p47)

Potential result indicators
Reduced imports of grain legumes into the EU

Extent to which the mitigation effect would be captured by National GHG Inventories
N_2O reduction from reduced rates of fertiliser application and cultivation of legumes (with an EF1 for direct emissions of 0) would be captured by current inventories.

Off-farm changes in emissions would not be captured within the EU, but may be reflected in AFOLU (agriculture, forestry and land use) reporting in reduced tropical deforestation.

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Potential yield penalties	(Luscher *et al.* 2014)
Yield variability	(Jensen *et al.* 2010)
Nutritional barriers (livestock)	(Luscher *et al.* 2014)
Other key risks/uncertainties	
Policy decision over whether to allow cultivation of GM soya, which could increase the attractiveness of legume cultivation to farmers	Rees *et al.* 2014

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Fiche M6: No tillage - MITIGATION

Proposed RDP articles and measures

	Article	Measure
2007-2013	20 (b) (I) (IV) (V), 29, 36 (a) (IV)	121: Modernisation of agricultural holdings 214: Agri-environment payments
2014-2020	15 17 28 29	Advisory services Investments in physical assets Agri-environment-climate Organic farming

Summary
No-tillage or no-till (NT), also called zero tillage, is a soil cultivation system in which seeds are deposited directly into untilled soil. NT farming systems ensure soil conservation, with biodiversity and water conservation. This crop management can be considered as mitigation and adaptation option and thus being promoted as a measure to be supported under the United Nations Framework Convention on Climate Change (UNFCCC). Several studies have pointed out the effects (positive and negative) of this crop management. NT has traditionally been recommended as a way to enhance carbon sequestration (or to avoid carbon losses), but recently, some studies show no statistical difference in terms of carbon storage between NT and conventional tillage (CT).

Strengths:

- soil quality improvement
- saving in fuel and labour,
- environmental benefits (e.g. reduction in soil erosion)
- increase biodiversity (soil microorganism)
- better water efficiency/quality

Weaknesses:

- not suitable for all soil types (compaction of clay soils)
- not suitable for all crops
- increase in weeds
- increase in pest disease
- potential increase in N_2O emissions (related to fertilisation practices)

Regulatory requirements that have to be met
There are no EU-wide harmonised specific policy measures to support the implementation of NT in European agricultural system. At Member States level, cross compliance requirements regarding control of soil erosion can contain prescriptions for reduced tillage. Some experiences through current RDPs show the possibility to implement measures related to NT and NT + cover cropping.

General description of the action and operation
NT is defined "as a system of planting (seeding) crops into untilled soil by opening a narrow slot trench or band only of sufficient width and depth to obtain proper seed coverage" (Derpsch *et al.*, 2010). No other soil tillage is performed. No-till is an

agricultural technique that increases the amount of water that infiltrates into the soil and increases organic matter retention and cycling of nutrients in the soil. In many agricultural regions, it can eliminate soil erosion. It increases the amount and variety of life in and on the soil.

It has been proven that no-till can significantly reduce soil erosion and conserve water in the soils. This is regarded as a basis for higher and more stable crop yields, but many studies shows that this is not necessarily true. Discouragingly, there are numbers of examples of no yield benefits or even yield reductions under no-till, especially in the first up to ten years. Although humus can be enriched under no-tillage, the sequestration of soil carbon, as result of the accumulated organic matter in the topsoil, is restricted to the upper 10 cm of the soil. However, the possible C mitigation due to NT practice could be only temporary, because in the case that the soil is ploughed after some years the C stock can be partially volatilised. Indeed, the accumulation is reversible if conventional tillage is adopted after several years of NT. This contributes to additional uncertainties of the operation regarding the long-term effectiveness for mitigation.

Compared with ploughing, no carbon benefit, or even a carbon deficit, has been found at soil depths below 20 cm. This is why no-till makes little or no contribution to carbon sequestration and does not prove to reduce greenhouse gas emissions in croplands. The quantification of carbon sequestration rates under no-till are still highly doubtful.

The most significant benefit of NT is improvement in soil biological fertility, making soils more enduring to soil impoverishment. Farm operations are made much more efficient, particularly improved time of sowing and better trafficability of farm operations. Soane *et al.* (2012) summarised the results from several studies on the mitigation GHG emissions of NT:

- Increase soil carbon sequestration;
- Reduction of GHG emissions (CO2 and CH4) from soils; Minimal soil disturbance (no ploughing and harrowing);
- Reduction of fossil fuel use;
- Reduction of synthetic nitrogen fertiliser use;
- Increase of soil organic carbon content (considering root deep in soil);
- Decrease soil erosion during the fallow period;
- Reduction in N leaching (maintenance of a permanent vegetative soil cover);
- Reduction in the amount of N that needs to be applied to the following crop.

The potential positive effect on soil organic matter (SOC) is attributed to the reduction in top soil disturbance, therefore reducing soil erosion, favouring the development of a litter layer (Strudley *et al.*, 2008). Regarding GHG mitigation, Smith *et al.* (2007) suggest that there is evidence that tillage management has a moderate impact on SOC increase, while the net effects on N_2O is more inconsistent and not well-quantified globally. Methane emissions or absorption by the soil normally contribute a minor component to the overall GHG budget, however with no-till and ploughed soils showing N_2O emissions of 258 and 551 mg N m^{-2} day^{-1} (Smith *et al.*, 2007; Soane *et al.* 2012). Regina and Alakukku (2010) suggest that CH_4 fluxes are not strongly affected by the tillage practices.

Other environmental benefits are attributed to the increase in water retention, which is especially relevant for semi-arid climates such as in Mediterranean countries (Fernandez-Ugalde *et al.*, 2009), and the enhancement of the aggregate stability, which reduces microbial activity (i.e. decomposition rate) of the organic matter which in turn lowers the CO_2 emissions (Madari *et al.*, 2005). On the contrary, implementing a CT practice can increase the CO_2 emissions as it enhances soil aeration (Soane *et al.*, 2012).

No-till agriculture is widely promoted as a climate friendly farming system, and the IPCC Fifth Assessment Report attributes GHG mitigation potential to no-till. However, there is a considerable level of uncertainty in the SOC response to NT. The response variability can be associated to soil types, climatic conditions, cropping systems and also to the depth (soil layer > 40 cm) of samplings to measure the level of soil carbon.

Proposed general operation
In order to achieve mitigation via the use of NT, the following operation is proposed:

- Investment support for the purchase of technologies and equipment for direct seeding;
- Hectare premium (such as existed until recently in the CAP for the use of cover crops and NT that appears to be the most effective in increasing the SOC content and avoiding GHG emissions).

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
No-till was initially developed as a farming method for conserving soil and water resources. Currently scientific sources and statistics show that NT often comes as a technical package with monocultures, genetically modified crops and wide use of herbicides. Studies have found that no-till farming can be more profitable (Luo *et al.*, 2010) if performed correctly. Less tillage of the soil reduces labour, fuel, irrigation and machinery costs (Baker *et al.*, 2007). NT can increase yield because of higher water infiltration and storage capacity and reduce the risk of soil erosion.

No-till farming can increase organic (carbon based) matter in the soil, which is a form of carbon sequestration. However, there is debate whether this increased sequestration detected in scientific studies of NT agriculture is actually occurring, or is due to flawed testing methods or other factors. Regardless of this debate, there are still many other technical reasons to use NT, e.g. reduction in fossil fuel use, less erosion and increase soil quality (Luo *et al.*, 2010).

Moreover, a study conducted by De Vita (2007) showed that NT causes yield reductions in the first 4-5 years, after the beginning of the NT adoption (Rhotin 2000 and Carter and Rennie, 1982 in De Vita *et al.*, 2007; Stagnari *et al.*, 2010). Later the productivity reaches a new productive status.

In order to maximise the benefits, PA should provide information on:

(a) type of rotation and crop combination with cover crops in arable rotations (for the reduction of N application to following crop);

(b) eligible crops, based on local agronomic expertise. In general, suitable crops will be fast growing with good N uptake characteristics (Schulte *et al.* 2012);

(c) a minimum seed sowing rate to guarantee a sufficiently dense canopy.

By comparison with the total body of scientific literature on NT agricultural systems, little attention has been paid to critical analysis of the environmental side effects of NT. It is possible to identify only a few scientific papers that critically deal with uncertain effects of NT (Baker *et al.*, 2007, Lal *et al.*, 2004).

High herbicide use is the most prominent side effect of NT agriculture today. It is the substitute mechanism for controlling weeds that would otherwise be controlled (at least in large-scale farming) by ploughing, other more intensive tillage techniques, manual weeding, and crop rotations that include forage legumes, which are known to suppress weeds and fix nitrogen. Excessive herbicide use causes a variety of environmental problems. Soils and water are affected, as well as wildlife habitats (Friedrick *et al.*, 2005). Because of the problems described above, NT systems could frequently cause glyphosate-resistant weeds (Baker *et al.*, 2007).

Regarding the machinery requirements, the seeding machine for NT is different from the conventional machinery. Investments in the new machinery would increase the costs of the farm operations. Where the agricultural structure is characterised by small and medium–size farms the cost of investments could be unaffordable. In this case, co-operative investments across farms could be promoted.

Timing and duration
PA should define the appropriate period of seed planting to avoid weed competition. Moreover, it is crucial to be efficient in weed control; otherwise the production can be compromised. Regarding N application, it is recommended to spread the fertiliser in winter before crop sowing to reduce N_2O emissions.

NT is not recommended in all types of soil (clay soil) for more than 5 years (compaction soil problems). Moreover, NT is not recommended with some types of crops, such as maize or perennial crops, because the productivity can be drastically reduced (even by 30-40%) during a few years (personal communication Prof. Morari).

Location
PA should define the areas within which the operation is available, taking into account the following points (Wiltshire *et al.* 2014):

- Soil type: NT is not widely applicable on different soil types. This crop management practice is suited to light soil types, and light-textured free-draining soils. It is not recommended to clay soils.
- NT are more suitable where there is a relatively high spring rainfall and high level of water table;
- Cooler soil temperatures under cover crop residues can retard early growth of subsequent crops grown near the cold end of their range of adaptation

Synergies - Incompatible operations and recommended combinations
M2 Use cover/catch crops and reduce bare fallow
M7 Retain crop residues
These two operations could have a positive synergy with NT crop management increasing the carbon stock in the soil, decreasing the potential evapotranspiration and reducing soil erosion.

M4 Precise N application
The timing of this operation is a crucial aspect to be considered in avoiding N_2O emission during N distribution in NT soil management.

Expected impacts on farm-level GHG emissions

Soil tillage practices have a profound influence on the physical properties of soil and the GHG balance. However, there have been very few integrated studies on the emission of CO_2, CH_4 and N_2O and soil biophysical and chemical characteristics under different soil management systems. A study, conducted by Mangalassery et al., (2014), recorded a significantly higher net global warming potential under conventional tillage systems (26–31% higher than zero tillage systems). Moreover, uncertainty regarding the mitigation effect on the reduction of N_2O emissions are still present (Pellerin *et al.* 2013). Some studies underline the possibility to increase the N_2O emissions through the uptake of nitrate and ammonium, when it is distributed on the top soil. Certainly, the quantity of energy use in this crop management is lower compared with CT. On the other hand, others studies (Posthumus *et al.* (2013), Pellerin *et al.* (2013)), highlight the on-farm mitigation effect of NT in enhanced soil carbon storage.

Table 1. Abatement rates for the no-tillage operation

Mitigation effect	Abatement rate	Source
Carbon stocks in the soil	1.75 tCO_2e/ha/yr	Posthumus *et al.* (2013)
	Increase in SOC	Kirk *et al.* (2012)
	1 tCO_2e/ha/yr	Schulte *et al.* (2012)
	-0.393/0.874 tCO_2e/ha/yr	Pellerin *et al.* (2013)
Reduce direct and indirect N>N_2O (Emission Factors)	Highly variable	Pellerin *et al.* (2013)
	Leached N reduced by 30 kgN/ha = 0.11 tCO_2e/ha	Schulte *et al.* (2012)
Reduce amount of applied N	0.06 tCO_2e/ha/yr	Pellerin *et al.* (2013)
Fieldwork CO_2 from machinery	0.062 tCO_2e/ha/yr	Pellerin *et al.* (2013)

Hermle *et al.* (2008) observed net carbon sequestration to a depth of 50 cm after 20 years of NT. NT can lead to a stratification of soil organic carbon at the surface in contrast to the more uniform distribution of carbon in conventionally tilled soils. The crop residues accumulated on the soil surface under NT conditions may result in carbon being lost to the atmosphere upon decomposition. Furthermore, climate change mitigation benefits such as reduced CO_2 emissions due to increased sequestration of carbon and increased CH_4 uptake under NT could be offset by increased emissions of N_2O. Increased N_2O emissions have been linked to increased denitrification under NT due to the formation of micro-aggregates within macro-aggregates that create anaerobic micro sites with increased microbial activity leading to greater competition for oxygen. NT can also create increased soil densification and a subsequent decrease in the volume of macropores leading to reduction in gaseous exchange. Additionally, the effect of tillage on the environment varies across farms geographically since the impacts of cultivation on soil organic matter and net greenhouse balance depends on soil type, climatic variables and management Mangalassery *et al.*, (2014).

Ancillary effects

Table 2. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG	Reduction in emissions arising from fertiliser manufacture if synthetic fertiliser application is reduced, Effect on land use change, impact on C stock	Pellerin *et al.* (2013) Buckingham *et al.* (2013
Production	No significant effect	
Adaptation	Mulch and cover crops combined with NT can provide significant adaptation benefits by decreasing soil erosion and increasing soil water retention capacity Increased C retention with crop rotation	Balkcome *et al.* (2012) Mandari *et al.* (2005)
Environment	Improved water quality via reduced runoff Contributes to soil protection (reduced erosion and improved porosity) Increase in biodiversity (e.g. soil microorganisms)	Schulte *et al.* (2012, p39) Kirk *et al.* (2012) Wiltshire *et al.* (2014)
Negative effects		
Off-farm GHG	No significant effects	
Production	Potential loss of production if they lead to switching from winter to spring cultivation	Wiltshire *et al.* (2014)
Adaptation	No significant effects, if the operation is applied in areas with suitable soils and adequate rainfall.	Backer *et al.*, 2007
Environment	Increased herbicide use	Schulte *et al.* (2012) Wiltshire *et al.* (2014)

Safeguards against maladaptation

No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations

Recurring costs arise from seed purchase and additional fieldwork for cultivation and destruction/incorporation of the cover crop (if combined operation). Savings may be made from reduced synthetic fertiliser application rates (see Table 3).

Costs - equipment

No-till requires specialised seeding equipment designed to plant seeds into undisturbed crop residues and soil. If the farmer has equipment designed for conventional tillage, purchasing new equipment (seed drills for example) would be expensive and while the cost could be offset by selling off ploughs, etc. doing so is not usually done until the farmer decides to switch completely over (after trying it out for a few years). This would result in more money being invested into equipment in the short term (until old equipment is sold off).

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Reduced fertiliser purchase Cover crop planting and destruction	(€41/ha/yr) €160/tCO_2e	Pellerin *et al.* (2013)
Labour cost	Highly variable depends on the country of application	Pellerin *et al.* (2013)
Investment in new machinery	Highly variable	De Vita *et al.* (2007)
Increase in spraying (NT)	€78/ha/yr	Wiltshire *et al.* (2014)
Field operation	€47/ha/yr	Posthumus *et al.* (2013)
Loss in agricultural production	€37/ha/yr	Wiltshire *et al.* (2014)
Purchase of seed and fuel costs associated with cultivation of the crop	€71.20/ha/yr ~€50/tCO_2e	Schulte *et al.* (2012)
Seed (€64/ha/yr) Cultivation/drilling (€70/ha/yr) Incorporating crop residues (€29/ha/yr)	€164/ha/yr	Posthumus *et al.* (2013)

The main driver of variation in cost-effectiveness is likely to be the cost of the crop seeding and weed control, which will depend on the efficiency of cultivation. These costs will vary depending on crop management. Payments should not provide compensation for lost production. However, the NT operations can be controlled with the purchase of NT machineries used for specific operations. Due to the contrasting results in terms of C content for NT crop management, no payment should be provided.

Control and Verification

Compliance could be verified by integrating the operation into current monitoring programmes.

Extent to which the mitigation effect would be captured by National GHG Inventories.

The tier 1 method of the IPCC 2006 guidelines could be used for NT but it has some limitations as it does not consider NT as soil management practice for N_2O. Changes in soil carbon stocks would require specific soil C emissions factors and would not be captured in most current approaches. Thus, tier 2 or 3 approaches have to be developed, based on empirical evidence from soil surveys. In order to depict the NT activity rates, detailed statistics on long-term application of NT are needed, which are normally not available (e.g. because in the Farm Structural Survey, only the current tillage technologies in the respective year are recorded).

Potential result indicators

- P4C: % of agricultural land under management contracts improving soil management and/or preventing soil erosion (ha)
- P5E: % of agricultural and forest land under management contracts to foster carbon sequestration/conservation

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	Source
Risk of negative effects on yield (possible 30-40% loss for maize)	Wiltshire *et al.* (2014) (pers. comm. Morari)
Concerns about herbicide use and resistance	Wiltshire *et al.* (2014)
Decrease water efficiency/quality in some soils (clay soil)	(pers. comm. Morari)
High cost of new machinery or contractor services	
Other key risks/uncertainties	
Effect on N_2O emissions and SOC is uncertain	Buckingham *et al.* (2014) Kaharabata *et al.* (2003) Kirk *et al.* (2012)

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Fiche M7: Retain crop residues – MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	36 (a) (iv)	214: Agri-environmental payments
2014-2020	28(1)	Agri-environment-climate

Summary
Area based payments for crop residue incorporation is proposed. Benefits include:

- Reduced GHG emissions (climate change mitigation)
- Improved soil quality
- Erosion control
- Carbon sequestration

Regulatory requirements that have to be met
There are no specific policy measures to support the use of crop residue retention in European agricultural systems.

General description of the action and operation
Agricultural crop residues are used for a variety of purposes including biofuel, industrial raw materials, and animal feed and bedding. Often they are returned to the soil where they provide a range of ecosystem services. These include nutrient cycling (Shah *et al.* 2003), improved biodiversity (Roger-Estrade *et al.* 2010), improved soil structure (Blanco-Canqui & Lal 2007), carbon sequestration (Andren *et al.* 2008) and erosion control (Dormaar & Carefoot 1996). Although in some circumstances crop residues are already currently returned to soil, it is important to maximise the incentives for this to occur and provide support to overcome technical barriers. In some circumstances, crops (green manures) are grown with the specific purpose of incorporation, but in other cases residues are incorporated as an optional component of rotational management.

In some circumstances, crops can be grown specifically to provide an input of organic material where there is a specific need to improve soil quality and fertility. The use of grass clover leys in organically farmed rotations is specifically aimed at increasing soil fertility as a consequence of the nutrients returned by decomposing plant residues when the rotation is returned to an arable phase (Watson *et al.* 2011).

The impact of crop residue incorporation on greenhouse gas emissions is uncertain. There is good evidence to demonstrate that crop residue inputs to the soil can increase carbon sequestration. Effects on nitrous oxide emission are less clear. The IPCC's Tier 1 approach assumes a N_2O Emission Factor of 1% for all crop residues added to soils. Experimental studies have shown that in some circumstances where N rich residues are added to soil that high N_2O emissions can result (Baggs *et al.* 2002). In other circumstances, crop residues with lower N content (often with a high C:N ratio) are less likely to result in significant N_2O emissions. Some recent experimental studies have shown that the Emission Factor for N_2O emissions from crop residues is significantly below the IPCC's 1%.

Retaining crop residues can mitigate GHG emissions in four main ways:

- Reducing direct emissions from N fertilisers
- Reducing the CO_2 emissions from fertiliser manufacture
- Increasing carbon sequestration
- Reducing the amount of N that needs to be applied to the following crop.

The extent to which crop residues can reduce N_2O emissions is dependent on the quality of the residue. Crop residues with high C:N ratio, such as cereal straw, tend to encourage immobilisation of nitrogen in the soil organic matter, thereby reducing N_2O emissions (Lin *et al.* 2013). By contrast, crop residues with lower C:N ratio, such as the residues from leguminous crops, are associated with more rapid mineralisation and release of nitrogen and a consequent emission of N_2O. Long-term changes in soil organic matter that occur as a consequence of residue incorporation lead to a slow accumulation of organic carbon with increasing range of soil quality attributes (Powlson *et al.* 2012).

Proposed general operation

In order to achieve mitigation via the use of crop residues the following operation is proposed:

An area-based payment is proposed based on the area over which crop residues are incorporated.

This measure is appropriate in the case of annual crops and annual forages. Non-harvestable parts of a crop should be left in the field after harvest. In some circumstances when large amount of residue is produced or where the residue is rich in nitrogen, it would be appropriate to recommend soil incorporation in order to avoid volatilisation losses.

Commitments, funding conditions and eligibility

When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities

- Cereal crops

Cereal straw to be chopped following harvest and incorporated into the soil within two weeks (a derogation of this time constraint could be considered if soil conditions were inappropriate, e.g. excessive soil wetness)

- Horticultural Crops

Residues to be incorporated into the soil as soon as possible after harvest, and within one month. Allowance for additional N provided to subsequent crops should be made in fertiliser N applications to the following crop.

PA should specify a minimum seed-sowing rate to provide a sufficiently dense canopy.

- Forage crops

Biomass should be incorporated into the soil as soon as possible prior to the establishment of a subsequent crop to maximise synergy between nutrient release and uptake. Allowance for additional N provided to subsequent crops should be made in fertiliser N applications to the following crop.

Timing and duration
PA should provide advice on N fertiliser application rates to crops following residue incorporation based on national recommendation systems.

Location
PA should define the areas within which the operation is available, taking into account the following points:

- Residue incorporation is widely applicable on different soil types in arable and grassland rotations; however, the process of incorporation may be dependent on suitable (i.e. not too wet) soil conditions.
- The residues left by N rich crop residues can result in rapid losses of N, so it is important to ensure that ground is not left fallow following the incorporation of legume residues.

Incompatible operations
This measure partly overlaps with measures defining the use of cover crops and legumes in farming systems.

Expected impacts on farm-level GHG emissions
The main on-farm mitigation effect of crop residue incorporation is via reduced or avoided nitrous oxide emissions (see Table 1). This results from reductions in N_2O where residue incorporation leads to a reduction in the amount of synthetic fertiliser applied. It can also contribute to carbon sequestration (Pellerin *et al.* 2013, p44).

Table 1. Abatement rates for cover crops sown during the fallow period of arable rotations

Mitigation effect	**Abatement rate**	**Source**
Reduce direct and indirect N>N_2O EFs*	Cereal crops, no abatement	
	Forages and high N residue crops 0.1 t CO_2e/ha/yr	Pellerin *et al.* (2013)
C Sequestration	0.1 t CO_2e/ha/yr	(Lal 2004)

*Possible increase in GHG from ammonia volatilisation and nitrate leaching from high N residues (Jensen *et al.* 2010)

Ancillary effects
Table 2. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG	Reduction in emissions arising from fertiliser manufacture if synthetic fertiliser application is reduced	Pellerin *et al.* (2013, p45)
Production	No significant effect	
Adaptation	Crop residues can provide significant adaptation benefits, by decreasing soil erosion and increasing soil water retention capacity	See Fiche M2 for further details
Environment	NA	
Negative effects		
Off-farm GHG	NA	

Production	Possible N immobilisation by high CN residues (straw)	
Adaptation	No significant effects.	
Environment	NA	

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations
No significant one-off costs arising from the operation are predicted.

Savings may be made from reduced synthetic fertiliser application rates (see Table 3).

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Fertiliser savings	(10 €/ha/yr)	Pellerin *et al.* (2013)

The cost-effectiveness is categorised as being in category 1, minor cost.

The main driver of variation in cost-effectiveness is likely to be the loss of income because of alternative uses for the crop residues.

Control and Verification
Compliance could be verified in a number of ways:

- Integrated into current monitoring programmes.
- Via remote sensing or aerial photography (Pellerin et al. 2013, p47)

Potential result indicators
Increased soil organic C

Extent to which the mitigation effect would be captured by National GHG Inventories
N_2O reduction from reduced rates of fertiliser application would be captured by current inventories.

Identified implementation challenges and barriers
Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Additional field operations	Dormaar and Carefoot, 1996
Disease carryover	
Alternative uses for residues	
Other key risks/uncertainties	

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Fiche M8: Loosen compacted soils / Prevent soil compaction - MITIGATION

Proposed RDP measure

	Article	Measure
2007-2013	20 (a) (iv)	114 Farm advisory services 111 Vocational training and information actions
2014-2020	14(1) 15(2)	Knowledge transfer and information actions Advisory services, farm management and farm relief services

Summary

Topsoil compaction has been reported to increase N_2O emissions and strongly reduce the soil ability to be a CH_4 net sink. However, emissions are associated with a high level of uncertainty due to the complexity of these processes and their interaction with soil bio-physical factors. Additionally, topsoil compaction can affect other soil functions and ecosystem services. Among these are reduced crop yields and decreased ability to filter soil water. Soil compaction may also increase the risks of soil erosion, which in turn may affect the risk of landslides as well as flooding. The main mitigation options are:

- Frequency and timing of field operations should be planned to avoid traffic on wet soil.
- Tillage operation should be avoided or strongly reduced on wet soils.
- Reduction of stock density.

Regulatory requirements that have to be met

Across the member states there are no specific measures or incentives to promote the prevention of soil compaction practices in agricultural system. Council Regulation (EC, No. 73/2009) has identified the main issues that should be address by the Good Agricultural practices, such as the physical soil degradation and erosion. However, it is left to member states to implements these practices at a national level.

General description of the action and operation

Prevention of topsoil compaction is an important practice in order to reduce potential GHG emissions (i.e. N_2O and CH_4) from agricultural land (Gattinger *et al.* 2011; Defra, 2007).

Topsoil refers to the top soil layer which is frequently tilled (often described as the plough layer, approximately 25 cm). The soil compaction is defined as "The densification and distortion of soil by which total and air-filled porosity are reduced, causing deterioration or loss of one or more soil functions" (van den Akker, 2008). This degradation is due to the inability of soil to withstand external pressures generated by traffic of heavy machineries and trampling by livestock.

Compaction alters the normal soil biological activity, decreases the porosity (in particular macroporosity) resulting in a decline of hydraulic conductivity, therefore modifying the soil conditions from aerobic to anaerobic. Soil type strongly affects the risk of compaction, sandy soils are the least susceptible when the soil water content reaches field capacity, while clay soils are the least sensitive to compaction under soil dry conditions (Fleige *et al.* 2002).

In aerobic conditions, soil organic matter decomposition produces CO_2, however anaerobic conditions promote the fermentation of organic matter and the decomposed C is realised as CH_4. Nevertheless, in aerobic conditions, the CH_4 produced in the lower part of the soil profile (anaerobic soil conditions) and the atmospheric CH_4 can be oxidized, resulting in the soil to be a CH_4 net sink. Several studies (Ruser *et al.*, 1998; Teepe *et al.*, 2004; Mosquera *et al.*, 2007) have reported that an increase in the level of soil compaction can alter the CH_4 net soil sink, transforming it in an emission source.
The two main processes that are generally accepted to be the main producer of N_2O in soil are nitrification and denitrification, which are mostly controlled by soil water content, temperature, the availability of organic carbon and by mineral N contents. Nitrification produces N_2O under aerobic conditions, while in limiting oxygen conditions denitrification takes place. Although the contribution of nitrification to N_2O emissions is likely to be significant, it is generally thought to be lower than the contribution of denitrification. Compacted topsoil promotes denitrification which generates a considerably increase in N_2O emissions. It has been reported that the increase in emissions can be up to 7 times, nevertheless this figure is associated to a high level of uncertainty due to the complexity of the process under consideration (Defra, 2007; Ball *et al.*, 2000; Teepe *et al.*, 2004; Mosquera *et al.*, 2007).

There are several potential measures that can be adopted to reduce soil compactions and therefore GHG emissions (Defra, 2007; Defra, 2010; Weiske *et al.*, 2007)

- The type and frequency of machine operations should be adequate to the soil texture and conditions, therefore reducing traffic especially in wet soils.
- Adjustment of tyres, inflation pressures and loads.
- Avoid tillage of wet soils.
- As compaction in traffic lanes cannot be avoided completely, the use of permanent traffic lanes via controlled traffic farming would restrict compaction to a smaller area (Vermeulen & Mosquera 2009).
- Avoid fertilisation in traffic lanes, this reduces N2O emissions from compacted soils and saves fertiliser (less CO2 emissions from synthetic fertiliser production). Only possible with more precise N-application technology (see fiche on "Precise N-application").
- Soil tillage. A moderate topsoil compaction can be eliminated by shallow tillage.
- Maintenance of good surface drainage. The wetness of the soil strongly affects the possibility of compaction as well as the risk of anoxic soil conditions, therefore drainage is an effective measure to increase soil strength and therefore reduce the risk of soil compaction and GHG emission.
- Use of plant species: Plants with desirable rooting characteristics can enhance the structure of soil.
- Reduce the livestock density.

Proposed general operation

The applicability of soil compaction mitigation options is highly dependent on several factors, e.g. soil water content. Therefore, operational guidelines should be provided to the operator in order to maximise the mitigation potential. Local authorities could organise workshops/training to inform operators on the benefits of soil compaction prevention and inform them on the possible mitigation options/practices:

- Work when soils are least sensitive, avoiding the wet periods. When possible work when soil is dry. The online decision support tool, Terranimo®, (www.soilcompaction.eu) could be used to identify whether traffic is sustainable.

- Maintain soil organic matter and keep surface soil, litter, and slash in place while harvesting. This can increase resistance to compaction and protect soils from erosion.

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
(PA should provide detailed guidelines for the implementation of countermeasures to prevent or reduce soil compaction. Guiding principles are set out below:

Guidelines on the minimum tyres width and inflation pressure should be provided.

Field operation should be combined as much as possible, in order to reduce machineries traffic.

Tillage operations should not be undertaken when the soil is not friable.

Timing and duration
Water content strongly affects soil compaction. The PA should provide indicators to assess the severity of the soil wetness, therefore preventing field operation during extreme conditions.

Location
PA should provide a list of high risk areas where a combination of soil texture and prevailing weather conditions increases the likelihood of soil compaction, such as the Wheel Load Carrying Capacity map created by van den Akker (2004) for the Netherlands.

PA should organise a series of workshops nationwide to raise awareness on risks associated to soil compaction and to inform about possible mitigation options, taking into account the following points (based on Wiltshire *et al.* (2014):

- Wet soil is more prone to compaction when exposed to external pressures, i.e. tyre inflation pressure and trampling of livestock.
- Soil texture. Sandy and silt soils are associated with a higher likelihood of compaction when the soil water content reaches field capacity, while clay rich soils are less prone to compaction under dry conditions.

Synergies - Incompatible operations and recommended combinations
No incompatible operations or particular synergies are anticipated.

Expected impacts on farm-level GHG emissions
The main mitigation effect associated to reduction in soil compaction is the decrease in N_2O and to restore the CH_4 net soil sink function. However, the uncertainty of its effects led this mitigation option not to be included in the French marginal abatement cost curve (MACC) (Pellerin *et al.* 2013) and Irish MACC (Schulte *et al.* (2012).

Table 1. Effects of soil compaction mitigation on N_2O and CH_4 emissions

Mitigation effect	Abatement rate	Source
Decrease direct N_2O NH_3 emissions	Highly variable 60% on average	Mosquera *et al.*, (2007) Defra, (2007) Ball *et al.* (2000) Ruser *et al.* (1998)
Restore soil CH_4 net sink effect	Highly variable 30 – 90%	Mosquera *et al.*, (2007) Defra, (2007) Ball *et al.* (2000) Ruser *et al.* (1998)

Ancillary effects

Table 2. Ancillary effects of the operation

Positive effects		**Source**
Production	Reduction in soil compaction improves crop yield	Hallett *et al.* (2012) Håkansson and Reeder (1994)
Soil filter function	Avoiding soil compaction maintains the natural risk of preferential flow of water (potentially carrying pollutants) to the water bodies, while compaction due to traffic with (heavy) machinery increases this risk.	Kulli *et al.* (2003 Etana *et al.* (2013)
Adaptation	Soil is better adapted to extreme weather events	
Environment	Improved field drainage via sustained in hydraulic conductivity Less erosion and related nutrient input into water bodies, eutrophication might be reduced as well as reducing nutrients leaching.	Hallett *et al.* (2012) Tunney *et al.* (2007)
Negative effects		
GHG	No significant effects	
Adaptation	No significant effects	
Environment	Deep ploughing can decrease soil organic carbon. Controlled traffic lanes heavy machinery gives effectively permanent damage to the soil below tillage depth.	Smith *et al.* (2007) Berisso *et al.* (2012) Schjønning *et al.* (2013)

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations
No significant one-off costs are predicted as the suggested actions (e.g. adjusting tyre pressure) can be easily integrated in the farmer best management practice.

Recurring costs arise from tillage operations for loosening the soil and to the workshop/training program that the member state/local authorities might want to organise. The costs of such training program are highly variable among member states as workshop/training structure and managements can strongly affect the final budget.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Tillage	58 - 80 €/ha/yr	SAC (2013)

The cost-effectiveness is categorised as being in category 2, no or limited cost.

Control and Verification
Compliance could be verified by random check for soil compaction. An alternative is to monitor farmers that have participated to the suggested workshop/training program. In situ monitoring would be the most appropriate approach; however the employment of remote sensing and/or aerial photography could also be an option.

Extent to which the mitigation effect would be captured by National GHG Inventories
Changes in soil compaction would not be captured in most current approaches

Potential result indicators
P4C Agricultural land under management contracts improving soil management and/preventing soil erosion (ha)

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Changing the operation timing could be difficult as the time of field operations depends on ownership of equipment and labour availability. In addition some field operations need to be performed at a specific crop growing stage.	Rickson *et al.*, (2010) Arvidsson *et al.* (2010)
Reducing stock density has a considerable economic impact and often economic benefits of production might outweigh soil compaction effects.	Rickson *et al.*, (2010)

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Fiche M9: Restoration of wetlands - MITIGATION

Proposed RDP article and measure:

	Article	Measure
2007-2013	38 39	213 Natura 2000 payments and payments linked to Directive 2000/60/EC 214 Agri-environment payments
2014-2020	17 20 29 31	Investments in physical assets Basic services and village renewal in rural areas Agri-environment-climate Natura 2000 and Water framework directive payments

Summary
Restoration of wetlands help to reduce GHG emissions from decomposition of peat by avoiding the drainage of wetlands and restoring the natural water table of drained wetlands. With an increased water table in organic, carbon-rich soils, accumulation of organic substances is higher than the decomposition, which facilitates the conservation and accumulation of peat and reduces the carbon release from these soils. However, as the permanent rewetting of wetlands is often associated with abandonment of current agricultural land-use practices, also the extensification of land-use and land-use on wet peat soils (paludiculture) are considered. These operations should be flanked by avoiding new drainage, renewal and deepening of existing drainage on organic soils. The wetland restoration can only be achieved with a combination of measures and the collaboration of land-users. The GHG abatement rate and costs depend on the intensity of the pre-existing degree of drainage, the land-use intensity and realised land rents. Production may be displaced to other sites, however, due to very high emissions per hectare on drained organic soils, the overall net mitigation effect is positive.

Regulatory requirements that have to be met
The restoration of wetlands is not addressed by national legislation in all MS (e.g. Germany). Wetland restoration is until now mainly facilitated by nature protection funds and in the past climate objectives have not been the focus of restoration projects. At EU level, the Biodiversity Action Plan for the Conservation of Natural Resources and the Water Framework Directive include the objective to protect and restore wetlands. Further National Nature Protection Legislation and National Strategies on Biological Diversity are setting targets for peat land protection.

General description of the action and operation
Peat soils are defined as a peat layer which is a minimum of 30 cm and consists of more than 30% of organic matter. Natural peatlands are an important carbon sink at global scale. Although they cover only 3% of the global land area, peat soils accumulate at least 550 Gt carbon, which accounts for 30% of the global soil carbon and about 75 % of the total atmospheric carbon (Parish *et al.*, 2007). High water tables in natural wetlands facilitate that the accumulation of organic substances is higher than the decomposition and thereby enable the accumulation of peat. When peat soils are drying up, carbon is released from the soil (Flessa *et al.*, 2012). The amount and type of GHG emissions depend on the water saturation in the soil, climatic conditions and the nutrient availability. In flooded natural peat soils, methane emissions occur besides the net storage of CO_2-C, while drained peat soils release CO_2 and N_2O through the aerobic peat decomposition (Flessa *et al.*, 2012). Intensively drained peat soils are hotspots for GHG emissions (Parish *et al.*, 2007), particularly

when N fertilisers are applied, because of the high emission factor associated with N_2O production from organic soils.

By raising the water tables of drained wetlands, GHG emissions can be reduced. The C storage function of wetlands can be restored when wetlands are nearly completely restored. The amount of emission savings depends on the height of the water table (the intensity of the drainage) and the following type of vegetation (e.g. peat composing plant species). The lower the water table of the drained wetland the higher the climate protection impact per ha after rewetting. Wetlands only become climate neutral when the water tables are very close to natural conditions (mean annual water table around 10 cm below the ground surface level, no flooding to avoid methane emissions). The permanent rewetting of wetlands is often associated with abandonment of land-use as with the current technologies and available cultures, the agricultural land-use of restored sites is almost impossible (Osterburg *et al.*, 2013).
The mineralisation of peatland can also be reduced by changing the agricultural land-use. The change from arable to grassland and the extensification of grassland in combination with increased water tables are of particular importance. Further, seasonal variation of water tables by increasing the water table in winter and decreased water tables in spring and autumn are leading to a reduction of CO_2 emissions (Osterburg *et al.*, 2013).

Drained peatland sinks because of soil compaction and in particular through the CO_2 release from oxidation of drained peat soils. With arable land-use on organic soils the subsidence ranges between 1-4 cm per year taking the surface closer to the water table year by year. Therefore, the existing drainage is deepened frequently which causes more decomposition. Additional emissions could be inhibited when new drainage is not established, renewed and deepened. This measure could complement extensification and the restoration of wetlands (Osterburg *et al.*, 2013). In many cases, a marked reduction of GHG emission from peatland cultivation can only be achieved when agricultural production is abandoned or at least land-use intensity is significantly reduced (Röder and Osterburg, 2012).

Proposed general operation

A) Restoration of wetlands through land consolidation, agri-environmental measures and investment support measures on organic soils.

B) Extensification of wetland-use and/ or land-use on wet peat soils (paludiculture). Extensification is achieved by a reduction of inputs such as N fertiliser and manure application lowering land-use intensity and productivity. As the effects on emission reductions of this operation are much lower than of the operation A, this operation should be seen as the second-best option when the complete and permanent rewetting of the site is not possible. For paludicultures, pilot projects are recommended, e.g. to support development of machineries that enable land-use at higher water tables, and to establish biomass production, e.g. reed.

C) No new drainages, renewal and deepening of drainages on organic soils

Commitments, funding conditions and eligibility

When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below

Eligible activities

Wetland restoration to a natural condition is expected to have the highest GHG mitigation effect. However, its implementation is associated with land-use change, not suitable to all sites and associated with a variety of different activities. Thus, wetland restoration is potentially important as a collective operation because a combination of different measures is necessary to complete the process, and many different land-users have to co-operate in order to restore larger wetland areas. Measures only addressing single farms are not effective as the area of a wetland in most cases covers a large number and variety of land-users. Eligible activities are:

- Studies to support the planning process, e.g. impact assessments regarding hydrology and land-use
- Land consolidation activities and land purchase by the public sector, if necessary
- Investment support for setting up of infrastructure for water management (raising the water table)
- Agri-environment-climate measures to support extensive wetland-use
- Pilot projects for improvement of wet use of organic soils / paludiculture
- Training and advisory services for land owners

Timing and duration
The emission reduction of rewetted drained peat is permanent when sites are permanently kept close to natural conditions. The emission reduction through extensification with a gradual increase of the water table reduces the peat decomposition but does not completely stop these emissions. The mitigation effect is enabled as long as the (partial) rewetting or the extensive land-use of the soils is maintained. When rewetted peatlands are drained again, they will become hotspots of GHG emissions again (Flessa *et al.*, 2102).

As permanent rewetting and extensification of wetlands need larger investments, purchase of land through the public sector and land-use changes, the achieved status should be safeguarded by legal means (e.g. entries in the land registry). Thus, the impact is expected to be long-term (Osterburg *et al.*, 2013).

Location
This measure is suitable for soils under agricultural land use classified as organic soils according to IPCC criteria (IPCC, 2006). Also soils with elevated C contents which do not meet the criteria of the IPCC, as their C_{org} content is below the threshold of 12% C_{org}, should be included. These soils should also be protected because rewetting these soils would lead to increased GHG emission savings. Therefore, soils with a C_{org} content above 5% could be considered conditionally for climate protection objectives.

Synergies - Incompatible operations and recommended combinations
Incompatible operations are investment aid supporting land-uses which are unsuitable for organic soils (arable farming, horticulture, intensive dairy production, e.g. M4, M6, A9), and the support of investments in (deeper and more efficient) drainage (A6 Optimising the adaptation benefits of drainage).

Operations that are supporting extensification of land-use and land-use with higher water tables are compatible with the wetland restoration operation. Further, the operation M16 Carbon audits can highlight the importance wetland restoration.

Expected impacts on farm-level GHG emissions

- Reduced emission of CO2 due to decelerated peat decomposition (largest climate effect)
- N2O emission reduction from mineralisation of organic soils

- Increased CH4 emission after rewetting should be avoided as far as possible by keeping the water table right below surface (no flooding).

The rewetting of peat soils leads to a slower degradation and to reduced CO_2 and N_2O emissions through the establishment of anoxic conditions. Rewetted peat soils could retain their CO_2-C sink function. Through anoxic degradation processes, especially in flooded areas, CH_4 emissions might increase after rewetting the soil.

Table 1. Abatement rates for restoration of wetlands and extensification of wetland-use

Mitigation effect	Abatement rate	Source
Increased soil C by raising the water table and land-use extensification	40 t CO_2e/ ha/ year (intensive sites)	Drösler *et al.* (2011)
	44 t CO_2e/ ha/ year (intensive sites)	UBA (2010) (German national GHG inventory)
	20 t CO_2e/ ha/ year (extensive grassland)	Osterburg *et al.* (2013)
	22 t CO_2e/ ha/ year (extensive grassland)	UBA (2010) (German national GHG inventory)
Operation A: Restoration of wetland		
Restoration of wetland	3.1-6.3 t CO_2e $ha^{-1}yr^{-1}$ (fen area > 50% of subarea, less ambitious) 3.9-7.8 t CO_2e $ha^{-1}yr^{-1}$ (fen area >20% of subarea, more ambitious)	Grossmann and Dietrich (2012)
	30 tCO_2e $ha^{-1}yr^{-1}$	Flessa *et al.* (2012)
Operation B: Extensification of agricultural land-use in wetlands		
Extensification of agricultural land-use: arable to grassland without changing the water table; Water table minimum 20 cm below the surface	0.9 – 2 tCO_2e $ha^{-1}yr^{-1}$ (arable --> grassland, less ambitious) 3 – 6.1 tCO_2e $ha^{-1}yr^{-1}$ (higher water tables, more ambitious)	Grossmann and Dietrich (2012)
Extensification of wetlands previously used as arable or intensive grassland and raising water table	24 – 26 t CO_2e $ha^{-1}yr^{-1}$	Drösler *et al.* (2011)
Avoid subsidence of organic soils through raising the groundwater levels	2.26 t CO_2 / ha/ year per mm subsidence.	Van den Akker *et al.* (2012)

The GHG abatement potential per ha depends on the intensity of the drainage. If the water tables are very low before the rewetting, the impact on GHG emission savings is higher (Osterburg *et al.*, 2013).

Ancillary effects

Table 2. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG		
Production	Wetlands can be used for paludiculture (production of renewable raw materials, e.g. peat bogs (sphagnum) and grasses as peat substitutes, or reed as renewable building material). Experiences with research and pilot projects in Germany (e.g. Mecklenburg-Western Pomerania and Lower Saxony) show promising results. Long-term practical testing and demonstration activities are necessary to enable up-scaling.	Wichmann and Wichtmann (2009) Joosten (2014)
Adaptation	Restored wetlands can serve as floodplains, protection against flooding	Grossmann and Dietrich (2012)
Environment	A) Improving habitat / biodiversity resilience, protection against flooding B) Positive effects on biodiversity and water quality via improved nutrient retention and hydrologic balance. C) Paludiculture: conflicts/synergies with biodiversity depend on land-use and regional conditions	Hjerp *et al.* (2012) Osterburg *et al.* (2013)
Negative effects		
Off-farm GHG		
Production	Complete restoration of wetlands shifts agricultural production to other sites, but emissions from intensification and new cultivation of other sites is usually lower than the avoided emissions from wetlands. A land-use concept should be developed for the entire wetland and the different types of land-use in the region to minimise leakage.	Osterburg *et al.* (2013)
Adaptation		
Environment	Paludiculture: conflicts/synergies with biodiversity depend on land-use and regional conditions	Osterburg *et al.* (2013)

Safeguards against maladaptation

When wetlands are rewetted after agricultural use, the production is shifted to other sites. If the production is moved to mineral soils, GHG emissions occur that reduce the climate protection impact of the rewetting (indirect land-use change). However, these emissions are much lower than those from drained wetlands and reduce the positive climate effect only marginally. The restoration of former peat extraction sites does not shift the production (Flessa *et al.*, 2012).

Guidance on costs and payment calculations
The operations A) wetland restoration and B) wetland extensification are associated with costs for investment and land-use change. Land purchases by the public sector might be necessary. The use of paludicultures has the same cost components as the other operations but there is added value through the land-use of the wetland.

For operation C) Avoid new drainage, renewal and deepening of drainage on organic soils cost could occur for the adaptation of the land-use to wet conditions. Cost for investment in drainages and water management are saved.
The economic opportunity costs of not converting wetland can be substantial (Grossmann and Dietrich, 2012) and depends on previous land-use.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
A) Restoration of wetland	€ 167 – 337 $ha^{-1}yr^{-1}$ (fen area > 50% of subarea, less ambitious) € 208 – 415 $ha^{-1}yr^{-1}$. (fen area >20% of subarea, more ambitious)	Grossmann and Dietrich (2012)
B) Extensification of wetland-use	€ 44 – 98 $ha^{-1}yr^{-1}$ (arable-->grassland, less ambitious) € 163 – 330 $ha^{-1}yr^{-1}$(higher water tables, more ambitious)	Grossmann and Dietrich (2012)
B) Compensation granted under agri-environmental payment schemes for fen wetland conservation and maintenance of high water tables in the German Federal states of the Elbe Basin	175 – 320 € $ha^{-1}yr^{-1}$	Grossmann and Dietrich (2012)

Table 4 Abatement cost of the operation, (figures in brackets are savings)

Mitigation	**Abatement cost**	**Source**
A) Wetland restoration (permanent rewetting)	2 – 42 €/tCO_2e	Röder and Osterburg (2012) Schaller *et al.* (2012)
	below 50 € per t CO_2e (without engineering and transaction cost)	Röder and Osterburg (2012)
	20 - 70 €/tCO_2e	Röder and Grützmacher (2012)
	€ 7 – 14 t CO_2e^{-1}	Grossmann and Dietrich (2012)
	15 – 135 €/tCO_2e	Flessa *et al.* (2012)
B) Extensification of land-use	€ 10 – 20 t CO_2e^{-1}	Grossmann and Dietrich (2012)
	>200 €/tCO_2e (forage crops --> extensive grassland)	Osterburg *et al.* (2013)
Restoration projects in Mecklenburg-Vorpommern, Germany	€7.5 – 12.5 t CO_2e^{-1}	Grossmann and Dietrich (2012) (based on Schäfer (2009))

Cost effectiveness is higher for restoration of wetlands compared to wetland extensification because the GHG savings are much higher. Especially when forage crop production is replaced by extensively used grassland the abatement cost can be as high as 200 €/tCO_2e (Osterburg *et al.*, 2013). For operation C) Avoid new drainage, renewal and deepening of drainage on organic soils cost could occur for the adaptation of the land-use to wet conditions. Cost for investment in drainages and water management are saved. Operation B) Paludicultures have a higher cost –effectiveness than A) because of added value from the land-use. Negative CO_2 abatement costs are possible (Osterburg *et al.*, 2013). Therefore, the cost-effectiveness of these operations can be attributed to category 1, 2 or 3 depending on the previous land-use, type of operation performed and local conditions (e.g. when land purchase is necessary, there is a huge variation of land tenure cost between different regions). As strong synergies with other environmental objectives such as biodiversity and the water protection exist, the cost-effectiveness is further improved. The rewetting of peatlands is at least in the medium and long run a cost-efficient measure to reduce GHG-emissions (Röder and Osterburg, 2012).

Control and Verification

The compliance with the commitments can be controlled by checking the level of the water tables. To enable a constant control of the water level at different locations of the wetland, automatic loggers can be used which are also more reliable than measurements at different points in time. The implementation of investment support can be controlled on-site for the establishment of hydro-engineering installations and infrastructure, and based on receipts and project records. Further land-use indicators, such as livestock density, can be used to analyse the intensity of land-use on wetlands and if it complies with the requirements of the operation.

Potential result indicators

Area (ha) of restored wetlands

Extent to which the mitigation effect would be captured by National GHG Inventories

Restored wetlands are captured in national GHG inventories in the category *Wetlands.* Precondition for the inclusion is the area-based assessment of the restored wetland areas (Flessa *et al.* 2012, p.223). Otherwise, the effects can be reported under the previous land-use categories cropland and grassland. Also, the transformation of arable land to grassland is captured in the national GHG inventories. A precondition for the inclusion in the inventory is the assessment of rewetted areas and their hydrologic conditions (Osterburg *et al.*, 2013). Also, avoidance of N_2O emissions of N applied to organic soils would be captured.

Identified implementation challenges and barriers

Table 5. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Not a single farm measure, collective action at local / regional level is necessary	
Substantial opportunity costs associated with land-use change (depend on previous land-use)	Grossmann and Dietrich (2012)
Abandonment/shift of production	
Loss of production, particularly some high value horticultural crops (e.g. in England), or relocation on mineral soils	
Other key risks/uncertainties	
Potential conflicts between biodiversity and climate objectives	

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Fiche M10: Fat supplementation in ruminant diets - MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	36 (a) (iv) 20 (a) (i) 20 (a) (iv)	214: Agri-environmental payments 111: Vocational training and information actions 114: Use of advisory services by farmers and forest holders
2014-2020	28(1) 14(1) 15(1)	Agri-environment-climate Knowledge transfer and information actions Advisory services, farm management and farm relief services

Summary

- Suggested operation: the use of livestock feed consultancy and advisory services for the formulation of a ruminant diet with fat content of 5-6 DM%, with the supplementary fat sourced from plant or animal products produced in Europe.
- An additional fat supplementation of 2-4% fat is suggested, bringing the total fat content to 5-6%, as increasing the fat content of the diet proportionally reduces enteric methane emissions.
- Some farmers already use supplementary fat in the diets, but there is potential for additional uptake.
- There are differences between fat sources in terms of their effect on land use and land use change, these differences should be considered.
- Support for direct costs (i.e. increased feeding costs) is not practical to implement.

Regulatory requirements that have to be met

We are not aware of any existing regulations or policy incentives which would encourage farmers to use high-fat diets.

General description of the action and operation

Action:

Feed ruminants with a diet containing a total of 5-6 DM (dry matter)% fat (i.e. additional 3-4% fat supplementation) to reduce enteric methane (CH_4) emissions.

Current practice and potential additional uptake:

A traditional ruminant diet contains 1.5-3% DM fat. The fat content of forages is 1.5-3 DM% (Dewhurst *et al.* 2001; Glasser *et al.* 2013; Mir *et al.* 2006), and though concentrates vary a lot in their fat content, they are typically around 2-3 DM% (Dewhurst, R. pers. comm.).

Some farmers with high-productivity herds, especially high-yielding dairy cows and fattening beef, are already supplementing fat to their animals. This is to boost the energy content of the diet, especially in the most productive periods of the year. However, even for those animals the total fat content might be below 5-6 DM% (Roberts, D. pers. comm.). Pellerin *et al.* (2013) suggests that in France 5% of dairy cows receive feed supplemented with fats.

Various supplementary fat sources exist: whole seeds (e.g. rapeseed, linseed, soybean), plant oils (e.g. sunflower oil, rapeseed oil, palm oil, coconut oil), and speciality, rumen-protected fat products (e.g. Energy Booster, Megalac). Alternative sources can be the high-oil by-products of the biofuel industries, like maize distillers' dark grains (McGinn *et al.* 2009). There are differences between them both in terms of their effect on enteric methane emissions and both in terms of the land use and land use change (LULUC) effects associated with their cultivation. As the methane reduction effect is proportional to the fat content of the diet, there is potential for additional uptake both in those herds that are currently not receiving fat supplementation and in those herds that receive supplementation but the total fat content of their diet is below 5-6 DM%. Additionally, for this latter group a switch between fat sources might improve the on-farm mitigation, and, more importantly, can reduce their LULUC effects.

Mechanism of mitigation:
There are three ways how the increased intake of fat reduces enteric CH_4 emissions (Johnson and Johnson 1995; Martin *et al.* 2010; Pellerin *et al.* 2013):

- A common effect for all fat types is that the increased amount of fat replaces other energy sources in the diet, which are mainly carbohydrates. Carbohydrates are digested in the rumen, associated with methane emissions, while fats are digested in the intestine, not contributing to enteric methane emissions.
- Some forms of fats, namely medium chain fatty acids (like most fatty acids in coconut and palm kernel oil) and unsaturated fatty acids (like those in linseed, rapeseed, sunflower, soybean) selectively reduce some of the rumen microbes thus shifting rumen processes towards lower CH_4 emissions. Rumen-protected fat products and long-chain saturated fatty acids (like half of the fatty acids in tallow) do not have these effects.
- Unsaturated fatty acids also act as a hydrogen sink in the rumen, resulting in lower amounts of H_2 produced and thus giving less space to CH_4 production. However, this is a less important effect compared to the other two mechanisms.

The overall reduction in enteric CH_4 emissions is proportional to the amount of fat in the diet (see Table 1 in section 'Expected impacts on farm-level GHG emissions'). However, nutritional and practical aspects (see below) necessitate a limit of 5-6 DM% total fat content. According to Hristov *et al.* (2013) and Martin *et al.* (2010) the question of persistence of the mitigation effect has not been adequately addressed yet: some studies do report long-term effects, but data are inconsistent.

There are two mechanisms which might partially off-set the mitigation in enteric CH_4 emissions: a potential increase in CH_4 emissions from manure storage and a potential increase in emissions related to the production of feedstuff. First, if the increased fat content reduces the digestibility of the whole diet the undigested organic matter in the manure increases, leading to higher methane emissions from slurry storage. However, so far there is limited scientific evidence about this effect.

Second, the change in diet results in a change in emissions related to crop production and possibly land use. The direction and size of this depends on the feed ingredients and their cultivation practices, thus to minimise the negative effect farmers should be encouraged to use low emission intensity fat sources (i.e. crops with relatively low GHG emissions per kg product). It is important to note that there are considerable differences in the land use and land use change effects and the related GHG emissions of the different fat sources. Generally, crops grown in Europe (linseed, oilseed rape) are associated with significantly lower GHG emissions from LULUC than those grown in tropical regions (e.g. coconut, oil palm or soybean). For this reason this operation should support high-fat ingredients that have low LULUC effect, e.g. which are grown in Europe.

Practical considerations:
High-fat feed ingredients can be easily provided as part of the ruminant concentrate diet and available on the market (Pellerin *et al.* 2013). They can be blended in the concentrate at farm (where facilities exist) or concentrates with high fat content can be bought-in from feed suppliers. The fat sources are going to replace other components of the diet. Farmers are likely to reduce concentrate components rather than forages, as concentrates have higher energy content and are more expensive than forages.

There are practical considerations in terms of mixing the oily ingredient with the rest of the concentrate feed. For example, to add 3% fat content using oily seeds, the total diet has to contain approximately 8% linseed or 6% rapeseed. With a 20 DM% concentrate diet, the concentrate should include 39% linseed or 31% rapeseed. With such a high fat content there can be handling problems and it might be difficult to maintain quality during storage. Therefore, there is a greater practical scope to this diet supplementation for animals on a low-forage diet receiving concentrates above 20 DM% of the diet (e.g. high-yielding cows or fattener beef cattle) or a total mixed ration where the forages can be blended with the high-fat sources. The high-fat ingredients cannot be easily offered to animals that are grazing or eating mainly unblended forages. Consequently, there are certain periods of the year when this supplementation is not practical even for high-yielding animals (e.g. when the cows are not lactating).

Medium chain fatty acids and unsaturated fatty acids (unlike rumen-protected fat products can have negative effects on ruminal fermentation and fibre digestion when the total fat content of the diet exceeds 6-7 DM% (Grainger and Beauchemin 2011). This might lead to a reduced daily weight gain or milk yield and cause a modification in the fatty acid composition of products (Beauchemin *et al.* 2008; Patra 2012; Pellerin *et al.* 2013).

Proposed general operations
Fat supplementation is based on increasing some of the commonly used feed ingredients in the diet. In a direct subsidy to the increased feeding costs it would be difficult to support only the additional, increased fat content in the diet beyond the baseline the farmer might have used for an increased performance. Therefore the main suggested operation is to support the cost of consultancy/advisory services on diet formulation for the herd if the diet is to be formulated to contain 5-6 DM% fat. Training courses on high-fat diet can also be offered to farmers.

Commitments, funding conditions and eligibility
Eligible activities

- The use of livestock feed consultancy and advisory services for the formulation of a ruminant diet with fat content of 5-6 DM%, with the supplementary fat sourced from plant or animal products produced in Europe.

PA should provide guidance on high-fat diet for farmers and advisors/consultants, with a list of most suitable regional sources for the high-fat ingredients.

Timing and duration
Fat supplementation can happen all year round, and financial support for diet formulation should not be constrained within the year or within the RDP programming period.
Location

There are no location considerations for this operation.

Synergies - Incompatible operations and recommended combinations
The suggested operation M11 'Precision and multi-phase feeding' is likely not to be influencing the methane mitigation effect of high-fat diets.

Expected impacts on farm-level GHG emissions

Table 1. Abatement rates for increasing the fat content of ruminant feed to 5 DM%

Mitigation effect	**Abatement rate**	**Reference**
Enteric CH_4 emissions	-17% CH_4 / DMI (dry matter intake) for 5 DM% fat content (assuming a baseline of 2 DM%) CH_4 reduction = 5.562 × percentage added fat	(Beauchemin *et al.* 2008)
	Cattle: -14% CH_4 / DMI for 5 DM% fat content (assuming a baseline of 2 DM%) CH_4 emissions (g/kgDM) = 24.55(±1.029) − 0.102(±0.0147) × fat[g/kgDM]}, i.e. 4.53% CH_4 reduction with each 1 DM% fat added **Sheep:** -29% CH_4 / DMI for 5 DM% fat content (assuming a baseline of 2 DM%) CH_4 emissions (g/kgDM) = 32.06 (±2.129) − 0.260(±0.033) × fat[g/kgDM], i.e. 9.68% CH_4 reduction with each 1 DM% fat added	(Grainger and Beauchemin 2011)
	no effect on CH_4 / DMI, but -9% CH_4 / day due to reduced DMI for 6.4 DM% fat content versus a baseline of 2.5 DM% fat content	(Eugene *et al.* 2008)
	-10% CH_4 / DMI for 5 DM% fat content (assuming a baseline of 2 DM%) CH_4 emissions (g/kgDM) = exp{3.15(±0.052) − 0.0035(±0.00061) × fat[g/kgDM]}, i.e. ~3.3% CH_4 reduction with each 1 DM% fat added	(Moate *et al.* 2011)
	-11% CH_4 / DMI for 5 DM% fat content (assuming a baseline of 2 DM%) CH_4 reduction = 3.8 × percentage added fat (depending on the type of fats)	(Martin *et al.* 2010)
	-14% CH_4 / DMI for 5 DM% fat content (assuming a baseline of 1.5 DM%) CH_4 reduction = 4±0.8 × percentage added fat	(Doreau *et al.* 2014; Pellerin *et al.* 2013)
	dairy cows: -401 kg CO_2e/animal/year beef cows and cattle 1-2 years: -240 - -320 kg CO_2e/animal/year other cattle: < -240 kg CO_2e/animal/year	(Pellerin *et al.* 2013)
Land use change	dairy cows: +191 kg CO_2e/animal/year beef cows and cattle 1-2 years: +100 - +130 kg CO_2e/animal/year other cattle: < +130 kg CO_2e/animal/year	(Pellerin *et al.* 2013)
Total GHG impact	dairy cows: -210 kg CO_2e/animal/year beef cows and cattle 1-2 years: -100 - -200 kg CO_2e/animal/year other cattle: < -100 kg CO_2e/animal/year	(Pellerin *et al.* 2013)

Variability in mitigation effect:

The direct mitigation, i.e. the reduction in enteric methane emissions varies between 2-10% for each % of added fat in the diet. According to Grainger and Beauchemin (2011) there is variability between livestock types, sheep showing higher respond than cattle. Some authors found variability between the type of fatty acids, medium-chain fatty acids being more repressive on methane production than polyunsaturated fatty acids, which, in turn, are more repressive than long-chain saturated and monounsaturated fatty acids (Martin *et al.* 2010). There are also differences in the mitigation effect between the form of the fats (e.g. sunflower seed versus sunflower oil) and on the type of diet (i.e. high forage versus high concentrate diet), but the studies are not yet conclusive (Martin *et al.* 2010).

The applicability of a high-fat ruminant diet varies most importantly with the proportion of concentrates in the diet. For animals fed on high-forage diet (> 80 DM%) where the forage is not prepared as a total mixed ration the high-fat ingredients cannot be easily supplemented. Therefore, it is likely that the uptake of this operation might be lower for medium- and low-productivity herds and even in high-yielding dairy and beef herds it might be only administered to lactating cows and finishing beef cattle, respectively.

Ancillary effects

Table 2. Ancillary effects of the operation

Positive effects		**Reference**
Off-farm GHG	-	
Production	The additional fat can increase the yield and also the milk fat content, even when, as in some cases, total feed intake is reduced. The fatty acid composition of the milk and the meat might improve (i.e. more unsaturated fatty acids) with certain fat sources (e.g. oily seeds). This is considered as an advantage by consumers.	(Grainger and Beauchemin 2011; Marette and Millet 2014; Patra 2012)
Adaptation	-	
Environment	-	
Negative effects		**Reference**
Off-farm GHG	The total land area under oils seed crops might slightly increase, while demand for the by-products or grains might slightly fall. This might be a positive or a negative effect. See more in the section 'Mechanism of mitigation'.	(Pellerin *et al.* 2013)
Production	If the fat content does exceed 5-6 DM% the rumen ecosystem might be disturbed (negative effects on fermentability and digestibility), decreasing dairy milk yield, milk fat content or beef/sheep growth rate.	(Grainger and Beauchemin 2011; Pellerin *et al.* 2013)
Adaptation	-	
Environment	High-fat ingredients originating from tropical areas are associated with a biodiversity loss linked to land use change.	

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations
Though in most cases farmers are likely to incur increased feeding costs if administering a high-fat diet, this operation is not suggested to support the feeding costs but only the cost of diet formulation through supporting the associated advisory/consultancy costs. Many farmers have feed formulation costs associated with their business-as-usual feeding practices, therefore the financial support for advisory/consultancy costs would partly cover the likely increased ongoing feed costs from high-fat diets in the first year.

When providing a high-fat diet to livestock recurring costs arise from purchasing the supplementary oily seeds, by-products or oils, as they are in most cases more expensive than the concentrate ingredients they are replacing – however, high variations between feed ingredients within a region and the same ingredients among regions are likely and fluctuations with time are inevitable. Therefore, an up-to-date, country- or region-specific recommendation on high-fat ingredients could facilitate uptake. An increased yield and improved milk and meat quality is possible, offsetting some of the costs.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Replacement of some of the concentrates in the diet with oily seeds	Dairy cows: €109/animal/year Other animals > 1 year: €47-78/animal/year	Pellerin *et al.* (2013)

The cost-effectiveness of feeding a high-fat diet is categorised as being in category 3, significant cost.

Given the limited private benefits and the private costs associated with the high-fat diet, uptake is likely to be limited. Clear advice and best practice examples, including potential cheap high-fat feedstuff at the local level can have an important positive influence on uptake.

Control and Verification
Compliance could be verified by providing the receipt of the advisory/consultancy charges.

Potential result indicators
- Result indicator 18: Reduced emissions of methane and nitrous oxide

Extent to which the mitigation effect would be captured by National GHG Inventories

The direct on-farm mitigation effect of high-fat diet is not included in the national inventories using Tier 1 or Tier 2 methodologies. However, a very small part of the effect, originating from the increased energy density of the diet, would be captured with Tier 2 methodology.

Similarly, the off-farm GHG effects of the change in feed ingredients are partly captured. The changes in fertiliser use due to the change in cropping patterns would be included in the national inventories, while carbon dioxide emissions and carbon sequestration linked to LULUC are not normally included. Additionally, they are likely to occur in countries other than where the high-fat feed ingredients are used.

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	Reference
Ruminant diet with less than 20% DM concentrates or not based on a total mixed ration (too big feed management change would be required to implement the action)	Pellerin *et al.* (2013)
Costs of high-fat feed ingredients	Hristov *et al.* (2013) Pellerin *et al.* (2013)
Other key risks/uncertainties	**Reference**
The abatement achieved relative to the business of usual feeding practices is likely to be difficult to assess, partly because the current ruminant feeding practices regarding fat content are not well explored and partly because the implementation of the mitigation action is difficult to monitor.	
The long-term persistence of the mitigation effect has not been consistently proved yet.	Hristov *et al.* (2013) Martin *et al.* (2010)

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Fiche M11: Precision feeding and multi-phase feeding for livestock- MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	20 (a) (i) 20 (a) (iv) 20 (b) (i) 36 (a) (iv)	111: Vocational training and information actions 114: Use of advisory services by farmers and forest holders 121: Modernisation of agricultural holdings 214: Agri-environmental payments
2014-2020	14(1) 15(1) 17(1) 28(1)	Knowledge transfer and information actions Advisory services, farm management and farm relief services Investment in physical assets Agri-environment-climate

Summary

- Suggested operation: supporting the capital investment and training/advisory costs of precision and multi-phase feeding techniques, where in feed formulation the nutrient requirements of groups of animals (or individual animals) are targeted.
- Additional uptake potential mostly exists with regard to medium-sized farms, in the ruminant sector and in improving current practice.
- Important pollution reduction opportunity in terms of nitrogen load, particularly ammonia emissions, though evidence on the effects on direct nitrous oxide emissions from manure are not conclusive
- While saving can be achieved in terms of feed costs, the capital investment required is likely to be an important barrier, especially for middle-sized and smaller farms.

Regulatory requirements that have to be met

Precision feeding and multi-phase feeding are currently applied on many of the biggest pig and poultry farms in Europe (JRC 2013), as they are covered by the IPPC Best Available Techniques requirements (JRC 2003). Pellerin *et al.*(2013) estimates that French pig farms use the following feeding systems: 20% monophase, 80% biphase, 0% multiphase and 48% of dairy cows have winter feed rations with a protein level not higher than the target 14%. According to Daemmgen *et al.* (2011), in an example district of Germany three- and two-phase feeding is applied to 52% and 45% of the pigs, respectively, with only 3% receiving monophase feeding.

Many countries have mandatory nutrient management systems to control nitrogen and phosphorous loads, at least above certain farm sizes (e.g. Germany, Denmark, the Netherlands, Belgium, and France). This, along with a drive for increased animal performance and competitiveness, is a major force for controlling animal nutrition and reducing excreta (JRC 2013). The mandatory policies on nutrient control are mostly related to diffuse water pollution (nitrogen and phosphorous) and air pollution (nitrogen, in the form of ammonia) (see e.g. the Water Framework Directive or the Best Available Techniques of the Integrated Pollution Prevention and Control Directive), and yield a co-benefit of reduced nitrous oxide (N_2O) emissions.

Despite the widespread implementation of these management techniques in the pig and poultry sectors of many countries, additional greenhouse gas (GHG) mitigation can be achieved by a wider uptake of precision feeding and multi-phase feeding techniques (e.g. on medium sized farms and on cattle and sheep farms) and by further improving precision and multi-phase feeding practices (e.g. considering better the individual needs of the animals – towards individual feeding –, or increasing the frequency of diet adjustments – towards daily tailored feeding (Pomar *et al.* 2011)).

General description of the action and operation

Action:

In precision feeding the nutrient content of the diet is optimised to the requirements of the animals. For better results multi-phase feeding is implemented whereby the animals are grouped depending on their growth stage, sex, reproductive status, exercise level, etc. and the feed conversion ratio and nitrogen (N) utilisation is maximised for each group.

Mechanism of mitigation:

In precision and multi-phase feeding the nutrient intake is closely matched with the animal's requirements. The balanced diet improves general health and fertility, improving production at the herd level (Van de Haar& St-Pierre 2006). Enteric methane emission per unit of product might also be reduced through maintaining a healthy rumen and maximizing microbial protein synthesis (Hristov *et al.* 2013).The main effects of the action are on direct and indirect N_2O emissions from manure (both manure storage and field application of manure).

Regarding GHG emissions, one of the most important components of precision and multi-phase feeding is the adjustment of protein content which, against current practice, means reduced protein intake. The effect of the reduced protein intake on N excretion is well explored. For low protein diets (in some cases supplemented with amino acids), authors usually report 5-60%, 10-35% and 25-50% reduction in N excretion for pigs, poultry and cattle, respectively, with an even higher reduction in ammonia emissions (Agle *et al.* 2010, JRC 2013, Lee *et al.* 2012, Monteny & Erisman 1998, Rotz 2004). The lower ammonia emissions result in decreased indirect N_2O emissions both from manure storage and from field application.

Though the IPCC Tier 2 calculations assume a linear decrease of direct manure storage N_2O emissions with decreasing protein intake (Paustian *et al.* 2006), there is no conclusive experimental evidence about these effects. Some authors report reduced emissions while some report increased emissions. Neither there is agreement on the effect on methane emissions from manure storage (Kulling *et al.* 2001, Lee *et al.* 2012, Misselbrook *et al.* 1998, Philippe *et al.* 2006, Velthof *et al.* 2005). The French Marginal Abatement Cost Curve study estimated the GHG benefits from manure storage and spreading of reduced protein intake to be between 70 - 124 kg CO_2e/animal/year for dairy cows and +276 - 692 kg CO_2e/animal/year for pigs (Pellerin *et al.* 2013). Nevertheless, the reduction in the N excretion provides important environmental benefits in terms of reduced N pollution, mostly affecting ammonia emissions and indirect N_2O emissions, with less clear effect on direct N_2O emissions.

Practical considerations

Precision and multi-phase feeding can be implemented for all types of livestock, including poultry, pigs and cattle. A wide range of technologies is available both for collecting information about the animals' requirements (e.g. by checking their yield or N excretion) and for precise feed formulation, including feed analysis and feed mixing.

The number of phases and the GHG mitigation potential depend on the type of the animals and should be adapted to local circumstances (JRC 2013). In Europe, nutritional recommendations are widely available, but the availability of feedstuff needed for precise feed formulation (e.g. synthetic amino acids) might vary among countries and might limit the applicability of the operation (JRC 2013).

Precision and multi-phase feeding are more applicable to monogastric animals (poultry and pig) than to ruminants, partly because it is easier to control and change the nutrient content of concentrates than of forages, and partly because ruminants' nutrient (in particular protein) requirements can be predicted with less accuracy than those of monogastrics due to the biochemical processes in the rumen (Dewhurst, R. pers. comm.). Poultry usually can be fed in three to five phases, while two to five phases are feasible for pigs. While reducing the protein content of the diet, poultry and pigs should be supplemented with essential amino acids (JRC 2013).

Precision grazing offers improved targeting of the nutritional requirements of pasture-based ruminants. Both animal performance and grass yield and quality are monitored and animals are matched to best suitable fields (O'Brien 2012). Precision feeding of ruminants receiving a high amount of grass silage includes monitoring the forage quality and adjusting the concentrate ratio. Potentially the protein content of forages can be reduced by increasing the maize or wheat silage content of the diet at the expense of grass products, though it has undesirable effects on land use change (Vellinga and Hoving 2011). Finally, if ruminants receive a high amount of concentrates, the diet can be adjusted by changing the composition of the concentrates (see e.g. Cole *et al.* 2006). However, the protein content of the ruminant diet cannot be reduced by as much as the monogastrics' diet as amino acid supplementation is less practical because rumen-protected amino acids are needed (Pellerin *et al.* 2013).

Precision and multi-phase feeding are mostly applicable to bigger farms due to economies of scale. The capital investment and personnel requirements make the action less affordable to small farms. For example, in Denmark for pig farms it is considered to be applicable above 1,300 pig places (JRC 2013).

A lower N content in the manure implies that higher amount of synthetic N fertiliser would be required in field application, living rise to increased GHG emissions from synthetic N (JRC 2013). However, Pellerin *et al.* (2013) suggests that there is little impact on the fertilising value of manure.

Proposed general operations

Precision and multi-phase feeding is based on a more precise feed formulation to animals. This operation is to support the capital costs and training and advisory costs of implementing or improving precision and multi-phase feeding activities.

Commitments, funding conditions and eligibility

Eligible activities

- Capital investment in precision and multi-phase feeding equipment (e.g. automated feed analysis and feed mixing system, feed storage facilities).
- Training on the use of precision and multi-phase feeding equipment and training on feed formulation.
- Advisory costs of preparing a feeding plan.

Only those farms are suggested to be eligible, which do not fall under mandatory regulations controlling livestock nutrient excretion (e.g. IPPC or NVZ regulations).

Capital investment required might include one or more of the following (JRC 2013):

- expansion of feed storage areas,

- feed mixing and supplying devices, including metering equipment, conveying technology, etc.,
- restructuring or expansion of animal houses to allow grouping,
- automatic animal grouping equipment (e.g. computerised scales).

Timing and duration
Precision and multi-phase feeding can happen all year round. Support for the operation should not be constrained within the year or within the RDP programming period.

Location
There are no location considerations for this operation.

Synergies - Incompatible operations and recommended combinations
The suggested operation M10 'Fat supplementation in ruminant diets' is likely not to be influencing the mitigation effect of this operation. The proposed RDP operation M14 'Climate proofing planned investments' might partially target the same capital investments. Care should be taken to avoid double funding. Due to the potential health benefits from precision feeding this operation is synergistic with M15 'Better livestock health planning'.

Expected impacts on farm-level GHG emissions
As mentioned above, the scientific literature on the GHG effects of precision and multi-phase feeding is scarce, and the GHG effects of reduced protein intake are not conclusive.

Table 1. Abatement rates for precision and multi-phase feeding

Mitigation effect	Abatement rate	Reference
Direct N_2O emissions from manure storage and spreading	No conclusive evidence (see section 'Mechanism of mitigation')	
Indirect N_2O emissions	The significant reduction in ammonia emissions reduces the indirect N_2O emissions	
Land use change	Dairy cows: +171 kgCO_2e/animal/year Pigs, 2-phase + amino acid supplementation: 306kgCO_2e/animal/year Pigs, multi-phase + amino acid supplementation: 374 kgCO_2e/animal/year	(Pellerin *et al.* 2013)

Beyond the uncertainty regarding the effects on N_2O emissions, there is variability in terms of total N_2O mitigation as the N_2O emissions from manure storage hugely depend on the manure management system. In liquid systems, the N_2O emissions are often negligible, while in deep litter and farmyard manure N_2O emissions are an important part of the total emissions. Furthermore, as GHG emissions from ruminants are dominated by enteric methane emissions, manure N_2O emissions are relatively more important on pig and poultry farms.

Ancillary effects
Table 2. Ancillary effects of the operation

Positive effects		Reference
Off-farm GHG	The change in the feed ingredients might result in a change in land use and associated CO_2	(Pellerin *et al.*2013)

Positive effects		**Reference**
	emissions / carbon sequestration. This change is likely to be positive due to a reduction in protein-rich feed ingredients mostly sourced from the tropical regions.	
Production	Balanced feed composition improves health and fertility, improving production at the herd level.	(Hristov *et al.* 2006)
Adaptation	Low-protein diets can reduce the heat production of the animals.	(JRC 2013)
Environment	Reduced ammonia emissions result in improvement in acidification levels, eutrophication, soil toxicity processes, human health (fine particles) and odour levels. Phosphorous excretion is also reduced (especially in the case of pig and poultry), improving water quality.	(Cerosaletti *et al.* 2004, Hristov *et al.* 2013, JRC 2013, Pellerin *et al.* 2013)
Negative effects		**Reference**
Off-farm GHG	-	
Production	A slight reduction in yield and milk quality is possible for dairy cows if the protein content is reduced below 14% (unless rumen protected amino acids are provided).	(Pellerin *et al.* 2013)
Adaptation	-	
Environment	-	

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated. If the diet needs to be changed (e.g. because of the changing climate) the equipment and infrastructure can be used for providing the new diet.

Guidance on costs and payment calculations
The operation offers support for the capital investment for the equipment (e.g. automated feed analysis and feed mixing system, feed storage facilities). Support for training costs on the use of equipment and on feed formulation; support for advisory costs related to preparing a feeding plan.

Cost elements at the farm:

- Capital investments (see in 'Eligible activities' section) – one-off
- Training and advisory costs – one-off and annual
- Feed cost (might slightly increase or decrease) – annual
- Feed analysis costs (e.g. silage analysis) – annual
- Reduction in water costs and slurry handling costs – annual
- Potential changes in yield (might slightly increase or decrease) – annual

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Equipment	Pigs, multi-phase & amino acid supplementation (amortised over 12 years): 29.5 €/sow/year (assuming 5-7% discount rate this is 250 to 270 €/sow capital cost)	(Pellerin *et al.* 2013)
Feed costs	Dairy (winter only): savings in feed costs &	(Pellerin *et al.*

Costs/savings	Total cost	Source
	reduced production (0-25 litres/day @ x €0.3/l) & reduction in milk protein (0.1 to 0.3 g/l @ €0.006/g/l) = (8) to 84 €/animal/year Pigs, 2-phase & amino acid supplementation: 49.2 €/animal/year Pigs, multi-phase & amino acid supplementation: 80.1 €/animal/year (total cost (incl. equipment) is 51.6 €/animal/year)	2013)
Feed costs	Pigs and poultry: 0 to -3 % i.e. for pigs: 0 to 4 €/pig place (assuming feed costs of 131 €/pig place; based on: feed costs 65.5 €/100kg meat (2009 EU average), 3.14 pig/year/pig place (EU average, (JRC 2013)), average carcass weight: 90 kg (EU average, (JRC 2013)), and assuming 70% carcass cutting yield)	(JRC 2013)
Feed costs	Pigs with individually tailored diet: -10.5%, i.e. -14 €/pig place (assuming feed costs of 131 €/pig place; see above)	(Pomar *et al.* 2011)
Equipment + feed costs	€1.35 to €1.88 / pig place	(Niemi *et al.* 2010)
Equipment + feed costs	€9 to 17/cow	(Ghebremichael *et al.* 2007)

The cost-effectiveness of precision and multi-phase feeding is categorised as being in category 1 or 2, negative cost or no/low cost.

Variation in the costs arises, depending on the technology to be implemented of precision and multi-phase feeding system, and the machinery and infrastructure needed for the farm's individual circumstances. Feed costs also fluctuate; a particularly important factor is the relative price of protein-rich feed components to other feed ingredients.

Control and Verification
Compliance could be verified in a number of ways:

- Integrated into current farm monitoring.
- Via provision of feeding records.
- Via provision of proof of purchase of equipment.

Potential result indicators

- Result indicator 16 (P5D(1)): % of Livestock Units (LU) concerned by investments in livestock management in view of reducing the GHG and/or ammonia emissions
- Result indicator 18 (P5D(1)): Reduced emissions of methane and nitrous oxide

Extent to which the mitigation effect would be captured by National GHG Inventories
Changes in direct and indirect N_2O emissions from housing, manure storage and spreading would be included in national inventories using Tier 2 methodology. However, these might not reflect the emission changes accurately (see section 'General description of the action and operation').

The off-farm GHG effects of the change in feed ingredients would be partly captured. The changes in fertiliser use due to the change in cropping patterns would be included in the national inventories, while carbon dioxide emissions and carbon sequestration linked to LULUC are not normally included.

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Reference**
Capital investment	(JRC 2013)
Potential need for trained personnel to operate computerised feeding systems	(JRC 2013)
Potential changes in farm infrastructure and management to provide separate feeding areas for the different groups	(JRC 2013)
Other key risks/uncertainties	**Reference**
The change in direct N_2O emissions from manure and manure application to soils are not well explored	
Possible medium-term effects of low protein rations on e.g. dairy cow fertility	

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Fiche M12: Solar fodder dryer - MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	20 (a) (I)	121: Modernisation of agricultural holdings
2014-2020	17 (1) (a)	Investment in physical assets

Summary
Financial support for the purchase of specific equipment required to develop a solar fodder dryer is proposed. Benefits include:

- Reduction in fuel used for the fodder system.
- Reduction in electricity used for drying thanks to the solar collector.
- Reduction of diverse inputs at farm level (feedstuff purchased, mineral nitrogen fertilisers, plastics).
- Increased carbon sequestration.

Regulatory requirements that have to be met
There is no specific regulation across Member State in Europe Union about fodder cultivation and/or preservation techniques. Farmers are free to decide which fodder system (silage, hay, pasture) they implement except in some regions where specifications related to AOP (Appellation d'Origine Protégée) exist or certification schemes for products such as hay-milk products[3]. The choice of a fodder system will induce specific direct energy consumption (i.e., the fuel consumption per ha).

A significant number of solar drying plants have been built throughout Europe, some 4,000 in 2005 (Voskens, 2005). The majority of the plants are located in Switzerland for forage drying (around 1,000). One factor favouring the implantation of solar drying is that barn-drying is the most recommended, if not the only permitted, preservation method in certain cheese-producing areas such as Comté, Gruyère, Emmenthal, Beaufort, Reblochon, Tomme, Roquefort etc. This has been the historical means of developing this technique. A recent French study (Bochu, 2011) showed that 600 to 700 solar dryer are established in France (Massif Central, Pyrenees, the Alps, Jura, and the West part of France etc.) against only 100 plants in 1996 (Bochu, 1996). In addition to France, there is a renewed interest for this technology in the territories along Switzerland such as Austria, North of Italy, South of Germany, etc.

General description of the action and operation
Drying fodder is a harvesting technique for fodder preservation by dry process, for loose hay or round bales. This technique is alternative and often complementary to other methods for fodder preservation using wet process (silage, etc.) or dry process (traditional hay).

This technique consists of harvesting a rich plant at an early stage, which gives a very high nutritive quality after conservation, ingested in high quantity without waste by animals. The final result is a fodder with 85-90% of dry matter (DM), which ensures its perfect preservation without heating or organic degradation.

The climate during spring period is the main limiting factor for the optimal harvest stage fodder. Usually, semi-dry hay (60-65% of dry matter) is obtained 48 hours after mowing plots, which is the desired humidity rate to barn the loose hay.

[3] http://www.kaeserebellen.com/the-kaeserebellen/facilities/

The solar dryer system is based on the recovery of hot air under the roof (presence of an insulating material) that allows recovering the thermal energy accumulated during sunny periods. A fan pulses this hot air through adapted cells where the loose hay is stored. This solar dryer system secures the quality of the harvested fodder, particularly by reducing half of the drying rate compared to the use of ambient air. The drying period is about one week to one month, depending of the fodder harvest moisture and the weather, which means that the fan is used 20 to 40 days per year for a total of 3 to 5 cuttings.

Drying forage requires a specific mechanisation. Usually, a hydraulic forage claw on rails allows the handling of forage to the hay barn at harvest and then it is distributed to the animals during winter. Also, a self-loading trailer is needed for harvesting half dried loose hay and bringing it to the barn. These trailers are already used and implemented in green forage feeding. The other machinery for loose hay is not specific: mower, hay tedder and windrower are used. The main difference with hay dried in field resides in reducing the number of forage handling operations on the plot.

The technique of capturing solar energy for drying fodder appeared in the 70’s with the aim of reducing energy costs. The large roofs of farm buildings receive large amounts of solar energy, which could indeed be transformed to utilise this energy. The solar collector systems used today are essentially bare roof sensors. The cover of the building is transformed into a solar collector by simply applying an insulating panel to the underside.

The solar collector used can recover the energy equivalent of 2,000 to 5,000 litres of fuel per year depending of the plant size (Bochu and Bordet, 2011). The average efficiency of a solar collector for drying fodder is about 30% of the solar radiation (ARPE, 2006). This solar energy increases drying speed by doubling the actual evaporative power of the air. The drying time is thus reduced by 30 to 50% compared to the ventilation of ambient air. The electricity savings for the fan operation are averaged 30 to 50%. Electricity consumption for drying loose hay is about 100kWh per tonne of dry matter. It can be reduced to between 50 and 70kWh per tonne of dry matter with a solar collector (Bochu, 2011).

Significant investments are required to develop a solar fodder dryer but there are also numerous savings and environmental benefits (ARPE, 2006):

- Reductions of fuel consumption for animal care inside buildings and also for the forage supply process.
- Reduction of inputs (seeds, fertilisers, pesticides, plastics). It is often observed that farmers with fodder dryer develop leguminous species in their temporary grasslands compared to their previous situation (lucerne is considered to be an easy plant to dry).
- Reduction of feedstuff purchased due to the production of rich hay protein (improve the farm dependency of protein). Feeding animals with high quality hay requires only a complementation based on cereals, which are easier to produce on arable lands than protein crops.
- Maintenance and development of grassland biodiversity by the rhythm of harvesting and the use of lighter machinery, limiting soil compaction, increase the lifespan of the meadows (which means less energy for resetting up new ones).
- It is often observed a decrease in veterinary costs and a lengthening of the life of animals (better health).

Proposed general operation
In order to achieve mitigation via the development of solar fodder dryer, the following operation is proposed:

- Financial support for the purchase of specific equipment required to develop a solar fodder dryer such as fan, hydraulic forage grab, timber cells to store loose hay and insulation material under the roof.

It can be noticed that in case of existing additional premium for hay-milk under certification schemes, sometimes farmers can invest in a solar dryer without investment support.

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
All farms that have a fodder system based on the constitution of fodder stocks could be eligible.

According to the amount of investment, there is a critical size below which there can be no economic return. For information, the average size in France is between 150 and 300 tonnes of dry matter (Bochu, 2011).

Also, it is possible to create a common solar dryer unit for several neighbouring farms to achieve a critical size (from 300 to 1,000 tonnes of dry matter). Thus, this measure may apply to either individual farms or a group of farms.

The initial investment is extremely variable depending on the farms. Some of the farms need to invest in the whole system (barn, equipment and machinery), other farms have just to buy a fan, cells and a forage grab, whereas other farms already under a hay barn system only need to invest in the solar collector. For example, around 1,000 farms in France could be concerned by just the addition of a solar sensor to improve their energy efficiency (Bochu, 2011).

PA could determine a list of efficient equipment or characteristics that strengthen the mitigation potential of the solar fodder dryer, e.g.:
- Quality of the insulation system under the roof
- Characteristic of the fan (high efficiency motors)
- Control system (electronic speed variation and pilot computer)
- Heat pump dehumidification in addition to the solar collector

Timing and duration
No specific requirements are foreseen.

Location
Except in the South of Europe, where weather conditions are often more favourable in spring, solar fodder dryer is well adapted to the Central and North Europe. Even in regions with high humidity conditions (e.g. littoral zones and mountains), solar fodder drying can be combined with technologies such as heat pump dehumidification to achieve a good efficiency.

Synergies - Incompatible operations and recommended combinations
Solar fodder drying is a widely applicable operation that can induce positive synergies with the following operations (ARPE, 2006):

- Development of Biological N fixation through the cultivation of pure leguminous species or grass-mixes (Fiche M5)
- Loosen soil compaction (Fiche M8)
- Better livestock health planning (Fiche M15)
- Behaviour change towards better energy efficiency (Fiche M13)

Expected impacts on farm-level GHG emissions
The solar dryer will increase the GHG emissions from electricity consumption due to the operation of the fan and the forage grab. Nevertheless, it is at least compensated by the decrease in fuel consumption due to the modification of the fodder system (fuel for crops cultivation and for fodder distribution inside buildings). It should be noted that solar collectors can be installed with photovoltaic panels, thus offsetting the annual electricity needs for the operation of the fan. Also, the solar collector leads to a 40% reduction in the electricity used for drying, which can lead to a significant mitigation effect depending on the emission factor for electricity of the Member State.

Besides this, the solar fodder dryer will induce some diverse reductions of inputs at farm level, whose effects are highly variable depending on the initial situations of each farm:

- Reduction of feedstuff purchased: quantities consumed are related to both the fodder system in place (more or less maize in the fodder area) and the efficiency of the feedstuff distributed (quantity of feedstuff per litre of milk produced).
- Reduction of nitrogen mineral fertilisation in relation to the development of surfaces with legumes; pure leguminous species will induce a total removal of mineral nitrogen or whereas grass-mixes will induce a reduction of about 30kg of mineral nitrogen per ha.
- Reduction of plastics used in silage systems.

Finally, the increase in the grassland productivity is favourable to an increase of the C in the soil.

Table 1. Abatement rates for a solar fodder dryer on a farm

Mitigation effect	**Abatement rate**	**Source**
Increase of electricity due to the operation of the fan (CO_2)	The EF for electricity is quite variable across EU-28, from 0.11kgCO_2e/kWh (Sweden) to 1.6kgCO_2e/kWh (Estonia).	Bochu *et al.* (2013)
	Electricity: 60 kWh/t DM, which means between 6.6 and 96 kgCO_2e/t DM. For an average size of solar fodder dryer of 250t DM, this leads to an increase of between 1.65 and 24tCO_2e/yr at farm level.	Bochu *et al.* (2011)
Reduction of electricity consumption	The EF for electricity is quite variable across EU-28, from 0.11kgCO_2e/kWh (Sweden) to 1.6kgCO_2e/kWh (Estonia).	Bochu *et al.* (2013)

Mitigation effect	Abatement rate	Source
compared to hay barn without a solar collector (CO_2)	40kWh/t DM saved, which means between 4.4 and 64kgCO_2e/t DM. For an average size of solar fodder dryer of 250t DM, this leads to a reduction between 1.1 and 16tCO_2e/yr at farm level.	Bochu *et al.* (2011).
Reduction of fuel consumption (CO_2)	An average reduction of 30% is observed due to the modification of the fodder system	Bochu *et al.* (2011)
	The average fuel consumption for a French dairy farm is 5,500 litres/yr, which means an average abatement of about 5 tCO_2e/yr at farm level.	Bordet *et al.* (2010)
Reduction of feedstuff purchased (N_2O & CO_2)	An average reduction between 20% and 50% is observed	ARPE (2006) Beauchamp *et al.* (2010) AgriClimateChange project (2013)
	The average quantity purchased for a French dairy farm is about 35 tonnes/yr, which means between 5.6tCO_2e/yr to 14tCO_2e/yr.	Bordet *et al.* (2010)
Reduce amount of applied N (development of legumes in grasslands) (N_2O & CO_2)	Increase of legumes in grasslands allows an attenuation of 284 kgCO_2e/ha/yr at farm level + 156 kgCO_2e/ha/yr upstream of the farm	Pellerin *et al.* (2013)
	Assumption of 30 ha converted based on a French survey: abatement potential of 13.2tCO_2e/yr at farm level	Bochu *et al.* (2011)
Reduction of CO_2 from inputs (plastics, strings etc.) (CO_2)	Emission factor for farming plastics: 2.59kgCO_2e/kg of plastic	Bochu *et al.* (2013)
	Plastics can represent several hundred kg of plastics per year for farms using fermented fodder (50kg/silage tarpaulin). Assumption of 100kg per farm, which means a reduction of 0.259tCO_2e at farm level	AgriClimateChange project (2013)
Increased soil C sequestration/increase the duration of temporary grassland	Stimulation of the biomass production and/or less carbon release in the atmosphere (less frequent turning grasslands): 1.416kgeCO_2/ha/yr. Depending of the location and the initial situation of the farm, these two benefits can be involved.	Pellerin *et al.* (2013)
	Assumption of 30ha concerned by an increase of productivity, which means an abatement of 42.48tCO_2e at farm level.	Bochu *et al.* (2011)

For an example of this operation in practice, see AgriClimateChange project (2013, p39), in which a farm producing sheep milk realises an energy saving of about 46% and of its GHG emissions by 6% once a solar dryer unit has been installed.

Ancillary effects

Table 2. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG	Reduction in emissions related to the manufacture of feedstuff purchased, mineral nitrogen fertilisers and plastics for fermented fodder.	Included in table 1
Production	Stable or increase of the milk production. Quality of the milk improved (lower butyric, better fatty acid profile, etc.).	Beauchamp *et al.* (2010)
Adaptation	Less vulnerability to climate conditions at harvest time (harvest time halved)	Bochu *et al.* (2011)
Environment	Improved biodiversity in grasslands, soil and water protection by promoting grasslands.	Bochu *et al.* (2011)
Negative effects		
Off-farm GHG	Increase the electricity consumption compared to a situation of a farm without a hay barn system. Emissions arising during the production of the equipment.	Bochu *et al.* (2011), already included in table 1
Production	-	
Adaptation	-	
Environment	-	

Solar fodder dryer are also known to improve the working conditions of the farmer: better organisation for fodder harvest, the whole fodder chain is mechanised which make the work less difficult, reduce the dependence on climate (tranquillity and security), fractionated harvest period and the speed for forage harvesting (Beauchamp, 2010).

Safeguards against maladaptation

This technology will help to secure the fodder stocks from the perspective of climate change.

Guidance on costs and payment calculations

The investment for the implementation of a solar fodder dryer includes the whole chain for harvesting – storage – preservation – distribution of fodder to animals. It is therefore not just adding a piece of drying equipment.

The capital cost varies from 50,000 to 300,000€ for storage capacity between 150 to 500 tonnes of dry matter. The cost can vary significantly depending on the suitability of the pre-existing equipment and buildings.

Description of the main costs (Bochu, 2011):

- Building: 20,000 to 200,000€
- Cells to store loose hay: 5,000 to 15,000€
- Claw handling: 25,000 to 45,000€
- Self loader trailer: 30,000 to 50,000€
- Fan: 5,000 to 20,000€
- Solar collector: 10,000 to 30,000€
-

Thus, the total cost varies between 500 to 1,000€/tonne of dry matter. The lifetime of this equipment is generally over 20 years (except for the harvest machinery). The amortisation period is about 12 years for a building and 7 years for machinery. After amortisation, the residual cost is often very low, the annual operating costs varies between 5 to 10€/tDM (wide variations across UE-28, from 0.12€/kWh to 22€/kWh). In summary, the initial investment is important whereas the operation costs are low.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost (at farm level)**	**Source**
Electricity costs Electricity savings	1,800€/yr* (1,200€/yr*)	Bochu *et al.* (2011)
Fuel savings	(1,240€/yr)	Bochu *et al.* (2011)
Feedstuffs purchased savings	(6,067€/yr)	Beauchamp *et al.* (2010), annual saving of 28€/1000 litres of milk
Fertilisation savings	(945€/yr)	Pellerin *et al.* (2013)
Plastics savings	(200 €/yr)	
Amortisation of equipment	15,000€yr/ (60/tDM during amortisation period) 0 €/yr (once amortised)	Beauchamp *et al.* (2010)

*Based on a French tariff 0.12€/kWh

The cost-effectiveness depends on the amortisation of the investment related to the solar dryer:

- It is categorised as being in category 3, significant cost, during the period of amortisation which is about 12 years (around 102€/tCO2e)
- It categorised in as being in category 1, negative cost, once the equipment is amortised (-112€/tCO2e)

The main driver of variation is the initial capital investment required. The-cost effectiveness would be categorised as being in category 2, no cost, for farms with a low initial investment (around 500€/tDM).

Control and Verification

The control will be the same as for all measures concerning investment.

Potential result indicators

Identify the number of solar fodder dryer in the Member State and their main characteristics:

- Capacity storage for fodder in tDM
- Surface of solar collector on the roof in m^2

P5C Capacity created and energy generated in RDP supported renewable energy projects, expressed in tonnes of oil equivalent (T.O.E.)

P5D(1) Livestock Unit (LU) concerned by investments in livestock management in view of reducing GHG emissions supported under RDP art. 18 Investments in physical assets as a percentage of total LU in a base year.

Extent to which the mitigation effect would be captured by National GHG Inventories

CO_2 emissions from electricity and fuel would be captured.

N_2O reduction from nitrogen fertiliser application would be captured.

Off-farm changes in emissions for the manufacturing inputs (feedstuffs, fertilisers, plastics) would not necessary be captured, depending on their origin (imported or not).

Changes in soil carbon stocks would require specific soil C emission factors and would not be captured in most current approaches.

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Investment costs	Bochu *et al.* (2011)
Other key risks/uncertainties	
A humidity rate for the fodder too high at harvest could cause the loss of the fodder stocks (extreme case)	Bochu *et al.* (2011)
A poor consideration of the improved nutritional value of fodder could prevent to achieve the total reduction potential from feedstuffs purchased.	Bochu *et al.* (2011)

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Fiche M13: Improved energy efficiency - MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	20 (a) (i) 20 (b) (I)	111 – Vocational training and information actions 121 – Modernisation of agricultural holdings
2014-2020	14(1) 15(1) 17(1) 28(1)	Knowledge transfer and information actions Advisory services, farm management and farm relief services Investment in physical assets Agri-environment-climate

Summary
Energy is used for a wide variety of purposes in farming, and the emissions arising from it can be significant. Improving the fuel efficiency of mobile machinery is arguably one of the most promising ways of reducing energy-related emissions. Many farmers have expressed an interest in improving their fuel efficiency but lack the knowledge required to do so. In order to meet this need, the following operations are proposed:

- Provision of training in methods to measure fuel consumption. Grants to (partly) cover the costs of purchasing equipment to monitor fuel consumption.
- Advisory support to develop a fuel use action plan, including provision of training in techniques to improve fuel efficiency such as eco-driving and tractor maintenance.

If barriers to uptake and rebound effects can be managed, this operation could lead to small but significant reductions in on-farm emissions and cost savings.

Regulatory requirements that have to be met
Examples of the existing non-RDP policies that seek to improve energy efficiency include:

- National schemes to improve industrial and domestic energy efficiency through measures such as the provision of grants, interest-free loans, tax incentives and advice (for example Carbon Trust 2012, Farming for a Better Climate 2014).
- The IPPC (Integrated Pollution Prevention and Control) Directive provides guidance on Best Available Techniques for reducing the environmental impact of industrial activities, (including intensive pig and poultry units above certain sizes). The guidance includes recommended techniques for the efficient use of energy (see Joint Research Centre 2013, p690, p710, p725).

Energy efficiency is targeted under some existing RDPs. For example, The French RDP has a specific energy efficiency operation under Axis 1, Plan de Performance Energétique (Energy Performance Plan, measure 121 C). This operation provides financial support between €400 and €600 for an energy audit and further support (between €16,000 to €24,000) to enable the purchase of a diverse range of renewable and energy efficient capital items (not including tractors) DGFAR (2014).

More general training operations that could be used to improve energy efficiency exist in some form in most RDPs, however, the extent to which they are targeted at energy efficiency is not known.

The emission intensity of agricultural energy use (i.e. the emissions per unit of output) are likely to decrease due to a combination of the development of more energy efficient equipment and decarbonisation of electricity generation (AEA/ FEC Services Ltd 2010, p8). Uptake of energy efficiency measures will be driven by a combination of market forces (primarily increasing energy prices) and policy.

General description of the action and operation

Energy is one of the main agricultural inputs and leads to significant emissions of CO_2 (and to a lesser extent CH_4 and N_2O) on- and off-farm. The energy use related emission intensity of an agricultural activity is a function of (a) the rate of energy consumption, and (b) the emissions that arise per unit of energy consumed. This operation focuses on (a) reducing the amount of energy consumed per unit of output – i.e. energy efficiency, but not on (b) which is a function of fuel type and the efficiency of energy generation and supply.

AgriClimateChange (2013) assessed the energy use and GHG emissions arising from more than 120 farms in Germany, Italy, France and Spain. The assessment covered a wide range of farm types, including: olive groves, fruit orchards, vineyards, greenhouse and field cultivation of vegetables, arable farms (producing cereals, oilseeds and rice), and livestock farms (including dairy, beef, pig and poultry production). The amount of energy used varies considerably between systems, and also within systems depending on factors such as the type of irrigation method used or the age and efficiency of cold storage. Despite this heterogeneity, the emissions arising from the use of energy in mobile machinery can be significant across all the farming systems.

The importance of mobile machinery was also highlighted by AEA/ FEC Services Ltd (2010) who reported field operations to be the biggest source of emissions from agricultural energy use (35% of total), followed by heating of greenhouses and livestock buildings (27% of total) and grain drying (19% of total). Furthermore, they note that because decarbonisation of electricity generation is not expected to lead to reductions in the emissions arising from mobile machinery and heating (where non-electrical power sources predominate) "these two energy source sectors may be the priority for the introduction of abatement measures. However, the extent to which emissions from those uses are reduced depends on the extent to which there are cost-effective abatement opportunities that can be adopted." (p 12).

Table 1. The ten energy efficiency measures with the largest abatement potential overall, and the top two measures within each farm type (note that some sectors, sheep and beef, had less than 2 cost-effective measures) in England (adapted from AEA/ FEC Services Ltd 2010). Renewable energy measures (such as biomass boilers) and measures costing >£100/tCO_2e are excluded (figures in brackets are savings)

Farm type	**Measure**	**Abatement potential ($ktCO_2e$)**	**Abatement cost-effectiveness (€tCO_2e)**
Protected[a] edible crops: high temperature	High efficiency boilers	155	(195)
Combinable crops	Improved maintenance of tractors and implements	100	(15)
Combinable[b] crops	Improved control of grain drying	80	(135)
Combinable crops	Minimum tillage	70	(127)
Combinable crops	Improved energy management	50	(80)
Protected edible crops: high temperature	Climate control computers	35	(148)
Broilers	Insulation/sealing of buildings	20	(98)
Protected edible crops: low temperature	High efficiency boilers	19	(178)
Protected edible crops: low temperature	Air leakage minimisation	14	(191)
Beef	Improved energy management	12	0
Broilers	Improved energy management	10	(224)
Pigs	Improved control of weaner heating	8	(259)
Potatoes	Storage controls	7	12
Laying hens	Automatically controlled natural ventilation (ACNV)	7	(319)
Dairy	Improved maintenance of mobile and dairy parlour machinery	7	(147)
Potatoes	Minimum tillage	6	(133)
Pigs	Automatically controlled natural ventilation (ACNV)	6	(121)
Dairy	Improved energy management	3.5	(199)
Sugarbeet	Minimum tillage	3	(102)
Laying hens	Installation of high-efficiency lighting	2	(179)

a. Crops grown under glass or in polytunnels
b. Arable crops that can be harvested with a combine harvester

An additional source of GHG emissions (and abatement), which is not in Table 1 but important in other parts of Europe, is the emissions arising from electricity used for irrigation of crops. For example, AgriClimateChange (2013, p44) found that on citrus farms irrigation accounted for from 32% of total energy (surface irrigation), 55% of energy use (drip irrigation), and that the emissions arising from this energy use could be significantly reduced with a payback period of "a few years" p45.

Proposed general operation
The proposed operation focuses on improved fuel use efficiency in mobile machinery as this is an area with potential that is not covered in the other fiches. Efficient 20 (2013, p6-8) argue that there is considerable scope for improving fuel efficiency, but found in a survey of farmers across Europe (in France, United Kingdom, Germany, Poland, Austria, Spain, Belgium, Slovenia and Italy) that "nearly the half of the farmers and foresters surveyed would like to save fuel without knowing how to do it." (p8), i.e. they would like to save fuel but do not know how to do it. Pellerin *et al.* (2013, p79) found tractor engine testing and eco driving to be the two actions with the greatest abatement potential within the reducing fuel use category. In light of these findings, the following operations are proposed:

- Provision of training in methods to measure fuel consumption in mobile machinery. Grants to (partly) cover the costs of purchasing equipment to monitor fuel consumption.
- Advisory support to develop a fuel use action plan, including provision of training in techniques to improve fuel efficiency such as eco-driving and tractor maintenance.

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
Payment of a defined proportion of the attendance fees (up to a specified limit) at PA-approved courses designed to provide training in methods to measure fuel consumption, and advice on developing a fuel use action plan.

Grants to cover a defined proportion of the costs of purchasing equipment for the purposes of monitoring fuel consumption.

Timing and duration
An initial training course (1-2 day) in the first year, which could be followed up with shorter refresher course and/or technique specific courses during subsequent years.

The presumption is that participation in the operation would last for the duration of the RDP programme period.

The courses should be timed to avoid busy periods in the arable farm calendar (i.e. spring and autumn).

Location
All areas, but likely to have greater uptake in areas with specialised arable farms.

Synergies - Incompatible operations and recommended combinations
Undertaking a carbon audit (fiche M16) would help to target the operation by identifying farms with significant emissions from mobile machinery. It may be worth

tailoring the operation to account for the needs of specific farm types/cultivation systems, e.g. those with alternative tillage regimes (fiche M6 No-till and A4 Reduced tillage/minimum tillage) or techniques to reduce soil compaction (fiche M8) or erosion (A3).

Other fiches that may be relevant for operations targeted at other aspects of on-farm energy use, such as:
M14 Climate-proofing planned investments
A9 Optimising greenhouse cultivation
A7 Improved irrigation efficiency

Expected impacts on GHG emissions on-farm
The achievable reduction in the on-farm GHG emissions will depend on the reduction in fuel consumption and the proportion of the total emissions arising from fuel use. AgriClimateChange (2013) reported the proportion of emissions arising from fuel consumption in mobile machinery as ranging from 37% in vineyards to 22% in orchards and olive groves, 19% on combinable crops, 8% for dairy farms and 5% on beef and rice farms.

Average fuel savings reported in the Efficient 20 database along with the reduction in on-farm that could be achieved on a farm where 20% of the emissions arise from fuel use in mobile machinery are given in Table 2. Pellerin *et al.* (2013, p78) estimated a reduction in fuel consumption of 10% for engine testing and 20% for eco driving. The actual reduction in fuel use achieved will vary from farm to farm depending on a range of parameters summarised in Table 3.

Table 2. Average fuel savings for mobile machinery actions reported in the Efficient 20 database (Efficient 20 (2013), p6)

Action	**Average % reduction in fuel use**	**% reduction in on-farm emissions if mobile machinery fuel = 20% of on-farm emissions**
Save tractor use	13.0	2.6
Eco-driving	5.4	1.1
Economic power take-off*	15.4	3.1
Longer work sequence	11.0	2.2
Adapt weights	5.7	1.1
Adapt implement's settings**	16.8	3.4
Tyre management	10.7	2.1

*A take-off that saves fuel by enabling the tractor engine to be run at lower RPM.
**For example, setting the plough to the optimal depth.

Table 3. The main parameters influencing fuel consumption (Efficient 20 2013, p3)

Level	**Parameter**
Farm level	Crop type Mode of cultivation Number of operations for each activity Local conditions, e.g. soil type
"Strategic" machinery management	Tractor efficiency Matching of tractor to machinery Planning and combining work/equipment
"Tactical" machinery management	Correct tractor maintenance Eco-driving techniques Correct tyre pressures and equipment settings etc.

Ancillary effects

The ancillary effects of the operation will depend on the indirect changes that arise in response to the operation (rather than as a direct result of the operation itself). For example, if reduced tyre pressures are adopted this could lead to reduced soil compaction with associated production and environmental benefits.

Table 4. Ancillary effects of the operation

Positive effects	
GHG emissions	Reduced upstream emissions arising from the production and transportation of fuel
Production	Variable, depending on the secondary effects of the operation
Environment	Variable, depending on the secondary effects of the operation
Negative effects	
GHG emissions	More frequent replacement of capital goods may result in increased upstream emissions arising from manufacture
Production	Variable, depending on the secondary effects of the operation
Environment	Variable, depending on the secondary effects of the operation

Safeguards against maladaptation

No significant negative effects on adaptive capacity are anticipated.

Guidance on costs and payment calculations

One-off costs arising from the operation are:

- Time to attend the initial training course
- Purchasing fuel monitoring equipment
- Paying for machine modification.

Recurring costs arise from

- Time required to monitor fuel consumption
- Time required to attend subsequent refresher courses
- Paying for machinery maintenance.

Table 5. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Source**
Reduction in fuel costs of between 5.4% and 16.8%	Efficient 20 (2013, p6)
Risk that some actions (e.g. eco-driving techniques) could lead to operations requiring additional time if not managed efficiently.	Efficient 20 (2013, p8)

The cost-effectiveness is categorised as being in category 1 (negative cost), as the fuel savings should more than offset the time cost of attending the training course.

AEA/ FEC Services Ltd (2010) estimated that improved energy management and improved maintenance on arable farms (measures largely concerned with improvements in the operation of tractors and implements) would result in cost savings. Similarly, Domingo *et al.* (2014, p15) argued that the costs of undertaking an engine test (€130/tractor) and adjusting the tractor (from €20 to €1,500, depending on the equipment) could "be easily compensated with the average fuel reduction of 10-15% achieved". For France, Pellerin *et al.* (2013, p78) estimated that the energy savings would be greater than the costs of both engine testing and eco-driving.

Pellerin *et al.* (2013, p80) observed that "for tractors, the price (of training and diagnostics) vary little". However, the savings (and hence the cost-effectiveness of the operation) will vary in response to the size, power rating and utilisation rate of the mobile machinery.

It is proposed that given the potential barriers that exist to the uptake of improved fuel efficiency, payments should be made available to encourage participation in training events. However, these should pay less than the full costs of attending, as private benefits should accrue to participants via reduced fuel costs.

Control and Verification
Attendance at training courses and purchase of capital items are straightforward to verify. Verification that participants have undertaken specific fuel consumption actions is not anticipated in this operation, as these are voluntary, however, if required, expenditures on purchases and machine maintenance and modification could be verified through the checking of documentation.

Potential result indicators
P5B Increase in energy efficiency of energy use in agriculture and food processing

Extent to which the mitigation effect would be captured by national GHG inventories
In theory changes in fuel consumption should result in changes in the activity data in the inventory category: 1.A.4 Other Sectors: c. Agriculture/Forestry/Fisheries, and in the GHG emissions calculated from them.

Identified implementation challenges and barriers
Potential barriers to uptake of energy efficiency are summarised in Table 6. However, it should be noted than when comparing it to other GHG mitigation measures, Domingo *et al.* (2014, p16) concluded that improving fuel use efficiency should be easy for farmers to implement and "could possibly be the best accepted measure by the farmers community".

Table 6. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
The approach is not well appreciated or understood	AEA/ FEC Services Ltd (2010, p4) Efficient 20 (2013, p8)
Use of current equipment is thought to be near optimum	AEA/ FEC Services Ltd (2010, p4)
Upgrades to equipment only considered at times of major refurbishment	AEA/ FEC Services Ltd (2010, p4)
Lack of investment capital	AEA/ FEC Services Ltd (2010, p4)
Expediency and the need to get a task completed means that the detailed set up and matching requirements are not properly considered	AEA/ FEC Services Ltd (2010, p4)
Other key risks/uncertainties	
Rebound effects – see below.	

Rebound effects are a general problem with energy efficiency – see e.g. Sorrell (2007). They are unlikely to be a significant issue with the use of mobile machinery where the marginal benefit of additional usage is likely to decrease rapidly beyond a certain level of usage. However, AEA/ FEC Services Ltd (2010, p12) warns that: "improvements in the energy efficiency of vehicle engines does not axiomatically translate into reduced fuel consumption by the fleet. Customers may opt for higher specification or higher performance machines. In particular the consolidation of farms into larger units, often quite distant from each other, has led to increased numbers of high-performance 'Fastrac' type tractors which can be seen travelling significant distances at high speed on open roads”.

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Fiche M14: Climate proofing planned investments - MITIGATION

Proposed RDP measure and measure

	Article	Measure
2007-2013	26	121 Modernisation of agricultural holdings
2014-2020	17	Investments in physical assets

Summary
The operation "climate proofing planned investments" relates to financial support for adjusting planned investments in order to improve their positive effect or alleviate their negative effect on climate mitigation. The operation discerns between investments related to climate friendly animal housings, covered manure storages outside of animal housings and investments in different manure treatment technologies, especially anaerobic digestion of manure. The first two options both mainly reduce NH_3 and thus indirect N_2O emissions. As this conserves nitrogen, less synthetic fertiliser is needed. Anaerobic digestion of manure also reduces CH_4 emissions. At the same time, it replaces fossil energies. In addition, several ancillary effects (positive and negative ones) on off-farm GHG emissions, production, adaptation and the environment were identified. Most investments belong to cost effectiveness category 3. Only manure storage covers for pig manure can be classified as category 1 and 2.

Regulatory requirements that have to be met
Existing regulations that have to be considered: EU NEC directive 2001/81/EC, EU Directive 2010/75/EU on industrial emissions, EU Directive 2011/92/EU on environmental impact assessment, EU nitrates directive 91/676/EEC (especially in relation to manure storage capacities and banning times for manure application), EU renewable energy directive 2009/28/EC, EU technical norms, BREF for Intensive Rearing of Poultry and Pigs (Best available techniques reference documents of the EU COM (2003, 2013); national regulations for livestock buildings, animal welfare regulations, national regulation on odour emissions, and national bioenergy regulations. Some RDPs already support such investments (e.g. the Scottish RDP). Only top-ups for meeting requirements going beyond existing regulations are supported.

General description of the action and operation
Climate proofing planned investments generally refers to the cross-checking of how a planned investment might be related to climate change issues and if applicable how it can be adjusted in order to contribute to climate change mitigation or adaptation. In agriculture, this is particularly relevant for investments related to livestock farming and manure handling since these activities cause large amounts of methane, nitrous oxide and ammonia emissions. Other investments, e.g. related to precision farming or irrigation, can also be supported. As the development of emissions can be intercepted with several technologies whose impacts might not be independent of each other, it is important to develop an overall concept, in order to undertake efficient investments.
One option would be to invest in climate friendly animal housings. NH_3 formation can be delayed by reducing the area covered with urine, by reducing air flows above these surfaces and by reducing the surrounding temperature. When designing animal housings, the available space should be limited to the specifications of animal health regulations (Zähner *et al.* 2005). Straight walking areas can be cleaned more easily and automatic scraper-systems can be used to ensure a regular and fast removal of manure. Slightly sloped floors with grooves allow for faster drainage of liquid manure.

Elevated feed stalls (for cows/cattle) and the separation of feeding spaces further reduces the contamination of animal housings (Zähner *et al.* 2005). Intelligent air circulation concepts decrease ammonia emissions (Clauß *et al.* 2013). This can be supported by open sidewalls and insulated roofs (outdoor climate housings) (KTBL 2011). Spray cooling of walking areas or yards and the roofing of open areas further contribute to reducing the temperature (Zähner *et al.* 2005). In closed housing systems, which are common in pig and poultry production, waste air purifiers can be used to decrease emissions. Most air purifiers are able to remove about 70% of NH_3 from the air. In cases where chemical scrubbers are used even 90% are possible (Hahne 2013). Air purification not only reduces ammonia and thus indirect N_2O emissions, but also captures the emitted N, which can be used as a valuable fertiliser (Clauß *et al.* 2013). However, if biotrickling filters are used, some N_2O can form (Melse *et al.* 2009). Building new animal housings could be combined with climate change adaptation investments (e.g. adapt stables against higher temperatures, extreme weather events (Guler 2011)).

The storing of manure also influences emission development. In order to improve animal health conditions and to reduce emissions, it is recommended to move the manure immediately from the livestock houses to outdoor storage facilities (Clauß *et al.* 2013). The manure storage can be cooled, though the additional GHG emission from the electricity usage has to be considered. Active cooling of the manure surface might also be an option in order to avoid emissions (UNECE 2007). Storage capacity should be significantly longer than the closed periods during winter, and be adapted to the regional and farm conditions to allow for optimised timing of application. In addition, manure storages should be covered in order to reduce ammonia emissions. In some cases, a natural crust is formed that reduces methane emissions, if stirring of manure is reduced (esp. in the case of cattle manure). However, manure storages can also be covered by using chopped straw, granulates, floating foils or solid covers (UNECE 2007). Natural crusts and straw coverage can increase N_2O emissions due to aerobic conditions (Külling *et al.*, 2003; Sommer and Petersen, 2002). Solid covers are the most expensive investments, but they last relatively long and avoid the mixing of rainwater with manure. To avoid the accumulation of flammable gases (e.g. methane), it is necessary to keep small openings or use facilities for venting (UNECE 2007). Gas tight covers might also be used in combination with gas flares or biogas plants.

Producing energy in biogas plants from manure converts the methane to the less potent GHG carbon dioxide and replaces fossil energy sources (Flessa *et al.* 2012). Furthermore, less storage capacity is needed for the fresh manure. The digestates, however, also need to be stored in a gas tight manner. Due to the fermentation process, digestates contain higher amounts of ammonium, which can be used by plants more easily. However, there is an increased probability of ammonia emissions during storage and application (Thiering and Bahrs 2011). Using manure in biogas plants does not induce land use changes or compete with food production.

Emissions from manure can also be reduced by using technologies for manure acidification or separation. Acidification of manure during application helps to reduce NH_3 emissions. The SyreN technology in Denmark was able to reduce 49% of the ammonia emissions (VERA 2012). This technique is especially of use where injection or other more precise N-application techniques are not employable. It is suited for application of manure to growing crops.

The separation of slurry into a liquid and a solid fraction also contributes to emission reduction. The liquid fraction infiltrates faster into the soil, which leads to lower ammonia emissions. Due to the separation, nutrients (P and C) accumulate especially in the solid fraction. Higher amounts of NH_4 in the solid fraction, however, increase the probability of NH_3 emissions. The advantage of slurry separation is that the solid fraction can be transported more easily. This is of relevance especially in intense livestock regions (Flessa *et al.* 2012). As the impact of the latter two options is not clearly identified yet, RD programmes could support pilot projects via the European Innovation Partnership approach.

Proposed general operation
Financial support for climate proofing planned investments.
This mainly relates to financial support for:

a) Investments in climate friendly (and climate proof) animal housings
b) Investments in covered manure storages outside of animal housings
c) Investments in different manure treatment technologies (i.e. anaerobic digestion, acidification and separation of manure)

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
In order to improve cost effectiveness and to avoid possible contradictory investments that might cancel each other's impacts, the farmers are required to provide an overall strategic investment plan related to animal housings and manure handling.

Operation a) If the farmer plans to invest in new animal housings, he can receive funding for choosing options that contribute to climate change mitigation (and possibly improve adaptation as well). For this the PA needs to define "climate friendly" options for animal housings. A check lists should be established, with minimum requirements used as additional eligibility criteria. Depending on the regional/local situation (climate, production system, type of animals, anticipated climate change impacts, etc.) different concepts for climate friendly animal housings are possible. A number of "climate friendly" elements for these concepts are described above (Section: General description of the action and operation).

Operation b) Farmers can be supported if they invest in manure storages outside of animal housings. In order to receive funding, the storages need to be covered with chopped straw (needs to be renewed after stirring or application), granulates, floating foils or solid covers, and the capacity of the storages has to be big enough to allow for flexible application of manure. In case of flexible coverage, the pipe feeding new slurry into the tank must be placed below slurry surface in order to avoid the destruction of the coverage. The storage capacity needs to be adapted in case the anaerobic digestion option under c) is planned as well. A regional manure management strategy is needed to decide whether to invest either in conventional storage capacities or in gas tight storage interlinked with biogas production.

Operation c) Different manure treatment technologies can theoretically be supported. However as the effects of manure acidification and separation are not completely clear yet, only anaerobic digestion is supported at the moment. In case the farmer plans to build new animal housings or new manure storages, it can be reasonable – from a mitigation perspective – to combine this with investments into a biogas plant that is mainly intended for anaerobic digestion of manure. In order to exploit the mitigation potential of this option, it is important to use large amounts of manure. To reduce the use of energy crops in the biogas plant, only biogas plants with small capacities should be supported (Osterburg *et al.* 2013, Thiering and Bahrs 2011), or farm co-operations

should be established. However this depends on the structure of the region (farm types, amount of manure produced…) and the costs for transporting manure, which are often too high (de Witte 2012). Another option is to combine manure based biogas production with other feedstocks, e. g. bio-waste from industry and households.
Investment support should only be granted, if

- enough manure is produced on farm, in order to avoid long transport distances (higher costs) and the use of energy plants instead of manure,
- a gas tight storage for digestates is installed (Osterburg *et al.* 2013),
- cogeneration is possible and a heat concept is in place (at least e.g. 50% of the heat is utilised) (Osterburg *et al.* 2013),
- the farmer has received training on how to effectively handle biogas plants
- the plants are examined regularly and measurements of methane leakage are conducted (Liebetrau 2012).

Timing and duration
The operation can be effective over the whole lifetime of the investment. The experiences gathered can be used to further develop new legal standards for livestock farm buildings.

Location
The overall strategy needs to be adapted to the local conditions. The focus should be on regions with high livestock densities and on large livestock farms.

Synergies - Incompatible operations and recommended combinations
There are no incompatible operations. Climate proofing planned investments should be combined with M4 Precise N-application in case it relates to the manure chain. Otherwise, all emissions from manure that are saved due to air scrubbers/ covering of manure storages will be lost later during application.
Climate proofing planned investments can also be combined with:
M16 Carbon Audit

Expected impacts on farm-level GHG emissions
Operation a)
Investments in animal housings mainly reduce NH_3 emissions and thus indirect N_2O emissions. Nitrogen is conserved and less synthetic fertiliser is needed, which reduces GHG emissions related to synthetic fertiliser production. The use of outdoor climate stables reduces CO_2 emissions from reduced energy demand.

Table 1. Abatement rates for investments related to animal housings

Mitigation effect	**Investment**	**Abatement rate**	**Source**
Reduced NH_3 (indirect N_2O) emissions	Grooved floor + toothed scrapers (Reference: Cubicle housing)	24.1kg CO_{2e}/cow place*year	Calculations based on UNECE (2014)
	Optimal barn climatisation with roof insulation (Reference: Cubicle Housing)	19.3kg CO_{2e}/cow place*year	Calculations based on UNECE (2014)
	Chemical air scrubbers (forced air ventilation systems only) (Reference: Cubicle Housing)	86.6 kg CO_{2e}/cow place*year	Calculations based on UNECE (2014)

Mitigation effect	Investment	Abatement rate	Source
	Different air scrubbing technologies	20.1 – 26.7 kg CO_{2e}/pig place*year	Calculation based on KTBL (2011)
	Outdoor climate housing with insulated roof (reference: closed, insulated and forced air ventilated pig housing with fully perforated stalls, 950 animals)	9351 kg CO_{2e}/year	Calculation based on KTBL (2011)
Reduced synthetic fertiliser demand	**N credit** (assumption: 64% of saved NH_3 emissions can be conserved): **Outdoor climate housing** with insulated roof (reference: closed, insulated and forced air ventilated pig housing with fully perforated stalls, 950 animals)	4608 kg CO_{2e}/year	Calculation based on KTBL (2011)
	N credit (use of waste water, 36% of saved NH_3 gets lost again**) Different air scrubbers** (reference: no waste air purification)	9.9 – 13.2 kg CO_{2e}/ pig place *year	Calculation based on KTBL (2011)

Operation b)
The covering of manure storages mainly reduces NH_3 emissions. The abatement potential depends on the emitting surface.

Table 2: CO_{2e} abatement rates (based on NH_3 reduction (direct N_2O are not included), assumption: 1% of NH_3-N will be deposited and emits as N_2O-N) of different manure storage covers

Abatement rates	**kg CO_{2e}/m^3 cattle manure**	**kg CO_{2e}/m^3 pig manure**
Concrete cover	0.87-1.25	4.29 – 6.15
Tent roof	0.85 -1.25	4.19 – 6.18
Floating foil	0.81- 1.18	4.01 – 5.08
Light aggregates	0.78 -1.14	3.86 – 5.56
Floating bodies	-	3.91 – 5.83
Straw cover	0.72 – 1.08	3.52 – 5.34

The same mitigation options have a much higher abatement potential in the case of pig manure. This can be explained by the fact that cattle manure forms a natural crust which already reduces emissions and pig manure does not.
CH_4 emissions can only be reduced by combining gas tight storages with anaerobic digestion.

Operation c)
The impact of biogas production from manure on climate change mitigation is dependent on

- the efficiency of the process chain and energy transformation (e.g. as little methane leakage from digester and storage as possible),
- the degree to which the heat is utilised and thus replaces fossil energies,

- the handling of digestates (e.g. gas tight storage, optimised land application management and technologies),
- the amount of manure that is used (higher amounts increase mitigation effect as fossil energies are replaced and methane that would occur during storage of manure, is used),
- the choice of (co-)substrates (e.g. bio-waste)

Table 3: Abatement rates for different activities in relation to anaerobic digestion of manure

Mitigation effect	**Activity**	**Abatement rate (g CO_{2e}/kWh_{el})**	**Source**
Substitution of fossil energies and avoiding CH_4 emission that would emit during storage of manure	Anaerobic digestion of manure	1250 g CO_{2e}/kWh_{el}	(WBA 2007)
	Anaerobic digestion of manure	1237 g CO_{2e}/kWh_{el}	(Flessa *et al.* 2012)
	Anaerobic digestion of manure	467-910 g CO_{2e}/kWh_{el}	(Bachmaier and Gronauer 2007; Effenberger *et al.* 2010)
	Anaerobic digestion of manure (Default value proposed by the Commission)	600 gCO_{2e}/kWh_{el}	(EU COM 2010)
	Increase proportion of manure used in biogas plant from 35 to 50%: 35 to 70%:	50 g CO_{2e}/kWh_{el} 225 g CO_{2e}/kWh_{el}	(Osterburg *et al.* 2013)
CH_4 emissions	Covering of digestate storages	120-615 g CO_{2e}/kWh_{el}	(Osterburg *et al.* 2013)
Substitution of fossil energies	Increase use of heat from 30% to 70% (based on German heat mix)	124 g CO_{2e}/kWh	(Osterburg *et al.* 2013)

Furthermore, due to a higher flow rate of digested manure, it infiltrates faster into the soil, which reduces NH_3 emissions during application. However, higher contents of NH_4 in digested manure increase the risk of ammonia losses (Thiering and Bahrs 2011).

Ancillary effects

able 4. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG	-Less synthetic fertiliser is needed and thus CO_2 and N_2O emissions due to fertiliser production are reduced. -Using manure for biogas production replaces fossil energies and does not cause indirect land use changes	(Flessa *et al.* 2012)

Positive effects		**Source**
Production	• fficiency increases as less fertiliser is needed for the same production output (reduced NH3 emissions lead to more nutrient (N) rich manures, separation of manure might further concentrate the nutrients (NH4 in the liquid fraction, P and C in the solid one)) • utrient availability is raised if digestates are used and their fertiliser effect is optimised • using digestates as fertiliser is less aggressive to plants compared to slurry (due to higher pH and quick infiltration, amongst others) • manure (esp. slurry) as substrate can be easily stirred, which stabilises the fermentation process and thus results in more efficient energy production	(Thiering and Bahrs 2011)
Adaptation	• The stables can also incorporate adaptation measures (e.g. air conditioning, weatherproof constructions, insulation etc.)	
Environment	• Emissions of odour, NH3, dust and bioaerosols are reduced • negative environmental impacts related to energy plant cultivation are reduced, if energy plants are replaced by manure	(Claus *et al.* 2013; Flessa *et al.* 2012)
other	• Outdoor climate housings also contribute to animal health	(KTBL 2011)
Negative effects		**Source**
Off-farm GHG	• the use of energy plants such as maize in addition to manure in biogas plants might induce land use changes	
Production		
Adaptation	• Outdoor climate housings might be more vulnerable against extreme weather events	
Environment	• The use of acids might pose a potential threat to the environment	
other	• Options that are best for combating climate change might not be the best for animal health (e.g. minimise space in animal housings) • transports of manure to biogas plants might have low society acceptance • more frequent transports of manure might increase costs for maintenance of roads compared to the case that manure is just stored and not transported to collective digesters.	(Thiering and Bahrs 2011)

Safeguards against maladaptation

The use of energy plants in biogas production should be avoided or limited. In case of air scrubbers, the filter residues from water and chemical scrubbing should not be mixed into the slurry but applied separately to the land with emission-reduced technologies in order to avoid displacement of NH_3 emissions.

Guidance on costs and payment calculations

Table 5: Costs/savings of the operation (figures in brackets are negative costs, i.e. savings)

Operation	Technology	Cost type	Cost	Source
a)	Waste Air Scrubbers	Complete cost (N-credit included)	15 – 28 €/pig place*year	Calculations based on KTBL (2011)
a)	Climate outdoor housings	Fixed cost	40 €/pig place*year	Calculations based on KTBL (2011)
		Variable cost	23 €/pig place*year	
		N-credit:	0.57 €/pig place*year	
	Reference: closed housing	Fixed cost	29 €/pig place*year	Calculations based on KTBL (2011)
		Variable cost	23 €/pig place*year	
		N-credit:	-	
b)	Covering of manure storages	no cover (reference)	1.17 – 1.78 €/(m^3*y)	Calculations based on KTBL (2011)
		Concrete cover	1.82 – 2.74 €/(m^3*y)	
		Tent roof	1.74 – 3.67 €/(m^3*y)	
		Floating foil	1.47 – 2.7 €/(m^3*y)	
		Light aggregates	1.3 – 2.03 €/(m^3*y)	
		Floating bodies	1.6 – 2.42 €/(m^3*y)	
		Straw cover	1.35 – 2.2 €/(m^3*y)	
c)	Biogas plant	Specific production cost	3,800 – 11,500 €/kWh_{el}	(Thiering and Bahrs 2011)

Operation a)
Costs are mainly influenced by fixed costs due to the investment as such. Considering air scrubbing, annual costs decrease with increasing number of pig places. 43-52% of the annual cost can be attributed to fixed costs, 25-32% to a higher energy demand and 2-9% to an increased workload. Outdoor climate housings in contrast have a reduced energy demand in comparison to closed housings. However, the expenditure for human labour increases, as cleaning is more complex (KTBL 2011).
Both options conserve nitrogen and thus receive an N-credit as less synthetic fertiliser needs to be purchased.

Operation b)
Depending on the cover type, the composition of costs differs. Concrete covers and tent roofs are characterised by high one-off investment costs. Floating covers are mostly determined by recurring costs, as they need to be renewed each time after stirring or application of manure. Manure storage costs decrease with an increasing amount of manure stored. Tent roofs and concrete covers are the most expensive options. When using floating covers instead of solid ones, it has to be considered that they reduce evaporation and most of them cannot prevent rainwater from entering the storage. Thus, the volume of manure that needs to be stored and applied increases, which also increases the related costs (KTBL 2011).

Operation c)
The investment one-off costs of biogas plants depend on its specific production cost (€/kWh_{el}). Costs decrease with increasing performance of the biogas plant. Increasing the amount of manure used for biogas production increases the costs as higher fermenter and digestate storage volumes are needed. Recurring costs strongly depend

on the cost of the used substrates, which can make up more than 50% of annual costs (Thiering and Bahrs 2011). Increasing the proportion of manure that is digested, decreases costs as manure from the farm itself has no cost. However, costs can result from transporting manure in case of cross-farm solutions. Other recurring costs result from repairs and maintenance as well as from safety examinations and measurements of methane slip by external experts. The net cost is influenced by the amount of energy that can be sold.

Cost-effectiveness

Table 6: Abatement costs of the different investments and technologies (figures in brackets are savings)

Operation	**Technology**	**Cost type**	**Abatement cost €/t CO_{2e}**		**Source**
a)	Waste Air Scrubbers	Total	571 – 1076		Calculations based on KTBL (2011)
		50% allocation to climate aim	285 – 538		
b)	Covering of manure storages		Cattle manure	Pig manure	Calculations based on KTBL (2011)
		Concrete cover	700 – 721	56 – 86	
		Tent roof	601 – 1459	33 – 236	
		Floating foil	296 – 730	(27) – 88	
		Light aggregates	103 – 176	(65) – (23)	
		Floating bodies	-	5 – 39	
		Straw cover	180 – 343	(51) – 11	
b)	Covering manure storages in combination with flares		59		(Pellerin *et al.* 2013)
c)	Biogas plant	Biogas plant (500 kW) that uses manure	120 - 305		(Thiering and Bahrs 2011)
		Biogas plant (600 kW) that uses only biological waste	69		(Scholwin *et al.* 2011)

Operation A: Abatement costs decrease with the number of pig places per animal housing. As the reduction of NH_3 not only contributes to climate change mitigation but also to ammonia reduction, the abatement costs were split between both aims. Still the cost effectiveness of air scrubbers belongs to cost effectiveness category 3.

Operation B: In general, abatement costs for manure storage covers decrease with increasing amounts of manure that are stored. The tent roof structure is the most expensive option for both manure types. Light aggregates represent the most cost-effective option. However, abatement costs are much lower for pig manure than for cattle manure, which can be explained by the higher abatement potential associated with pig manure.

The light aggregates, straw cover and floating foil covers are very cost effective and belong to cost effectiveness category 1. At least for higher volumes of manure even the tent roof structure belongs to category 2. For cattle manure all options belong to category 3.

Operation c) Increasing proportions of manure and an increasing degree of heat utilisation decrease abatement costs. If manure needs to be transported, these costs increase.

All variations fall under cost efficiency category 3.

Control and Verification
Compliance could be verified in a number of ways:

- Proof of investment
- On site-examination of buildings, storages and biogas plants
- New buildings, storages and biogas plants can be detected via aerial photographs
- Operation C: Provision of certificates for the control of methane leakage and general examination of the biogas plants
- Operation C: Control of feed stocks according to protocols

Potential result indicators

P5 D "Reducing greenhouse gas and ammonia emissions from agriculture"

- Target indicators:
    - LU concerned by investments in livestock management in view of reducing GHG and/or ammonia emissions
    - % of agricultural land under management contracts targeting reduction of GHG and/or ammonia emissions
- Complementary result indicators:
    - Reduced emissions of methane and nitrous oxide (measured in CO 2 equivalent)
    - Reduced ammonia emissions (measured in CO_2 equivalent)

P2 A "Improving the economic performance of all farms and facilitating farm restructuring and modernisation, notably with a view to increase market participation and orientation as well as agricultural diversification":

- Target indicator: % of agriculture holdings with RDP support for investments in restructuring
- Complementary result indicator: Change in Agricultural output on supported farms/ AWU

Extent to which the mitigation effect would be captured by National GHG Inventories
Ammonia, N_2O and indirect N_2O and CH_4 emissions from animal housings and manure storages are included depending on data and methods. NH_3 emissions are reported under the National Emission Ceilings Directive 2001/81/EC, and depending on the national accounting systems, these emissions are included into the GHG accounts. If this is the case and activity rates (such as the share of emission-reduced storage) are part of farm surveys, different application techniques can be differentiated and credited against the GHG reduction aims. Reduced synthetic fertiliser purchases are captured in the inventory, as well as saved upstream emissions from reduced production, but the latter not under source category 4 "Agriculture" (Flessa *et al.* 2012). The emission saving due to less energy demanding techniques (e.g. outdoor climate housing) and the replacement of fossil energies by biogas is reported in the GHG inventory under source category 1.

Identified implementation challenges and barriers

Table 7: Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Expensive investments (esp. small biogas plants)	(Thiering and Bahrs 2011)
Complex considerations are needed to develop an overall investment strategy	
Lack of qualified personnel for using biogas plants	
Overall regional strategy for manure management is needed and adjusted to EAFRD support and legal requirements for farm buildings	
Other key risks/uncertainties	
Investments need to be planned properly, otherwise they might be ineffective	
Land use, land use change and food security impacts of bioenergy crops which are potentially (and usually) co-digested with manure	

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Fiche M15: Improving animal health through training events - MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	20a(i) 20a(iv)	111 – Vocational training and information actions 114 – Use of advisory services by farmers and forest holders
2014-2020	14(1) 15(1)	Knowledge transfer and information actions Advisory services, farm management and farm relief services

Summary

- Evidence suggests that there is significant potential for mitigating emissions by improving animal health.
- Due to the productivity benefits that arise from improving animal health, much of this mitigation potential could be achieved at low or negative cost.
- The RDP represents an opportunity to increase awareness of this "win-win" mitigation potential through an operation providing training courses that (a) raise awareness of the relationship between certain diseases, productivity and emissions, and (b) provide examples of cost-effective disease reduction interventions.

Regulatory requirements that have to be met

Maintaining agreed standards of animal health is one of the main aims of agricultural policy across the EU, and it is achieved through a wide range of national and supranational measures, such as the EU Animal Health Strategy (European Commission, 2007). These measures seek to maintain and improve animal health by, for example:

- Setting minimum standards for the conditions for housed animals.
- Controlling animal movements.
- Obliging responsible parties to inform authorities of the incidence of "notifiable" diseases.
- Removing infected animals from the herd and/or the food chain.
- Preventing the contamination of feeds with pathogens.
- Establishing disease eradication schemes.

Actions related to prevention and control of exotic diseases into and across Europe are the responsibilities of national and international bodies. However, actions of farmers for private gain (e.g. biosecurity practices) often have a positive impact on these public good actions. Where exotic diseases are introduced, the consequences can be catastrophic. Climate change will increase the risks of some exotic disease incursions. While some RDPs may provide training that improves health, measures specifically targeting health are not routinely included.

General description of the action and operation

The OIE has estimated that: "at the worldwide level, average losses due to animal diseases are more than 20%" (Vallat 2014). These diseases impose significant costs on the livestock industry. Recent estimates put the losses arising from disease in the EU livestock sector at €5bn (van der Poel 2014), but this could be as high as €28bn (O'Brien 2014). A significant proportion of these losses are avoidable and arise due to, for example, farmers' lack of awareness of endemic disease losses and their reluctance to deal with them (Heffernan *et al.* 2008). According to Elliot (2014), the main direct farm level losses arise from:

- Mortality or loss of breeding or productive animals.
- A lowering of the efficiency of the production process and the productivity of resources employed i.e. through reduced feed conversion.
- A reduction in output quantity e.g. a drop in egg production or milk yield, or a reduction in the quality of output / per unit value of the product.

Reducing this disease burden could in principle lead to significant reductions in emissions intensity (EI) by, for example, improving the feed conversion ratio of individual animals and reducing the herd breeding overhead (through improved fertility and reduced mortality). However, disease reduction is not yet widely recognised as a mitigation measure. In fact, the IPCC Fifth Assessment Report (IPCC 2013) does not mention livestock health. This reflects the lack of information on the impact of disease reduction on GHG emissions. The mitigation potential of disease prevention and control was recognised in the Irish marginal abatement costs curve and is "likely to be included in future iterations of the MACC for Irish agriculture, when more detailed information is available on their overall extent and impact" (Schulte *et al.* 2012, p42). The growing interest in this area is shown by the recent establishment of the Global Research Alliance's "Animal Health & Greenhouse Gas Emissions Intensity Network"[4] and the commissioning of a major study on disease and GHG emissions in UK cattle (ADAS UK Ltd, 2014). The RDP represents an opportunity to contribute to this area by increasing awareness of the links between health, productivity and GHG emissions amongst livestock farmers.

Proposed general operation

In order to achieve mitigation via improved animal health, the following operation is proposed:

- Support for attendance at training events that (a) raise awareness of the relationship between certain diseases, productivity and emissions, and (b) provide examples of cost-effective disease reduction interventions.

The general operation of training is proposed as it has wide applicability. The operation could be extended to include incentives to encourage participation in schemes that improve disease management, such as the Premium Cattle Health Scheme in Scotland. As Stott *et al.* (2010) note "Berends *et al.* (2008) found that Dutch dairy herds engaged in a certification programme for freedom from Bovine Viral Diarrhoea Virus (BVDV) had significantly lower abortion rates than control herds (of unknown BVDV status)". Membership of a scheme is therefore likely to lead to significant reductions in GHG intensity as there is a strong link between cow fertility and GHG emissions (Garnsworthy 2004).

The operation could also be extended to provide support for specific disease prevention and control measures in response to changing disease risks (such as the increased incidence of fasciolosis in UK cattle and sheep, see COWS 2013, p3, SCOPS 2014)

Commitments, funding conditions and eligibility

When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

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[4] http://www.globalresearchalliance.org/updates/2014/the-animal-health-and-ghg-emissions-intensity-network/

Eligible activities
The focus in the training events should be on disease interventions that are (a) likely to be win-win (i.e. which reduce emissions while providing financial savings) and (b) likely to lead to significant reductions in emissions intensity (the amount of GHGs emitted per kg of milk, meat or eggs). Existing data sources should be used to prioritise specific disease interventions, e.g. DISCONTOOLS (http://www.discontools.eu/).

Preference should be given to disease prevention/control measures that do not lead to increased pathogen resistance to existing treatments.

Some disease treatments require co-ordinated effort in order to be effective. The PA may wish to identify collective actions based on this operation.

Timing and duration
An initial training course (1-2 days) could take place in the first year, and could be followed up with a shorter refresher course and/or disease/technique specific courses during subsequent years.

The presumption is that participation in the operation would last for the duration of the RDP programme period.

The courses should be timed to avoid busy periods in the farm calendar (i.e. during lambing and calving). It may also be possible to schedule courses to enable farmers to take advantage of particular windows of opportunity, for example some health problems are seasonal, such those associated with parturition in spring.

Location
The courses should be organised in all areas but be focused on areas of higher disease risk and tailored to suit the systems and interventions in these areas.

Synergies - Incompatible operations and recommended combinations
Fiche M14 Climate-proofing investments could have positive synergies with animal health by, for example, requiring cow comfort features that reduce lameness to be included in the design of new dairy units.

The following fiches could lead to impacts on animal health:
M10 High fat diet
M11 Precision feeding

Expected impacts on farm-level GHG emissions
The emission reductions arising from this operation will depend on the specific disease, the efficacy of the intervention and the extent to which this operation encourages uptake of the disease intervention. While the mitigation potential of reducing disease is starting to be recognised, only a small number of studies have attempted to quantify it within the EU; the results of these are summarised in Table 1.

Table 1. Abatement rates for animal health interventions

Disease and treatment	Effect	Source
Preventive program for mastitis in Spanish dairy cows	Reduction in the incidence of clinical mastitis from 25% to 18%, and a reduction in sub-clinical from 33% to 15% leading to a reduction in GHG emissions intensity of 2.5%	Hospido and Sonesson (2005)
Increasing routine disease treatment in Scottish sheep	*Treating for all common ailments:* 5% reduction in EI compared to treating for common ailments 22% reduction in EI compared to treating only when sick. *Treating for some common ailments:* 18% reduction in EI (compared with treating only when sick)	Stott *et al.* (2010)
Eradication programme for BVD	Dairy herd: 2% improvement in milk production per animal and a 3% reduction in replacement rate. Beef herd: 3% improvement in replacement rate leading to a 1.5% reduction in GHG emissions	Guelbenzu and Graham (2013, p27)
Implementation of cost-effective[a] disease mitigation measures for ten cattle diseases in the UK	Reduction in emissions intensity across the UK cattle herd of between 2% to 6%, depending on the disease control scenario.	ADAS (2014)

a. Where the cost per t of CO_2e mitigated is less than the DECC non-traded price of C

Ancillary effects

The potential ancillary effects are summarised in Table 2.

Table 2. Ancillary effects of the operation

Positive effects	
Off-farm GHG	Increased production arising from improved health may reduce production and the associated emissions in other places.
Production	Increased quantity and quality
Adaptation	See below
Environment	Improved animal welfare, reduced impact per unit of product across a wide range of impact categories. Improved human health from reduced zoonotic disease risk.
Negative effects	
Off-farm GHG	Increased production arising from improved health may lead to increased upstream feed emissions for farms importing feed. Other sources of off-farm GHG include vet travel and production of medicines (ADAS 2014, p ii).
Production	No significant impacts anticipated
Adaptation	See below
Environment	No significant impacts anticipated

Adaptation

Climate change can lead to direct impacts on livestock health through increased exposure to extreme events and increased susceptibility to stress-induced pathologies. It can also lead to indirect health effects through increased exposure to diseases arising from the introduction of exotic pathogens or increased levels of endemic pathogens (Skuce *et al.* 2013). Improving (or maintaining) animal health in response to climate change is therefore an adaptation challenge as well as a mitigation opportunity. Finally, the potential health impacts of other mitigation and adaptation actions should be taken into consideration.

Safeguards against maladaptation
The maladaptation risks (e.g. pathogen resistance arising from the indiscriminate use of drugs) are likely to be disease/treatment specific and should be identified and explained during the training events.

Guidance on costs and payment calculations
One-off costs

- Experts time to design the content of the training courses.
- Provision of training materials.

Recurring costs

- Staff time for delivery of the training courses.
- Participant time to attend.
- Venue hire.

Courses could be delivered by private or public sector bodies. The costs of providing the training should be recouped by charging fees. Given the potential social benefits arising from the courses, public providers may wish to recoup less than 100% of the costs of the courses.

Cost and benefits of measures subsequently adopted as a result of the operation
In order to achieve mitigation, the courses will need to lead to increased uptake of the disease control measures outlined in the courses. While these are not the direct costs and benefits of the operation itself, a brief discussion is provided for illustration.

The cost-effectiveness of any measures adopted will depend on the specific disease and measure (see Table 3). For example, Stott *et al.* (2010) found that the cost-effectiveness of sheep health management strategies ranged from €36/tCO_2e to €159/tCO_2e. Guelbenzu and Graham (2013, p27) estimated that the benefits of eradicating BVD in Ireland would significantly greater than the costs, i.e. that the emissions reduction arising from eradication had a negative cost. The analysis undertaken by ADAS (2014) indicated that there was significant potential for win-win measures, i.e. measures that reduce disease and emissions while providing financial savings.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Total cost	**Source**
€36/tCO_2e to €159/tCO_2e	Stott *et al.* (2010)
Negative net cost	Guelbenzu and Graham (2013, p27)
Significant mitigation available at negative cost	ADAS (2014)

Assuming that the training courses lead to the adoption of cost-effective disease interventions, the cost-effectiveness of the training can be categorised as 1-2, i.e. negative or no/low cost.

The cost-effectiveness will vary depending on (a) the (one-off and recurring) costs arising from the disease control measure and (b) the benefits that arise from it in terms of reduced impacts of mortality and morbidity. Cost arising from disease morbidity include: reduced growth rates, reduced milk yields, reduced milk and meat quality (resulting from both the disease and the treatment), poorer feed conversion, shortened life spans, increased culling risks, reduced fertility and increased abortion rates. The control measure costs can vary widely depending on the approach adopted. For example, ADAS (2014) proposed three different control measures for BVD (see Table 4).

Table 4 Examples of the cost elements for three different BVD mitigation measures (ADAS 2014)

Treatment	**Costs**
Vaccination	Establishing a vaccination plan Vaccine purchase Labour and handling involved in vaccination
Identification of persistently infected animals	Establishing a testing and control plan Purchase cost of ear tags or blood tests Labour and handling involved in sampling
Double fencing and buying policy (not buying in-calf cows and heifers)	Purchase and installation of double fencing Opportunity cost of reduced genetic material availability Delayed reproduction cycle

Control and Verification
Attendance at training courses is easily verifiable.

Potential result indicators
P2A Change in agricultural output
P3B % of agricultural holdings supported to manage risks

Extent to which the mitigation effect would be captured by National GHG Inventories
Depends on the specific disease and the intervention, but in general it is not easy to capture the often complex systemic effects that diseases (and their control) have on production and emissions. For example, reducing the disease burden will often reduce the feed conversion ratio (i.e. the kg of feed required to produce a kg of live weight gain, milk or eggs), however the reduction in feed use will not lead to a proportionate reduction in national feed emissions if, as in most cases, some of the feed is imported.

Identified implementation challenges and barriers
Levels of uptake will be influenced by the perceived risk and could be expected to vary between different locations, systems and diseases. Some common barriers are given in table 5.

Table 5. Potential barriers to uptake

Barrier to uptake	**Source**
Lack of awareness of the potential economic benefits	ADAS (2014, p50)
Lack of capacity to address the disease	ADAS (2014, p50)
Lack of willingness to change practices due to constraints such as lack of access to vaccines or lack of the coordinated approach required to prevent reinfection	ADAS (2014, p50) Gunn *et al.* (2005)
Lack of acceptance of biosecurity measures amongst beef and sheep farmers	Heffernan *et al.* (2008)

Other key risks/uncertainties
"Simulation results seem promising, but reliable quantitative estimates of the mitigation potential of improved health will require more research." Hristov *et al.* (2013, p111)

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Fiche M16: Carbon audit - MITIGATION

Proposed RDP article and measure

	Article	Measure
2007-2013	Article 20 (a) (iv) Article 20 (c) (ii) Article 36 (a) (iv)	114 Use of advisory services by farmers and forest holders 132 Supporting farmers who participate in food quality schemes 214 Agri-environment payments
2014-2020	Art 15(1) Art 16(1) Art 28(1)	Advisory services, farm management and farm relief services Quality schemes for agricultural products and foodstuffs Agri-environment-climate

Summary
Financial support for a carbon audit carried out at farm level over a cultivation period (one crop season or year) by a “certified” external adviser. The carbon audit includes an action plan in addition to the results showing the main sources of GHG emissions at farm level. The aim of the carbon audit is to define which mitigation actions are suitable for the farm, quantify the GHG reduction potential and prioritise the mitigation actions. To assess the GHG reduction achieved, a second carbon audit has to be done 3 to 5 years later.

Regulatory requirements that have to be met
Emissions at a farm level arise from the use of fossil fuels and manufactured inputs, by-products of animal digestion, cultivation of soils and changes in land use and vegetation. Beyond the farm gate, agri-food chains also emit greenhouse gases through activities such as processing, packaging, waste management and haulage (SRUC 2014).

A farm carbon audit will identify the type, extent and source of emissions from the business and identify opportunities where greenhouse gas emissions can be reduced (SRUC 2014). In addition, lowering emissions can sometimes benefit businesses by increasing resource use efficiency and reducing costs.

According to Colomb *et al.* (FAO 2012), 18 main carbon calculators for agriculture have been identified in the world (including tools made in France or UK) in which some of them correspond to a farm level approach.

There is no current requirement in Europe for a farmer to report greenhouse gas emissions at farm level. Nevertheless, there exist many voluntary initiatives to evaluate GHG emissions from agricultural activities and mitigation actions. Climate audits are used in some existing RDPs. For example, the Lower Austrian Ecopoints programme takes into account the GHG emissions and C stock variations to determinate the payments to farmers with a graduation from extensive to intensive farm’s GHG emissions. The French RDP also addresses a carbon audit indirectly in its energy efficiency farm assessment (Axis 1, Plan de Performance Energétique, mesure 121 C) in which a report of the total GHG emissions of the farm is required (more than 10,000 energy and GHG assessments have been carried out between 2009 and 2013).

Carrying out a farm carbon audit is useful for farmers to:

- Identify GHG emissions on farm and benchmark against other similar farm enterprises in order to identify cost savings, e.g. through improved use of inputs and energy efficiency.
- Investigate the impact of changing farm practices by running scenarios to see the effect the changes have on the overall GHG emissions of the farm.

General description of the action and operation

According to the AgriClimateChange results (2013) built on a network of 120 farms from Germany, France, Spain and Italy, a great variation in GHG emissions has been observed between farming systems and even within a same farming system. These results are linked to farm practices but also to farmers' skills and interests. These variations in terms of GHG emissions are observed both per ha or per quantity of product. Bochu *et al.* (2010) have assessed more than 400 dairy French farms with the PLANETE software reporting an average impact of 1.5 tCO_2e/1,000 litres of milk (minimum of 0.8 and maximum of 3.8 tCO_2e/1,000 litres of milk). PLANETE software has also been used on more than 270 French crop farms and reported average emissions of 0.45 tCO_2e/tDM[5] (minimum of 0.14 to a maximum of 1.15 tCO_2e/tDM).
The analysis on 415 Great Britain dairy farms (DairyCo, 2012) found an average impact of 1.309 tCO_2e/1,000 litres of fat corrected milk. Across the sample of farms, carbon footprint ranged from 0.832 to 2.808 $kgCO_2e$/1,000 litres.
Similarly, Langevin *et al.* (2013) have assessed more than 230 French dairy farms using Dia'terre® tool and shown a variation between 1.1 to 11.0 tCO_2e per ha utilised agricultural area (UAA), and a median of 5.6 tCO_2e/ha UAA (variations are mainly related to livestock density and fodder system). For 51 French crop farms, variations between 0.7 to 4.3 tCO_2e/ha have been observed by using Dia'terre® tool and a median of 2.7 tCO_2e/ha UAA (variations are mainly related to the amount of nitrogen fertilisation). It therefore seems quite relevant to implement a carbon audit on each farm, given the huge variations observed in results within a same farming system and the potential for improvement.

There are a number of carbon auditing tools available for agriculture and forestry, all these calculators providing results in tCO_2e, but differing in system boundaries and parameters for calculations which significantly influence the final results (Colomb *et al.* 2012). Little *et al.* (2010) have compared 9 farm-level carbon calculator from UK and conclude that inconsistencies between them, in terms of what exactly is included in the assessment and the raw data they use, can give rise to a certain amount of confusion. Different calculators are suited for different purposes, and this has a significant impact on the scope and methodology of the calculators. Then it is essential to choose a suitable calculator, sufficiently precise for building coherent strategies for mitigation actions. In this way, only tools along with a methodological guide describing the calculations and emissions factors used should be retained for interpreting the final results.

The European Commission's Joint Research Centre (JRC) has developed recently a user friendly open-source carbon calculator suitable for assessing the lifecycle GHG emissions from different types of farming system across the whole EU (Tuomisto *et al.* 2013). The Carbon Calculator tool is available for free download, together with its User Guidance Manual (http://mars.jrc.ec.europa.eu/mars/Projects/LC-Farming). It quantifies direct and indirect GHG emissions according to international standards (e.g. ISO and PAS2050) and guidelines on lifecycle assessment and carbon footprinting (e.g. the Organisation Environmental Footprint and the Product Environmental

[5] Dry Matter

Footprint methodologies). In addition to the quantification of GHG emissions, the tool proposes mitigation options and sequestration actions suitable for single farms. Thus, in the absence of a local and robust carbon audit tool, each Member State in Europe can use the Carbon calculator developed in the European Commission's Low Carbon Farming Practices - project.

Implementing a carbon audit implies gathering data on the farm process. A survey of the availability of data to run the Carbon Calculator was conducted by interviewing farm advisors in six different Member States (Tuomisto *et al.* 2013). In general, they considered significant data input by farmers (i.e. up to 80 data entries) of which 90% could be available with the help of the advisers if the data is not available on the farm record. The survey showed that substantial differences in data availability exist between countries across Europe. Farmers from UK, Denmark and the Netherlands have more data available from farm records than do farmers from Slovenia and Spain, Germany having an intermediate level of data availability.

Given that the tools can be complex and that the data to gather are numerous, it is preferable that advisers support the carbon audit with the objective to strengthen the results and explain them to the farmers. The main sources of GHG emissions are not well known by farmers. A survey of 200 individual farms in UK showed that there were less awareness among farmers of the impact of CH_4 and N_2O emissions, which are largely unseen, even though these are more dominant than CO_2 emissions for most farms (Holmes *et al.* 2008).

The principle of the carbon audit should not be to compare products in Europe but to improve the overall situation of each farm involved. The audit has to focus on how to improve, not to judge the performance of the farm towards climate change, otherwise the operation would appear unattractive for farmers. Finally, it is essential that the audit includes an action plan suggesting short, medium and long-term mitigation and sequestration actions while quantifying the possible mitigation gains. It is likely that this would need to be accompanied and interpreted by advice from specialist farm advisors.

Proposed general operation

Financial support is required for a carbon audit. The proposed carbon audit is an annual GHG assessment at farm level that could be run by a "certified" external adviser. The carbon audit includes an action plan in addition to the results showing the main sources of GHG emissions at farm level. The aim of the carbon audit is to define which mitigation actions are suitable for the farm, quantify the GHG reduction potential and prioritise the mitigation actions. To assess the GHG reduction achieved, a second carbon audit has to be done 3 to 5 years later.

The assessment must be carried out at farm level over a cultivation period (one crop season or year). The user defines the beginning and the end of this period based on present agricultural production on the farm and the production cycles. Most of the required data are usually available in various farm documents: CAP statement, fertilisation plan, the farm accounts, invoices, identification of the herd, etc. Most data could therefore be checked if verification is needed.

2 possibilities are available for the national authorities:

- In case of the absence of local carbon audit tool, they should specify the software to be used which will help to create GHG references at farm level for different farming systems.

- In case of the existence of local carbon audit tool, they should (1) determine a list of data, stating which are mandatory or not or (2) determine a list of approved tools whose accuracy is judged to be sufficient enough to suggest an action plan at farm level. Where local audit tools are employed, it would be valuable for these to be calibrated against certified carbon tools (such as DairyCo's E-CO2 or SRUC's AgreCalc) to allow a comparison of mitigation activities in different counties.

Since GHG emissions are not very well known by farmers, the description of the operation is very important to make farmers understand what it can engage (illustration through examples of improvement actions).

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
All farming systems could be suitable for a carbon audit. However, PA could make the choice to target the most significant farming systems in terms of GHG emissions.

Timing and duration
The PA should impose a minimum duration for the whole carbon audit. A base of 2 days divided in (1) ½ day for the visit of the farm and collecting data with the help of the farmer, (2) ½ day for entering data in the software and analysing results, and (3) one entire day to design an action plan that quantifies the potential for GHG reduction. In some cases, it might be possible to link the Carbon Calculator with existing data sources, so that the time consumption for data collection could be reduced.

In addition, the PA should provide guidance on the action plan, such as requiring the certified advisers to suggest a minimum of one mitigation options for the 3 or 4 main sources of GHG emissions of the farm.

In order to globally monitor the action plans, it is also recommended that PA determine a standard reporting format for the data recorded and a table to report the GHG reduction potential (denomination of the action, reduction potential in tCO_2e and % of the total GHG emissions of the farm, is it a short / medium / long-term action).

Location
A visit of the farm by the external certified adviser is strongly recommended to ensure that the mitigation options are applicable.

Synergies - Incompatible operations and recommended combinations
The action plan designed in the carbon audit process will provide a high number of actions (between 5 to 10). In case of incompatibility for some of the suggested actions, these should be highlighted in the carbon audit report. It is anticipated that the action plan will build upon other mitigation and adaptation measures proposed in the RDP.

Expected impacts on farm-level GHG emissions
Generally, drawing up an action plan at farm level can result in a GHG emissions reduction potential of at least 10% (AgriClimateChange network of farms) for a wide range of farming systems in Europe (dairy milk farms, cereals, olives, vineyards, etc.). Indeed, the GHG reduction potential is extremely variable within farms, depending of the initial GHG emissions per ha and the type of mitigation actions proposed (optimisation of agricultural practices, investment, etc.).

Table 1. Abatement rates for carbon audit

Mitigation effect	**Abatement rate**	**Source**
Carbon audit at farm scale	10% average reduction potential in a 3 year period	AgriClimateChange 2013
	20% reduction potential in a 5 year action plan	Holmes *et al.* 2008

Ancillary effects

An assessment at farm level always results in a better knowledge of the farm and many advantages therefore arise through farm level assessments. Economic improvements (money saving, better knowledge for future investments, added value for the product, etc.) as well as social benefits (improved effectiveness for certain tasks, optimisation of time, etc.) are frequent when supporting farmers in this kind of process.

As this measure potentially includes all individual measures outlined in the fiches, the ancillary effects depend on the actual measures implemented. Most GHG mitigation actions generally have also other environmental benefits (reduction of inputs such as fuel or nitrogen mineral fertilisation, etc.). However, it is also possible that a given mitigation action could have negative environmental effects (i.e., no-tillage can reduce GHG emissions from fuel but can cause an increase of herbicide if no restrictions are imposed). Therefore, it is important to set restrictions that minimise any potential negative side-effects.

Table 2. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG	Generally positive effect, but depends on the type of action	
Production	Generally neutral effect, but depends on the type of action	
Adaptation	-	
Environment	Generally positive effect, although special cases can exist.	Domingo *et al.* 2014
Negative effects		
Off-farm GHG	-	
Production	-	
Adaptation	-	
Environment	-	

Safeguards against maladaptation

No significant negative effects on adaptive scarcity capacity are anticipated. This will, however, also be dependent of on the proposed measures in the action plan so the action plan needs to consider appropriate safeguards relating to individual measures.

Guidance on costs and payment calculations

The implementation cost should be based on the work of the certified adviser during this 5-year period. The time devoted to the advisory work is estimated to be between a minimum of 2 days for the initial carbon audit, and again 2 days for the second carbon audit. However, this has to be adjusted depending of the complexity (diversity of production on the farm) and the farm size (maximum of 4 days per carbon audit).

With an average daily rate of 500€, the final cost would be between 2,000€ and 4,000€.

Apart from the carbon audit, the farmer will receive recommendations to implement mitigation actions related to investments (consequently, there is a cost) and/or mitigation actions related to a reduction of inputs (resulting in a savings).

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Carbon audit	400 to 1,000€ average of 550€	Aile and Solagro, 2012
Mitigation actions related to investment	This will lead to a cost for the farmers (whose payback return can be variable)	
Mitigation actions related to a reduction of inputs	This will lead to a saving for the farmers	

The cost-effectiveness is categorised as being in:

- Category 3, significant cost (around 50€/tCO2e), for a farm combining an average level of GHG emissions per ha and an average size.
- Category 2, low cost (under 50€/tCO2e):
  - For a farm combining an average level of GHG emissions per ha, an average size and a GHG reduction potential around 15%.
  - For a farm combining a high level of GHG emissions per ha and an average size.

Control and Verification

The implementation of certain conditions will help PA to control the commitments:

- Establishment of a process with certified auditors conducting carbon audit on farms
- Select a tool whose accuracy is precise enough for a monitoring of mitigation actions
- Determine the use of a standard table to report the GHG reduction potential (denomination of the action, reduction potential in tCO_2e and % of the total GHG emissions of the farm, is it a short / medium / long-term action).

Potential result indicators

The advantage of the carbon audit is that it allows the reporting of the total GHG reduction (in tCO_2e) at farm level for over a given time period.

Extent to which the mitigation effect would be captured by National GHG Inventories

Because the audit tools generally follow IPCC guidelines, emission reductions would be captured by national inventories, but emissions are highly variable and linked to the type of mitigation actions implemented following the carbon audit.

Identified implementation challenges and barriers

As a new and result-based measure, thus needing a complete new implementation protocol and post-harvest control, the national and regional administrations in charge of CAP implementation can regard this measure as complex. A possible way to overcome this situation would be to integrate this climate module into other previous existing schemes (e.g. agri-environment schemes), so that part of the protocol (tool, data input, inspection, etc.) would already be well established and would only have to be extended.

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
High number of data required for the carbon audit, variability of farm records across EU	Tuomisto *et al.* 2013
Economic barriers (absence of national investment subsidies program, etc.) and technical barriers (insufficient technical advice)	AgriClimateChange 2013
Farmers would be willing to do a carbon audit only if they had financial incentives	Tuomisto *et al.* 2013
Farmers seemed more ready to address practices that produced carbon dioxide emissions, particularly the use of energy and fuel on the farm	Holmes *et al.* 2008
Other key risks/uncertainties	
Differences in methodologies and perimeters for calculations significantly influence the final results from carbon calculators for the agricultural sector	Colomb *et al.* 2012

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Fiche A1: Use of adapted crops - ADAPTATION

Proposed RDP article and measure

	Article	Measure
2007-2013	20 (a) (i) 20 (a) (iv) 36 (a) (iv)	111 – Vocational training and information actions 114 – Use of advisory services by farmers and forest holders 214 – Agri-environment payments
2014-2020	14(1) 15(1) 28(1)	Knowledge transfer and information actions Advisory services, farm management and farm relief services Agri-environment-climate

Summary
Year-to-year variability in yields is generally expected to increase throughout Europe, due to extreme climatic events and other factors, including pests and diseases. The different regulations in Europe (Good Agricultural and Environmental Condition (GAEC), Crop diversification, RDP) all aim to ensure a minimum diversity of crops in the crop rotations. To go beyond, the suggested operation involves (i) training and awareness raising helping farmers screening the most resistant varieties/crops to climatic hazards and disease resistance and/or (ii) area-based payments (agri-environment-climate) for a diversified cropping pattern more resilient to climate change in terms of yield variability.

Regulatory requirements that have to be met
Each member state (MS) has a specific baseline through Good Agricultural and Environmental Conditions for soil organic matter levels through appropriate practices standards that sometimes involve crop rotations. Generally, it has specifications to avoid monocultures of more than 2 consecutive years (Bulgaria, etc.), or the obligation to plant, at least, three crops per holding and year (France, Austria, etc.).

From 2015 onwards, the CAP introduces a new policy instrument in Pillar 1, the Green Direct Payment including three obligatory agricultural practices, namely maintenance of permanent grassland, ecological focus areas and crop diversification. As the green direct payment is compulsory, it has the advantage of introducing practices that are beneficial for the environment and climate on most of the utilised agricultural area. Crop diversification will impose across the EU a minimum of 2 to 3 different crops on arable land depending on the farm size (Regulation No 1307/2013, 17 December 2013, article 44). In addition, restrictions are imposed for the minimum and maximum share for each crop.

Existing policy incentives to crop diversification are included in existing RDP (e.g. in the French RDP) measures with the objective of limiting the development of crop pests and the intensity of use of pesticides. Thus, there is a potential to increase the crop diversity through this system.

General description of the action and operation
While some aspects of climate change such as longer growing seasons and warmer temperatures may bring benefits, there will also be a range of adverse impacts, including reduced water availability and more frequent extreme weather. These impacts may put agricultural activities, certainly at the level of individual land managers and farm estates, at significant risk (Iglesias *et al.* 2007).

"Varying seasonality and inter-annual variability will affect crop cycles and farm management, affecting yields and rural economies. Temperatures are expected to rise beyond the optimum growing conditions for many common crop species. Increased concentrations of tropospheric ozone are expected to reduce crop yields. The delineation of agro-climatic zones is likely to change, leading to the loss of some indigenous crop varieties, regional shifts in farming practices and to shifts in optimal conditions for pest species and disease types" (Iglesias *et al.* 2007, pvi).

"Summary of risks and opportunities across the agro-climatic regions in Europe (Iglesias *et al.* 2007, piv):

- In the Alpine, Boreal, Atlantic north and central, and Continental north zones, risks relate mainly to potential changes in precipitation patterns, with projected increases in winter rainfall and decreases in water availability in summer.
- Whilst influxes of new pests and diseases present a high risk in the Boreal, Atlantic central, and Continental north zones, there is likely to be considerable opportunity in these zones for increased agricultural production.
- In the Atlantic south, Continental south and Mediterranean zones, the greatest risks are reduced crop yields and conflicts over reduced water supply."

Climate change is already having an impact on agriculture and has been attributed as one of the factors contributing to stagnation in wheat yields in parts of Europe despite continued progress in crop breeding (Füssel *et al.* 2012). Year-to-year variability in yields is generally expected to increase throughout Europe, due to extreme climatic events and other factors, including pests and diseases.

Donatelli *et al.* (2012) have analysed the vulnerability for priority crops in Europe (wheat, maize, sunflower, rapeseed and rice) providing an indication of which regions and farm types may expect potentially significant production changes by the horizons of 2020 and 2030 in comparison to the baseline centred on the year 2000.

Current yields of potatoes, wheat, sugar beet, maize and field beans, which are dependent on summer rainfall, will decline in areas where there is reduced water availability. In this case, farm level adaptation options are based around resistance actions (i.e. improve water efficiency, increasing the use of fertilisers to maintain yields so as to reduce the effects of pests and diseases) or accepting that it is no longer economical to grow such water demanding crops and diversifying to alternative crops or new varieties (Iglesias *et al.* 2007).

When possible, some producers also stagger their seeding and therefore, harvesting dates by choosing a variety of crops that require a range of growing conditions so that crops are at different stages (and therefore more or less vulnerable) if and when climate/weather conditions start having a negative impact (Iglesias *et al.* 2007).

Changing cropping by switching to less water intensive crops already occurs, particularly in the South of Europe with for example sorghum instead of maize. However, the economic context (high price for some cereals) slows the adoption of these kinds of crop diversifications because most farmers have short-term thinking when selecting their crops. Policy support may be given as a stimulus to farmers to select crops that have more stable yields but lower maximum yield, or that have significant environmental benefits in terms of reduced pesticide or water use.

A diversity of crop types and varieties are grown in rotation and in different areas of farm properties. This spreads the risk of losing an entire year's production since conditions can vary across fairly small areas and different crops vary in how they respond to those conditions (Iglesias *et al.* 2007). Building a crop system based on a long crop rotations provide a more resilience to climate change, while ensuring environmental benefits including low GHG emissions per ha (AgriClimateChange 2013, case study in South of France p28).

Proposed general operation
The measure involves the use of crops which can deliver more stable yields under changing climate conditions, or which have lower water demand. Depending on the local climate and soil conditions, this may involve the switch in varieties of crops, but also the switch from one type of crop to another.

<u>First level:</u>
Training and awareness raising, help farmers screening the most resistant varieties/crops to climatic hazards (e.g. using sorghum instead of maize in South of Europe) and disease resistance. This operation should provide both technical and economic information for a more efficient implementation by farmers.

<u>Second level (more ambitious):</u>
Implementing area-based payments (agri-environment-climate) for a diversified cropping pattern more resilient to climate change, including obligations of a minimum number of crops in the cropping pattern and share of each crop to balance the climatic risk. In addition, a list of adapted crops and varieties could be established.

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
All farms with a significant area with arable land. To be sure to target the specialised crop farms, PA could also impose a threshold for a minimum share of arable land in the total utilised agricultural area (UAA) (for example 70%).

To ensure a crop diversification, farmer would have to grow a minimum of 5 main crops in their cropping system. In addition, minimum and maximum share for each crop have to be set. For example, a minimum of 5% of the UAA and a maximum of 60% of the UAA could be used (it is the eligible criteria for the French AEMC for crop system, DGPAAT-SPA-SDEA/BATA, 2013).

Finally, PA could also impose a minimum % of protein crops in the UAA (for example 10%) to ensure the fertility of the rotation and develop the mitigation potential of the adaptation operation.

Depending of the GAEC standards in the MS, specifications against monoculture for two consecutive years could be imposed to better control pesticides (fungicides and herbicides).

Timing and duration
The specifications could be based on a 5-years period.

Location
The operation could be targeted in areas with low crop diversification.

Synergies - Incompatible operations and recommended combinations
Used of adapted crop could be combined with the following operations:

- M1 Extend the perennial phase of crop rotations
- M2 Use of cover/catch crops and reduce bare fallow

- M5 Biological N fixation in rotations and in grass mixes
- M6 No tillage
- A4 No tillage

Adaptation benefits
Vulnerability to climate change for priority crops in Europe has been demonstrated (Donatelli *et al.* 2012). Year-to-year variability in yields is generally expected to increase throughout Europe, due to extreme climatic events and other factors that hence the importance of crop diversification for more secured yields.
In addition, a long-term rotation including a minimum share of protein crops will allow increasing the organic matter content and water-absorbing capacity of the soil thus increasing the yield of following crops while reducing erosion.

Table 1. Adaptation benefits

Action	**Effect**	**Reference**
More secured yields	A diversity of crop types and varieties are grown in rotation and in different areas of farm properties. This spreads the risk of losing an entire year's production since conditions can vary across fairly small areas and different crops vary in how they respond to those conditions	Iglesias *et al.* 2007
Increase C stock in the soil	+0.5 to 1 tC/ha/yr (comparison between wheat monoculture and rotation including protein crops and cereals)	Bues A *et al.* 2013

Ancillary effects
Crop diversification, with the alternation of winter and spring crops combined to the variability of the type of crops, will reduce disease cycles and help reduce pesticides whilst strengthen biodiversity. Moreover, a significant share of protein crops in the long-rotation will help to reduce the use of mineral nitrogen fertilisers. The nitrogen left behind in the residue of the protein crop helps boost the yield and reduce the need for nitrogen fertilisers in subsequent crops. Finally, protein crops break the cycles of soil-borne diseases of cereals so less pesticide is needed on the following crop. Thus, diversification of the crops can help achieve low GHG emissions per ha (AgriClimateChange, 2013).

Table 2. Ancillary effects of the operation

Positive effects		**Source**
Off-farm and on-farm GHG	Could be significantly reduced if protein crops are used in the cropping pattern (see Table 1)	Bues *et al.* 2013
	-33% of energy consumption per ha and -30% of GHG emissions per ha (for a farm cultivating 6 main crops, including a significant share of protein crops) compared to a group of 155 farms growing cereals	AgriClimateChange, 2013
Production	Potentially useful form of risk management towards year-to-year variability in yields (more stable yield production in time)	Füssel *et al.* 2012

Positive effects		Source
	Expected decrease in EU crop productions if no adaptation measures are implemented under a warm scenario for 2030: Maize -9%, Sunflower -10%, wheat -8 to -18% (for France Poland Lithuania and Latvia), rapeseed - 11 to 18% (France)	Donatelli at al., (2012)
Adaptation	Increased of the organic matter content and water-absorbing capacity if protein crops are used in the cropping pattern	Bues *et al.* 2013
Environment	Less pesticides, less mineral nitrogen pressure per ha, less water for irrigation	Meynard *et al.* 2013
Negative effects		
Off-farm GHG	NA	
Production	NA	
Adaptation	No significant effects	
Environment	NA	

Safeguards against maladaptation
No significant negative effects on adaptive scarcity are anticipated. If affects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations
The main risk concerns the loss of farm profitability at short term due to the price volatility for cereal (wheat, maize) when comparing a specialised farm (selecting a main crop only on price) and a diversified farm. However, only a multi-year approach, including inputs savings generated by the long rotation and making the average sales price over several years at regional level could have a sense for payment calculations (DGPAAT-SPA-SDEA/BATA, 2013). Generally, on a long-term period, there is a balance between saving of expense and decrease in revenue.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	Total cost	Study
Proposed remuneration for the French AEM "crop system" in the RDP 2014-2020	74€/ha to 234€/ha according the level of environmental constraints for the farmers	DGPAAT-SPA-SDEA/BATA, 2013

The cost-effectiveness is categorised as being in category 2, no cost or low cost.

Control and Verification
Attendance at training courses is straightforward to verify as well as the surfaces engaged for area-based payments (agri-environment-climate) for a diversified cropping pattern more resilient to climate change.
Potential result indicators
Number of farms subscribing the agri-environment-climate and total surfaces engaged.

P2A Result. Enhancing competitiveness of all types of agriculture and enhancing farm viability through the change in output per Annual Work Unit (€/AWU).

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Build regional references (yield, gross margins) at the cropping pattern instead of simple annual analysis in order to demonstrate the economic and technical interest of using diversified crops	Meynard *et al.* 2013
Not enough investment in minor crop plant-breeding program (lots of room for improvement for yield, development cycle, resistance to disease etc.)	Meynard *et al.* 2013
Other key risks/uncertainties	
This holistic approach should also ensure that used of adapted crops are both cost-effective and proportionate to the risks (and loss of profitability) that may be incurred	Iglesias *et al.* 2007

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Fiche A2: Cover crops/reducing bare fallow - ADAPTATION

Proposed RDP article and measure

	Article	Measure
2007-2013	36 (a) (iv)	214: Agri-environmental payments
2014-2020	28(1)	Agri-environment-climate

Summary
Soil degradation induced by climate change presents an economic and environmental risk.
Cover crops are one way of reducing the risk of soil degradation by providing temporary or permanent surface cover. The RDP could encourage uptake of cover crops by:

-
- Provision of area-based payments for the sowing of cover crops in arable rotations to provide vegetative cover during the fallow period
- Provision of area-based payments for the sowing of temporary or permanent green cover in vineyards and orchards.

While cover crops can significantly reduce soil degradation, they need to be carefully targeted in order to have a net economic benefit (i.e. a benefit: cost (B:C) ratio >1).
There are a range of ancillary effects and barriers to uptake that should be taken into account when designing a specific RDP adaptation operation for cover crops.

Regulatory requirements that have to be met
Existing policies encouraging the use of cover crops include the Nitrates Directive (specifically the use of catch crops) and the CAP (for example, in England payments are available for cover cropping under the Higher Level Scheme). Despite these, low rates of use of cover crops in some MSs indicates potential to increase uptake. Moran *et al.* (2013, p117) estimated an uptake rate of 10% in the UK, while Ruiz-Colmenero *et al.* (2013) have argued that "While cover crops are used widely to control erosion in more mesic areas, they are not used extensively in the Mediterranean Basin because of the belief that they will compete with the vines for soil water." Eurostat (2014) reports that in 2010 25% of the arable area in the EU-28 was bare soils during the winter and 5% cover or intermediate crops.

General description of the action and operation
Soil degradation induced by climate change presents an economic and environmental risk. Changing precipitation patterns, temperatures and wind strengths can lead to increased soil degradation, depending on factors such as "crop management, vegetation cover, climate and topography, and on soil physical properties…of these land use and surface cover are the principal determinants of erosion" Ruiz-Colmenero *et al.* (2013).

Cover crops are one way of reducing the risk of soil degradation by providing temporary or permanent surface cover. A cover crop is a fast growing crop grown at the same time as, or between plantings of, a main crop. They provide a variety of benefits, notably: reduce soil erosion, improved soil structure, N fixation, weed suppression and insect habitat provision (Lu *et al.* 2000).

Compared to conventional tillage, providing vegetation cover during winter can reduce water soil erosion by: intercepting rainfall, increasing water infiltration, intercepting surface runoff, increasing surface roughness and stabilising the soil with root networks (Ruiz-Colmenero *et al.* 2013). The dead biomass also imparts roughness that disrupts the air flow and reduces wind-borne erosion (Wiltshire *et al.* 2014 p18).

Cover crops can be grown following the early harvest of main summer crops such as cereals or horticultural crops (typically in June/July), and in the autumn during the break between a summer/autumn harvested crop and a following spring crop. An alternative is to under-sow spring crops with a cover crop that will be in place to take up nutrients and provide vegetation cover once the spring crop has been harvested. The establishment of a temporary cover or catch crop can provide green cover over winter using crops such as grass, winter rye, winter barley or mustard (Wiltshire *et al.* 2014).

Proposed general operation

In order to achieve mitigation via the use of cover crops, the following operations are proposed:

- Provision of area-based payments for the sowing of cover crops in arable rotations to provide vegetative cover during the fallow period
- Provision of area-based payments for the sowing of temporary or permanent green cover in vineyards and orchards.

Another potential cover crop operation is buffer strips. However buffer strips are expensive as a stand-alone option (Pellerin *et al.* 2013) but may be more cost-effective as part of a soil erosion control plan (see Fiche A3).

Commitments, funding conditions and eligibility

When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities

1. Planting of cover crops in arable rotations during the fallow period.
2. Provision of area-based payments for the sowing of temporary or permanent green cover in vineyards and orchards.

PA should provide a list of eligible rotations and cover crops, based on local agronomic expertise. In general suitable cover crops will be fast growing crops such as mustard (Sinepsis alba) Schulte *et al.* (2012, p19). De Baets *et al.* (2011) suggest that species with frost resistant fibrous roots (i.e. ryegrass, rye, oats) and white mustard are the most suitable species for controlling concentrated flow erosion, while noting that oats and white mustard become less effective after frost.

Methods have been developed to identify the most suitable cover crop for a given combination of agronomic and economic criteria see De Baets *et al.* (2009, 2011 p238).

PA should specify a minimum seed-sowing rate to provide a sufficiently dense canopy.

No fertiliser (synthetic or organic) should be applied to the cover crop. Pesticide use may also be restricted.

Timing and duration
PA should define the appropriate period of planting and the minimum and maximum length of the cover crop period. Autumn sown cover crops should be established early to enable uptake of N before the onset of winter. For vineyards, Ruiz-Colmenero *et al.* (2013) recommend "cover crops should be sown before maximum vine development in early spring to reduce the effects of competition for moisture".

For some cover crops, it may be beneficial to set a date by which the cover crop should be destroyed, in order to negate the impacts on spring production.

The presumption is that cover crops will have to be used during each year of the RDP, although exemption criteria may be provided to enable suspension of the operation on farms under specified conditions (e.g. rainfall beyond certain thresholds).

Location
The operation should be targeted at areas where the cover crops will lead to a significant enough reduction in soil erosion to make the operation cost-effective. These are likely to be where there are high soil erosion rates, e.g. high winter rainfall and sloping ground. Existing data on soil threats could be used to target the operation (see: http://eusoils.jrc.ec.europa.eu/library/themes/ThreatsData.html).

The operation should be targeted at areas where the cover crops will not lead to a reduction in yield of the main crop. Preference should be given to areas where cover crops are likely to lead to an increase in yield.

PA should define the areas within which the operation is available, taking into account the following points (based on Wiltshire *et al.* (2014):

- Cover crops are widely applicable on different soil types in arable rotations; however, they are best suited to light soils types, due to the spring ploughing requirement, and light-textured free-draining soils to enable preparation of a good seedbed for the succeeding crop.
- Cover crops are more suitable where there is a relatively high spring rainfall as the cover crop will deplete soil moisture reserves and, hence, where there is insufficient rainfall, the main crop can suffer. This is supported by Dabney et al. (2001).
- Cooler soil temperatures under cover crop residues can retard early growth of subsequent crops grown near the cold end of their range of adaptation (Dabney et al. 2001).

Synergies - Incompatible operations and recommended combinations
Hristov *et al.* (2013, p100) noted that for cover crops "Interactions with other soil conservation practices are significant (tillage system, for example) and must be considered when the goal of cover cropping is reducing whole-farm GHG emissions." Related operations include:

M1 Extend the perennial phase of crop rotations

M2 Cover crops (mitigation)

A3 Soil erosion control plan

A7 Improved efficiency of irrigation

Adaptation benefits

Action	Effect	Reference
Providing winter cover in an arable rotation	Reduction in surface flow erosion from 31t/ha/yr to 2.5t/ha/yr	Kort *et al.* (in De Baets 2011)
Providing grass cover in vineyards	Reduction in surface flow erosion from 5.88t/ha/yr to 0.78-1.27	Ruiz-Colmenero *et al.* (2013)
Providing winter cover in an arable rotation	10% reduction in run-off 10% reduction in soil erosion	Posthumus *et al.* (2013)

Posthumus *et al.* (2013, Table 11) estimate a benefit: cost (B:C) ratio for cover crops of 0.12-0.59, based on an estimated reduction in soil loss of 10% . This B:C ratio is based on the (one –off and recurring) private costs of implementing cover crops and the economic ecosystem benefits occurring on-farm (e.g. reduced yields) and off-farm (e.g. siltation of water courses and water treatment costs) from the resulting reduction in soil erosion. While this analysis excludes some potentially important ecosystem effects (i.e. support of biodiversity and landscape value) they highlight the need for cover cropping to be carefully targeted in order to have a net economic benefit (i.e. a B:C ratio >1). Some studies (e.g. De Baets 2011 ; Ruiz-Colmenero *et al.* 2013) have reported significantly higher reductions in soil erosion than the 10% assumed in Posthumus *et al.* (2013) implying that cover cropping could have a net economic benefit in some areas.

The B: C ratio is also likely to be highly sensitive to any changes in yield that arise from the use of cover crops. For example for spring wheat yielding 6.5t/ha, the grain and straw output has a value of €1473/ha (Craig and Logan 2013, p15), so a 10% increase in yield would lead to a benefit of approximately €147/ha, which would change the range of the B:C ratio from 0.12-0.59 to 1.01-1.48. Moran *et al.* (2013) assumed a 15% increase in yield arising from the use of cover crops, while others, such as Posthumus *et al.* (2013) assume no effect or even a reduction in yield.

Ancillary effects

Reducing soil erosion can provide a range of benefits, notably: "support of food, fuel and fibre production, carbon sequestration, water discharge, flood regulation, provision of drinking water, water quality, infrastructure and recreation." Posthumus *et al.* (2013).

Table 2. Ancillary effects of the operation

Positive effects		Source
GHG emissions	Likely to lead to a net reduction in GHG emissions, primarily through enhanced soil carbon storage	See Fiche M2 for further details
Production	No significant effect	
Environment	Improved water quality via reduced runoff	Posthumus *et al.* (2013, p6) Schulte *et al.* (2012, p39) Kirk *et al.* (2012, p36) Wiltshire *et al.* (2014, p23) Flynn *et al.* (2007, p8, 24)

Positive effects		**Source**
Other	Other potential benefits include: reduced siltation of watercourses, reduced flood risk and reduced drinking water treatment costs.	Posthumus *et al.* (2013, p6)
Negative effects		
GHG emissions	No significant effects	See Fiche M2 for further details
Production	Potential loss of production if they lead to switching from winter to spring cultivation. Risk of negative effect on yield of main crop if competition for water or nutrients occurs	Wiltshire *et al.* (2014, p24)
Environment	Increased herbicide use	Schulte *et al.* (2012) Wiltshire *et al.* (2014, p23)

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible (although it should be noted that some cover crops, such as rye, oats and ryegrass are more difficult to remove, De Baets *et al.* (2011).

Guidance on costs and payment calculations
No significant one-off costs arising from the operation are predicted.

Recurring costs arise from seed purchase and additional fieldwork for cultivation and destruction/incorporation of the cover crop. Savings may be made from reduced synthetic fertiliser application rates (see Table 3).

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Reduced fertiliser purchase CC planting and destruction	(41) €/ha/yr 160 €/tCO_2e	Pellerin *et al.* (2013)
seed costs and fuel costs associated with cultivation of the crop	71.20 €/ha/yr 50 €/tCO_2e	Schulte *et al.* (2012)
seed (€65/ha/yr) cultivation/drilling (€70/ha/yr) incorporating crop residues (€30/ha/yr)	165 €/ha/yr	Posthumus *et al.* (2013)
seed purchase machinery operations	"highly variable. In general…low to medium cost"	Domingo *et al.* (2014, p9)

The cost-effectiveness is categorised as being in category 3, significant cost.

The main drivers of variation in cost-effectiveness are likely to be (a) the cost of the cover crop cultivation and incorporation, which will depend on the efficiency of cultivation, and (b) any effects on the yield of the main crop. This operation is unlikely to be cost-effective in areas where cultivation costs are high, or where there is a risk of yield penalties through use of the cover crop.

Given the limited private benefits of cover crops, payments are likely to need to offset a significant proportion of the farmers costs of implementing the operation. These costs will vary depending on, for example, the particular cover crop, but should be sufficient to meet seed purchase costs and most, if not all, of the costs of planting and incorporating the cover crop. In Italy the average agri-env payments for cover crops (with quite limited uptake of the operation) are around 150-255 euro per hectare (Povellato 2014 per comm).

Control and Verification

Compliance could be verified in a number of ways:

1. Integrated into current monitoring programmes (if they coincide with the cover crop cultivation timing).
2. Via provision of proof of purchase of cover crop seeds
3. Via remote sensing or aerial photography (Pellerin *et al.* 2013, p47)

Potential result indicators

P4C Agriculture. % of agricultural land under management contracts improving soil management and/or preventing soil erosion (ha)

P5E % of agricultural and forest land under management contracts to foster carbon sequestration/conservation

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Establishment of cover crop coincides with busy period in the farming calendar Reduces time to establish the following crop	Kirk *et al.* (2012, p34) Wiltshire *et al.* (2014, p21)
Cost of seed and cultivation	Kirk *et al.* (2012, p34), Wiltshire *et al.* (2014, p21)
Risk of damage to soil from establishing or destroying the cover crop in wet conditions	Kirk *et al.* (2012, p34)
Risk of negative affect on yield of following crop	Wiltshire *et al.* (2014, p21)
Concerns about herbicide use and resistance	Wiltshire *et al.* (2014, p21)
Lack of suitable land	Wiltshire *et al.* (2014, p21)
Lack of farmer awareness of the management needs and benefits of cover crops	Domingo *et al.* (2014, p9)
Other key risks/uncertainties	
Effect on N_2O emissions uncertain	Pellerin *et al.* (2013, p44) Kirk *et al.* (2012, p33)

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Fiche A3: Soil erosion control plan - ADAPTATION

Proposed RDP article and measure

Period	Article	Measure
2007-2013	36 (a) (iv); 39	214: Agri-environmental payments
2014-2020	15 (1) 28 (8) 31 (3)	Advisory services, farm management and farm relief services Agri-environment-climate Payments to areas facing natural or other specific constraints

Suggestion of other suitable RDP measures for the new programming period:

- Art 14 (1): knowledge transfer and information actions 1.1 support for vocational training and skills acquisition actions
- Art 18 (5): restoring agricultural production, in particular 5.1, support for investments in preventive actions aimed at reducing the consequences of probable natural disasters, adverse climatic events and catastrophic events

Summary
Farm based payments for scheduling and recording erosion prevention activity takes place on the farm. Benefits include:

- Increased efficiency of soil erosion prevention in order to achieve:
    - Reduced soil organic carbon (SOC) loss
    - Reduced GHG emissions (direct N_2O and CO_2 from fertiliser manufacture)
    - Reduced energy use

Regulatory requirements that have to be met
In many European countries Good Agriculture and Economic Condition standards requires the maintenance of cover over the winter in areas above a certain thershold of slope.

General description of the action and operation
In general, increased erosion contributes to increased GHG emission from farming activity. In dryland cropping systems, management interventions of tillage, cropping intensity, and crop type significantly influence CO_2 efflux (Martens *et al.* 2005; Liebig *et al.* 2005). Soil C erosion is defined as the sum of human accelerated erosion and the effect of 'natural' processes, and is a flux in the European GHG budget that cannot be neglected (Ciais *et al.* 2008). Van Oost *et al.* (2007) created a global map of soil erosion and showed significant cropland soil erosion rates in EU-25, of the order of 10–15gCm^{-2} y^{-1}, compared to arable lands in the rest of the world, which have lower rates.

SOC has received increasing attention due to its potential capacity to play an important role in mitigating (human) GHG emissions (Wander and Nissen, 2004). The estimated loss of organic C from the soil pool due to anthropogenic influences over the last century is significant. For instance, globally around 42–78 Gt of C have been lost due to soil management practices and soil erosion (Paustian *et al.* 2000; Lal, 2004b). There is some theoretical basis to suggest that the size of the potential SOC sink should be equal to the amount of C lost due to past managements. This is probably an overly optimistic estimate and Lal (2004a) suggested that the C sink capacity of agricultural and degraded soils might be only 50–66% of the historic C loss, due to the need to account for irreplaceable losses of mineral soil mass through processes such as soil erosion. Some of the C lost via erosion may end up 'buried' via terrestrial sedimentation, up to 1 Gt C yr^{-1} (see Stallard, 1998; Quinton *et al.* 2010; Uta *et al.* 2013).

An erosion control plan provides a multi-annual, structured and scientificly sound framework to implement multiple techniques, which are cost effective. They can be seen as a particular implementation of Environmental whole farm management plans which are one of 49 agri-environmental indicators currently being developed by the OECD as part of their Environmental Indicators for Agriculture programme (Manderson *et al.* 2007).

For instance, as well as increasing agro-ecosystem carbon storage, improved field boundary management could create buffer zones to prevent nutrient losses to surface water (Falloon *et al.* 2004) and reduce surface runoff and erosion (Falloon and Betts, 2010). Reducing tillage intensity is expected to increase the storage of soil organic carbon (SOC) relative to conventional ploughing as these practices reduce soil erosion through the development of a litter layer (Abdalla *et al.* 2002). Compared to conventional tillage, no-tillage often has more environmental advantages including surface runoff reduction and soil erosion mitigation (Triplett and Dick, 2008). The no-tillage method uses crop residue mulch to provide a protection against raindrop impact, thereby increasing soil organic carbon and decreasing decomposition of soil organic matter and oxidization of soil organic carbon. Other possible environmental benefits include energy and emissions savings resulting from less fuel consumption for operating farming equipment and associated air emissions (Kim and Dale, 2005; Lal and Kimble, 1997). In some circumstances, crops can be grown specifically to prevent erosion. While much research has investigated GHG impacts, conservation tillage has been implemented for reasons other than GHG mitigation – soil erosion control, soil quality enhancement, and reduced fertiliser needs (related to SOC retention). Research and experience show that less soil disturbance not only controls soil erosion and improves soil quality but also decreases SOM decomposition rates. This has been demonstrated by a comparison of ^{13}C signatures in SOC from no till and conventional sites (Six and Jastrow, 2006) and by the observation of soil C sequestration in many studies, reversing the trend initiated by the early agricultural settlers (Six and Jastrow, 2006; Eagle and Olander, 2012). Summer fallow can also accelerate soil C loss through erosion, although this may actually redistribute C locally rather than release it to the atmosphere (Gregorich *et al.* 1998). Vegetation breakdown of ungrazed pastures may also lead to increased runoff and erosion (Webber *et al.* 2010).

The use of erosion control plan can increase the efficiency of the included actions whereby contribute to:

- Reducing direct emissions from N fertilisers
- Reducing the CO2e emissions from fertiliser manufacture
- Reduction in N leaching
- Reduction in the amount of N that needs to be applied to the following crop.

Proposed general operation

In order to accomplish adaptation by the application of the control plan the following operation or combination of operations is/are proposed:

- Provision of payments for the development of soil erosion plan.
- Provision of payments for the documentation of the implementation of the plan.

The use of the measure(s) is relevant and suitable to all branches or farm type but with different required activities. The plan has to include the applied activity for each year including the crop to be grown and the way it is expected to be utilised (e.g. in case of grassland whether it will be utilised via grazing or mowing). The way of reducing and/or avoiding erosion could be performed by appropriate tillage and cultivation, application of cover crops, creates strips of vegetal cover by planting bushes and sowing a mixture of cereals in order to control soil erosion. As a result, there is also better management of water and more plant diversity.

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities

- *Arable crops (including horticulture)*

  Arable lands should be eligible if they are identified as being susceptible to erosion risk (e.g. wind or fluvial erosion). The effectiveness of certain activities to some extent depends on the soil type, which might not be possible to take into account. However, the compensation should reflect the average effectiveness of different activities. All relevant soil erosion prevention activities could be used:
  - residue management
  - manure management
  - crop rotation
  - cover crops/perennial crops
  - buffer strip establishment
  - erosion preventing tillage practices

- *Permanent crops*

  In case of permanent crops, residue management might be less applicable and the importance of tillage is also less significant in most cases. Establishment of permanent cover using crops or sometimes residue (mulches) is the most important.

- *Grassland*

  Maintaining good condition and canopy density of grassland is the most important. Timing of grazing can be also included.

Timing and duration
Soil erosion plan is a long run commitment with a minimum duration of 5 years. PA should provide advice on included activities that can contribute to soil erosion prevention.

Location
PA should define the areas within which the operation is available (using certain slope threshold).

Synergies - Incompatible operations and recommended combinations
This action overlaps with any action that has erosion prevention effect, i.e.:

M1 Extend the perennial phase of crop rotations
M7 Retain crop residues
M8 Loosen compacted soils / Prevent soil compaction
A1 Use of adapted crops
A2 Cover crops/reducing bare fallow
A5 Establishment and management of shelterbelts and hedges to provide multiple adaptation benefit
A4 Reduced tillage/minimum tillage
A6 Optimising drainage to achieve multiple adaptation benefits

Expected impacts on farm-level GHG emissions

The main on-farm adaptation effect of using an erosion plan is the increased mitigation efficiency and benefiting from the application of the appropriate action or combined actions. The actual impact depends on the action(s) included in the plan. For example, crop residue incorporation contributes to reduced nitrous oxide emissions (see Table 1). This result from reductions in N_2O where residue incorporation leads to a reduction in the amount of synthetic fertiliser applied. Furthermore, it can also contribute to carbon sequestration (Pellerin *et al.* 2013, p44).

Table 1. Example of abatement rate (PA have to pre-select region specific actions)

Mitigation effect	**Abatement rate**	**Source**
Reduce direct and indirect N>N_2O EFs	Forages and high N residue crops 0.1 tCO_2e/ha/yr	(Pellerin *et al.* 2013)
	0.1 tCO_2e/ha/yr	(Lal 2004)
C Sequestration	*site specific*	

Note: For other relevant action, please check the fiche on those

Adaptation benefits:

- Increased efficiency of erosion prevention activities. (see relevant fiches: A1, A2, A4, A5)
- Increasing soil water retention capacity. (see relevant fiches: A1, A2, A4, A5)
- Increase C stock in the soil. (see relevant fiches: A1, A2, A4, A5)

Ancillary effects

Table 3. Ancillary effects of the operation

Positive effects		**Source**
Off-farm GHG	Reduction in emissions arising from fertiliser manufacture if synthetic fertiliser application is reduced or loss is decreased.	Pellerin *et al.* (2013, p45)
Production	Prevention of soil loss can contribute to increased soil quality and hence yields.	
Environment	In the case the activity results higher biomass intensity on the field, it also increase the biodiversity.	
Negative effects		
Off-farm GHG	No significant effects.	
Production	No significant effects.	
Environment	No significant effects.	

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations
The preparation of the plan means significant one-off costs arising from the operation, complemented by the registration of erosion prevention actions (erosion prevention diary).

Savings may be made from reduced synthetic fertiliser application rates (see Table 3).

Table 3. Costs/savings of the operation (figures in brackets are negative costs, i.e. savings)

Costs/savings	Total cost	Source
Erosion prevention plan	€100/farm/yr	Expert estimation (no relevant study found yet)
Erosion prevention diary	€40/farm/yr	

The cost-effectiveness is categorised as being in category 1, minor cost.

The main driver of variation in cost-effectiveness is likely to be the loss of income as a result of alternative uses for the crop residues.

Control and Verification
Compliance could be verified in a number of ways:

- Integrated into current monitoring programmes.
- Via remote sensing or aerial photography (Pellerin *et al.* 2013, p47)

Potential result indicators
P4C (agriculture): % of agricultural land under management contracts improving soil management and/or preventing soil erosion (ha)

P5E (agriculture): % of agricultural land under management contracts to foster carbon sequestration/conservation

Extent to which the mitigation effect would be captured by National GHG Inventories
N_2O reduction from reduced rates of fertiliser application would be captured by current inventories.

Identified implementation challenges and barriers
Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	Source
Additional field operations	
Alternative uses for residues	
Other key risks/uncertainties	

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Useful readings

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Fiche A4: No tillage - ADAPTATION

Proposed RDP article and measure

	Article	Measure
2007-2013	36 (a) (iv)	214: Agri-environmental payments
2014-2020	28(1)	Agri-environment-climate

Summary
The strengths and weaknesses of the minimum and no tillage soil management practices are as follows:

Strengths:

- Saving in fuel and labour,
- Environmental benefits (e.g. reduction in soil erosion)
- Soil quality improvement
- Potential increase of soil organic carbon (SOC)
- Better water efficiency

Weaknesses:

- Not suitable for all soil types
- Increase in weeds

Regulatory requirements that have to be met
There are no specific policy measures to support the implementation of no tillage in European agricultural system.

General description of the action and operation
Several studies have discussed the potential of different land management practices, such as no tillage, as an option to reduce the GHG emissions from the agricultural sector (Smith *et al.* 2007; Soane *et al.* 2012). In addition, this soil management practices can help minimise the risks of soil degradation, which can be caused by changes in climatic conditions and management.

Tillage is performed before sowing to enhance soil aeration and to loosen up the top soil, these improve the conditions for the crop establishment. It can be loosely subdivided into three categories: conventional (CT), reduced (RT) and no tillage (NT). CT (e.g. mouldboard plough) is to a depth of 20-30 cm and through the full top soil inversion and the crop residues are buried under the soil. The no tillage option is the least invasive: crops are established without any soil management process and crop residues are left on the soil (Buckingham *et al.*, 2013, Soane *et al.*, 2012).

The adoption of a NT soil management practice has a positive effect on soil quality. Tillage imposes mechanical stresses which weakens the soil structure and reduces the stability of soil aggregates (Six *et al.* 2000). An improved soil structure is more resilient to soil erosion by wind and water. In addition, NT promotes the development of a litter layer which further reduces the likelihood of erosion (Strudley *et al.* 2008). The soil ability to retain water is also increased, therefore reducing the effects of droughts (Fernandez-Ugalde *et al.* 2009), which are likely to increase in frequency due to climate change (Berry *et al.* 2013) .

Arable soils are regarded as a source of GHG, nonetheless, reducing the tillage intensity, moving from a CT to NT, has been reported to have a positive impact on the soil organic carbon (SOC), therefore reducing the CH_4 and CO_2 production (Smith *et al.* 2007).

Smith *et al.* (2007) suggest that there is evidence that tillage management has a moderate impact on SOC increase, while the net effects on N_2O are more inconsistent and not well-quantified globally. Methane emissions or absorption by the soil normally contribute to a minor component to the overall soil GHG budget (Smith *et al.* 2007; Soane *et al.* 2012). Regina and Alakukku (2010) suggest that CH_4 fluxes are not strongly affected by the tillage practices (Ball *et al.* 1999).

Similar conclusions have been presented by Buckingham *et al.* (2013), regarding the N_2O. This systematic review has highlighted the fact that there is a high level of variability in the mitigation potential associated to the NT. Soane *et al.* (2012) summarise the results from several studies on the capabilities of soil sequestration under NT, concluding that there is a considerable level of uncertainty in the SOC response to NT. The response variability can be associated to soil type, climatic conditions, cropping system and the sampling depth is also an important factor. In addition, a recent review of data comparing the effects of CT, RT and NT (Buckingham *et al.* 2014) has highlighted the uncertainty in the SOC response under these soil management practices, suggesting that part of this inconsistency could be related to the effect of NT to redistribute SOC within the soil profile.

The NT implementation has several advantages:

- Reduction in the soil erosion due to the improvement of soil structure
- Retention and improvement of soil fertility
- Increases in water holding capacity, which is particularly beneficial for countries with a semi-arid climate
- Reduction in labour, fuel and machinery costs per hectare.

However, the disadvantages of this soil management practice are:

- Greater potential for yield loss due to weeds invasion
- Greater use of herbicides and pesticides
- Increases in water holding capacity can be associated to an increase in N2O emissions
- Risks of increasing bulk density which may lead to reduction of roots penetration depth, affecting crop yield.

Proposed general operation

The implementation of reduced and no tillage methods is somewhat encouraged by existing regulations on soil conservation. It is reasonable to assume that the introduction of both incentives led and regulatory policy could promote these practices even further.

Commitments, funding conditions and eligibility

When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities

In order to maximise the benefits, PA should provide information on the level of synergy that NT have with other mitigation options and regular improved cropping practices. These could include crop residue management, cover crop management and alleviation of compaction.

Time and duration
PA should define the appropriate period to implement this practice in order to minimise the potential side effects, such as soil compaction. In order to realise the full benefits of implementation, a minimum period of 5 years should be recommended.

Location
Existing data could be used to assess soil threats and used by the PA to define the risk areas where the benefits of implementing a NT could be offset by their side effects, such as increases in herbicide and pesticides.
(see: http://eusoils.jrc.ec.europa.eu/library/themes/ThreatsData.html).

Synergies - Incompatible operations and recommended combinations
No significant negative effects are anticipated. If effects do emerge, the operation is easily reversible.

Adaptation benefits

Action	**Effect**	**Reference**
Reduction in water erosion	25% reduction in erosion	(Rickson *et al.* 2010)
Reduction in wind erosion due to the increase of soil structure	Effective	(Wiltshire *et al.* 2014; Kirk *et al.* 2012)
Increases in the water holding capacity	0.06% - 1.93%	(Soane *et al.* 2012; Berry *et al.* 2013)

Expected impacts on farm-level GHG emissions
The main adaptation benefits of NT are related to improvement of soil quality, through enhancing soil aggregate stability, reducing the risks of N leaching, soil erosion prevention and improving the soil water holding capacity.

Ancillary effects
Table 2. Ancillary effects of the operation

Positive effects		**Source**
Environment	Maintaining soil fertility, especially in semi-arid regions	(Eagle *et al.* 2012; Berry *et al.* 2013)
Economic	Reduction in labour, fuel and machinery costs per hectare	(Berry *et al.* 2013)
Negative effects		**Source**
Environment	Increased herbicide use	(Weiske 2005)
	Risks of increasing bulk density which may lead to a reduction of roots penetration depth, affecting crop yield.	(Weiske, 2005)

Safeguards against maladaptation
Effects on maladaptation have not been anticipated, however if negative effects arise the operation is reversible.

Guidance on costs and payment calculations
The implementation of a NT management practice may have one one-off costs, i.e. purchase of specialist machinery.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	Total cost	Source
Labour cost (savings)	Highly variable depends on the country of application	(Pellerin *et al.* 2013)
Increase in spraying	€79/ha/yr (NT)	(Wiltshire *et al.* 2014)
Increased field operation	€47/ha/yr	(Posthumus *et al.* 2013)
Loss in agricultural production	€38/ha/yr (cereals)	(Wiltshire *et al.* 2014)

The cost-effectiveness is categorised as being in category 2, no or limited cost.

There are two main factors that are associated to a reasonable level of variability and therefore can change the cost-befit analysis: labour cost, which is strongly dependent on the country considered, and potential losses in yield due to the increase of weeds.

Control and Verification
Compliance could be verified by integrated the NT management into current monitoring programmes. If member states do not have an established monitoring programme, random checks of soil quality could be an effective approach to monitor farmers' compliance

Extent to which the mitigation effect would be captured by National GHG Inventories
The tier 1 method of the IPCC 2006 guidelines could be used to account for NT but it has some limitations as it does not consider this soil management practice for N_2O.

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	Source
Risk of negative effects on yield	(Wiltshire *et al.* 2014)
Concerns about herbicide use and resistance	(Wiltshire *et al.* 2014)
Other key risks/uncertainties	
Effect on N_2O emissions an SOC is uncertain	(Pellerin *et al.* 2013; Kirk *et al.* 2012)

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Fiche A5: Establishment and management of shelterbelts and hedges to provide multiple adaptation benefit – ADAPTATION

Proposed RDP measure

	Article	Measure
2007-2013	36 (a) (iv) 36 (a) (vi)	214: Agri-environmental payments 216: Support for non-productive investments
2014-2020	22(1) 28(1)	Afforestation and creation of woodland Agri-environment-climate

Summary
Hedges and shelterbelts have been identified as measures that have adaptation benefits. They have the potential to:

- Decrease soil erosion, and loss of nutrients to water
- Provide shelter for livestock from wind
- Provide shade for livestock from the sun

They have the added advantage of potentially sequestering carbon, and they provide an environment which will encourage biodiversity.

Regulatory requirements that have to be met
Existing policy incentives to extend hedges are included in existing RDP measures in some MS with the objective to increasing biodiversity. There is the potential to increase uptake for new plantings of hedges and shelterbelts.

General description of the action and operation
The establishment of shelterbelts and hedges is the planting of new hedges or fast growing trees, which are adapted to local conditions, within the farm. Hedges will typically be planted along fence lines whereas shelterbelts will be planted in areas that provide shelter either to livestock or crops. Alternatively, the trees or hedges may be planted in agroforestry systems that combine crops with perennial woods. The management of shelterbelts and hedges will ensure that the plantings are maintained to provide maximum benefit. The effectiveness of planting new hedges or shelterbelts will take longer to establish than the maintenance of existing plantations.

Hedges and shelterbelts will provide multiple benefits, notably: reducing erosion; maintaining water tables, and therefore reducing the effect of drought; shelter from wind; shelter for livestock from heat stress; and carbon sequestration. In terms of adaptation, to be of most benefit, the hedges and shelterbelts would need to be planted in locations where there was an identified risk of wind causing erosion or where shelter was required for livestock either to protect them from wind or provide shade. The carbon sequestration effect will be greater on arable land than grasslands.

Hedgerows and belts of trees will provide protection against downwind for up to 20 times their height. However, the benefit depends on the frequency and direction of any damaging winds (Rickson *et al.* 2010). Hedges also promote the removal of nutrients from the soil and therefore reduce the loss of nutrients to water. The planting of shelterbelts and hedges tend to maintain the water table, increase the soil biomass and hence improve the water holding capacity of the soil (Wiltshire *et al.* 2014). Woodland plantings can also result in increased rainfall retention, and therefore, reduce the risk of flooding (AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007), and reduce the risk of run-off and hence pollution reaching water courses (e.g. Hjerp *et al.* 2012, Reese *et al.* 2010). Shelterbelts provide shelter for livestock from heat and wind (Wall and Smit, 2005). The hedges and shelterbelts moderate the microclimate which can reduce crop evapotranspiration, and therefore, conserve water (AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007).

Hedges and shelterbelts can aid in adaptation in three main ways:

1. Decrease soil erosion, and loss of nutrients to water
2. Provide shelter for livestock from wind
3. Provide shade for livestock from the sun

Proposed general operation

In order to achieve the climate change benefits via hedges or shelterbelts the following operation is proposed:

- The provision of capital payments to support the establishment of hedges, shelterbelts or agroforestry schemes. The hedges or trees planted should be fast growing (e.g. poplars and willows).
- The measures will also include payments for the maintenance of hedges, shelterbelts and agroforestry so as to enhance the provision of shelter from the elements.

The shelter from the wind or provision of shade can be of benefit to rural communities as well as cropping or livestock systems.

Wiltshire *et al.* (2014) advises that for plantations to be most effective against wind they need to:

- Permit 30-50% of the wind to pass through.
- Be evenly permeable from top to bottom.
- Run at right angles to the damaging winds.

Commitments, funding conditions and eligibility

When developing a specific operation, programming authorities (PA) should provide specific conditions for the activities. Guiding principles are set out below.

Eligible activities

The eligible activities include a) planting fast growing trees that will form hedges, shelterbelts, agroforestry and will provide shelter from the elements and b) the maintenance of existing plantations to enhance the shelter potential.

PA should provide a list of eligible trees that can be planted and are appropriate to their location.

Timing and duration

PA should define the appropriate period of planting and the minimum period before the trees are felled. The PA should also stipulate when the maintenance of the hedgerows can take place to minimise the disturbance on nesting birds and insects.

Location
PA should define the areas within which the operation is available, taking into account the following points:

- The plantations should provide shelter from the prevailing wind to crops, livestock or rural communities, or
- They provide shade for crops, livestock or rural communities.

Synergies - Incompatible operations and recommended combinations
There are no incompatible or synergistic operations.

Expected impacts on farm-level GHG emissions
The main impact on farm of hedges and shelterbelts will be to provide shelter from the prevailing wind or provide shade for livestock and crops. In the former case, the shelter will reduce the risk of erosion of soils due to wind, and it will also potentially have a positive impact on the micro-climate under which the crop is grown and hence enhance yield. In the latter case, the plantations will potentially reduce the heat stress suffered by livestock and crops.

Table 1. Adaptation measure: benefits

Adaptation effect	**Benefit**	**Source**
Water erosion	5-10% reduction in soil loss	(Collins *et al.* 2009)
	10% reduction in erosion	(Rickson *et al.* 2010)
Wind erosion	Protects soils from wind erosion	(Rickson *et al.* 2010); Newell-Price *et al.* 2011)
Organic matter decline	Reduces loss of soil organic carbon due to reduced soil erosion	(Bhogal *et al.* 2009)

Ancillary effects
Table 2. Ancillary effect of the operation; +indicates carbon sequestration

Positive effects		**Source**
On-farm GHG	Avoided carbon loss due to reduced erosion and increase in stored carbon in • Hedgerows (the effect is small for grasslands and moderate for arable lands) • Shelter belts - +14 kg C/ha/yr • Agroforestry - +138 kg C/ha/yr	(Bhogal *et al.* 2009; Posthumus *et al.* 2013)
Flood risk	10% reduction in run-off Increased water infiltration	(Rickson *et al.* 2010; Carroll *et al.* 2004)
Water quality	Reduction in P loss Positive effects on stream quality	(Cuttle *et al.* 2007; Anthony *et al.* 2009; Carroll *et al.* 2004)
Biodiversity	Enhance bird and insect biodiversity. Potential to enhance soil microbial biodiversity	(Szajdak *et al.* 2002)
Negative effects		
Production	Hedgerows and shelterbelts will decrease the field size, and may increase the time required for field operations. There is the risk that shelterbelts may have	(Newell-Price *et al.* 2011)

	negative microclimatic effects which would result in competition with main crops for water, nutrients etc., and may attract pests	(Rickson *et al.* 2010)

Safeguards against maladaptation
No significant negative effects on adaptive capacity are anticipated.

Guidance on costs and payment calculations
The significant costs are associated with the planting of hedges or shelterbelts

Table 3. Capital costs/savings of the operation (figures in brackets are negative costs, i.e. savings)

Capital costs	**Total cost**	**Source**
Shelter belts	€2000-€6000/ha	http://www.forestry.gov.uk/forestry/infd-6dcegu
Hedges	€5/m	http://www.scotland.gov.uk/Topics/farmingrural/SRDP/RuralPriorities/Options/Extendedhedges/AgrienviroCapitalItems
Savings costs	**Total cost**	**Source**
Value of woodland at end of 40 yr rotation	(3500)-(4800) €/ha	Bell and Greaves (2010)

Recurring costs arise from maintenance of the hedges, and shelterbelts. With regards to hedges, this will be required on a 5-30 year cycle.

Table 4. Recurring costs/savings of the operation (figures in brackets are negative costs, i.e. savings)

Recurring costs/savings	**Total cost**	**Source**
Maintenance of shelterbelts	€220-€270/ha/yr	(Bell and Greaves 2010)
Maintenance of hedges – carried out every 10-30yrs Laying Coppicing	 €10/m €5/m	http://www.scotland.gov.uk/Topics/farmingrural/SRDP/RuralPriorities/Options/Extendedhedges/AgrienviroCapitalItems
Loss of production	€13-€23/ha	(Rickson *et al.* 2010)

The cost-effectiveness is categorised as being in category 3, significant cost.

The main driver of variation in cost-effectiveness is likely to be the variation both between sites and between years of the benefits of the hedges and shelterbelts. The benefits of shelterbelts and hedges are:

- Shelter for livestock from heat and wind
- Shelter for crops from wind:
  - Protects soil from erosion
  - Change microclimate so can have positive effects on yield.

Given the limited private benefits of hedges and shelterbelts, payments are likely to need to offset a significant proportion of the farmers' costs of implementing the operation. These costs will vary depending on, for example, the particular choice of species of trees or hedging used for the shelterbelts. Payments should not provide compensation for lost production due to the reduction in area of cropped land.

Control and Verification
In the case of new planting, compliance could be verified in a number of ways:

- Via provision of proof of purchase of materials for planting hedges or shelterbelts
- Via remote sensing or aerial photography (Pellerin et al. 2013, p47)

Potential result indicators
P4C Forestry and P4C Agriculture % of forestry/agricultural land under management contracts improving soil management and/or preventing soil erosion (ha)

P5E % of agricultural and forest land under management contracts to foster carbon sequestration/conservation

Identified implementation challenges and barriers
Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
They may increase the time required for field operations and therefore be resisted by larger farms.	(Newell-Price *et al.* 2011)
Hedge laying which would be part of a maintenance programme requires considerable investment and time. It is likely that this would be carried out over a number of years to fit in with farming operations.	(Newell-Price *et al.* 2011)
Other key risks/uncertainties	
Effect on erosion Benefit of shade	

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Fiche A6: Optimising drainage to achieve multiple adaptation benefits - ADAPTATION

Proposed RDP article and measure

	Article	Measure
2007-2013	36 (a) (iv)	214: Agri-environmental payments
2014-2020	28(1) Art 18 (5) Art. 17(4)	Agri-environment-climate Restoring agricultural production 5.1 support for investments in preventive actions aimed at reducing the consequences of probable natural disasters, adverse climatic events and catastrophic events 5.2 support for investments for the restoration of agricultural land and production potential damaged by natural disasters, adverse climatic events and catastrophic events potential/prevention Investments in physical assets 4.3 support for investments in infrastructure related to development, modernisation or adaptation of agriculture and forestry

Summary
Drainage has been identified as a measure that has adaptation benefits for mineral soils. In locations of water scarcity, drainage can improve the soil absorption capacity, although there is an increased risk of salinity issues for crop production. In areas prone to waterlogging, drainage will improve the soil structure and hence crop production, although there is an increased risk of flooding downstream. However, in these areas, it should be considered whether it would be better to implement a measure that allowed the restoration of natural floodplains. In waterlogged soils, drainage is likely to have the added benefit of decreasing N_2O emissions.

Regulatory requirements that have to be met
In general, across the member states (MS), there are no policy incentives to encourage the uptake of drainage. There is therefore the potential to increase uptake of improving existing drainage systems or installing new drainage systems.

General description of the action and operation
The action would include improvements to existing drainage systems and the installation of new drainage systems on mineral soils.

In terms of adaptation, drainage will have two main benefits. The first, in terms of water shortage, improved field drainage will result in an improved soil absorption capacity and hence have positive benefits for crop growth. In the Mediterranean countries, under climate change, yields may decrease by 40% (AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007), although reduction will not be solely enhanced by drainage as other factors will also be important. Secondly, when there is the risk of waterlogged fields, improved drainage will have benefits to the soil structure and hence crop production, and animal health (AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007). Although the effects of drainage will vary from year to year, on clay soils winter wheat yields have been reported to increase by 1t/ha (Armstrong, 1979), and similarly waterlogging has been shown to reduce winter wheat yields by between 1 and 32% (Belford *et al.* 1985). In addition, drainage can increase the length of the working season by up to three weeks in the spring and autumn (Armstrong *et al.* 1988).

Nevertheless, these benefits may be nullified by the negative effects. Regarding improved drainage for areas of water shortage, there is an increased risk of salinity (Van Ittersum *et al.* 2003), which can lead to reductions in productivity (AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007), and in severe cases desertification (Karas, 1997). This is a particular risk in the Mediterranean countries. In areas where waterlogging is an issue, improved drainage can increase the rate at which water is discharged to watercourses which may result in an increased risk of flooding downstream. Hence, there may be the need to improve flood defences in vulnerable areas (AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007). In these areas, it should be considered whether it would be better to implement a measure that allowed the restoration of natural floodplains.

In addition to the adaptation benefits, improved drainage can reduce N_2O emissions and therefore has potential mitigation benefits (Lilly *et al.*, 2012).

Drainage can therefore have benefits in three main ways:

- Improve the soil absorption capacity which can potentially increase yield in areas that are at risk of water shortage,
- Improve the soil structure of areas likely to waterlog and hence improve crop yields and animal health, and
- Reduction in N2O emissions
- Provide a method of retaining water in the case of shortage.

Proposed general operation

In order to achieve the climate change benefits via drainage, the following operation is proposed:

1. Provision of capital payments to
    a. reinstate existing drainage and
    b. to install drainage in areas identified as vulnerable either due to water shortage or waterlogging issues.

As part of the criteria for payment, there would need to be an assessment of the risk of flooding and the associated costs. It would be advisable to have a clause in the measure that stipulated that the farmers are obligated to maintain new or upgraded drainage systems.

The suitability of the measure depends also on the technical status of agricultural land in the MS (e.g. in Denmark, 50% of the agricultural land are artificially drained (Sand-Jensen *et al.* 2006)). Assuming the drainage schemes are still in good condition, the measure would not be necessary as the technique is already widespread. It is important to define the framework of the measure in order to avoid conflicts with other objectives of the RDPs. Organic soils, according to IPCC criteria[6], and soils in the

[6] The definition of organic soils is based on the IPCC (2006) which is mainly based on the definition of histosols of the FAO. However, the thickness criterion from the FAO is not used in order to allow the consideration of national circumstances (IPCC, 2006).

designated areas of Directive 2007/60/EC[7] on the assessment and management of flood risks should be excluded from this measure. Also soils with elevated C contents which do not meet the criteria of the IPCC as their C_{org} content might be below the threshold of 12 % C_{org} should be excluded. These soils should be protected as well because drainage of these soils would lead to increased GHG emissions. Therefore, soils with C_{org} content above 5% should be treated conditionally to avoid conflicts between climate protection and adaptation, and agricultural production objectives.

Soil maps on organic soils and maps of the designated areas for floodplain management should be used to proof eligibility for the operation. If MS might have difficulties to provide nationwide maps on organic soils and floodplains, the proof of evidence could be reversed. Farmers would then need to proof that the soil is not organic or a floodplain before the measure can be implemented.

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide specific conditions for the activities. Guiding principles are set out below.

Eligible activities
The PA should provide capital expenditure to reinstating or install new drainage. The PA should provide a list of basin requirements of the drainage system in terms of types of drains and spacing. The presumption is that the drainage system will be maintained. Draining systems should be provided with facilities to control (i.e. increase) the water level in order to facilitate active water level management. This activity would not be eligible for funding on organic soils according to the definition of the IPCC (IPCC, 2006) and soils in the designated areas of Directive 2007/60/EC (EC, 2007) on the assessment and management of flood risks.

Location
PA should define the areas within which the operation is available, taking into account the following points (based on AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007):

- Drainage would improve the water absorption capacity of the soil without the risk of reducing yield because of salinity issues.
- Drainage would reduce the risk of waterlogging and hence improve soil quality, increase yield and / or reduce the risk of animal health issues. However, the PA needs to assess the benefits against the additional risks of flooding in downstream areas, caused by the improved drainage systems, and the associated costs of that flooding.

Synergies - Incompatible operations and recommended combinations
With regard to drainage, this measure would be incompatible with:

- M9 Restoration of wetlands. This is because they are not applicable on the same land.

There are no synergistic measures.

[7] According to the EC Directive 2007/60/EC on the assessment and management of flood risks Member states shall carry out assessment to identify areas where potential significant flood risks exists or might be considered likely to occur. Flood hazard maps and flood risk maps for the identified areas shall be prepared and periodically reviewed and if necessary updated, taking into account the likely impacts of climate change on the occurrence of floods (EC, 2007).

Expected impacts on farm-level GHG emissions

The main on-farm adaptation effect is via improved soil structure and hence water holding capacity of the soil which will have benefits for crop yield in both water shortage and potentially waterlogged soils. Nevertheless, there would be expected to be a yield benefit which would be expected to be a maximum of 15%, although this benefit would not occur in all years. On soils that previously suffered from waterlogging, there may be the benefit due to an increased length of working season; however this effect is difficult to quantify.

Table 1. Adaptation measure: benefits

Adaptation effect	Benefit	Source
Increased yield due to amelioration of waterlogging	e.g. 1 t/ ha for winter wheat	(Armstrong., 1978)
	e.g. 1-35% for winter wheat	(Belford *et al.* 1985)
Increased yield due to amelioration of water scarcity	Maximum of 40%	(AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007)
Increased working season	Possibly up to 3 weeks. Effects of this benefit are difficult to quantify	(Armstrong *et al.* 1988)

Ancillary effects

Table 2. Ancillary effect of the operation

Positive effects		**Source**
Reduction in N_2O emissions	Applicable to soils that are prone to waterlogging	(Lilly *et al.* 2012)
Environment	Improved water quality through reduced N input in water bodies through surface run-off	
Negative effects		**Source**
Off-farm	Flooding downstream	(AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007)
Production	Reduction in yield in areas prone to salinity issues	(AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007)
Environment	drainage activity could create water quality problems in streams due to enhanced mineralisation of organic matter releasing excessive nitrogen and phosphorus to surface waters	(Sand-Jensen *et al.*2006)

Safeguards against maladaptation

The safeguards on maladaptation are that the measure is not implemented where there is a high risk that it will lead to increased flooding downstream where the effect out ways the potential benefit. In addition, the measure is not implemented where there is a high risk of salinity having additional major impacts on production

Guidance on costs and payment calculations
The major cost of the measure would be the installation / upgrading of drainage systems. Based on costs in the UK, this would be in the region of €2000-€2750/ha for new drainage (http://www.fwi.co.uk/articles/13/01/2012/130966/extreme-weather-means-good-land-drainage-is-vital.htm). There would also be the costs involved in the assessment of the effect of the drainage scheme on additional flooding downstream.

The recurring costs would be due to maintenance of the drainage system, and the recurring benefits would be an increase in yield, although the actual benefit in any given year will be a function of the prevailing weather conditions (Table 3).

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Savings from increased yields (waterlogged soils)	10% increase in yield	(Armstrong, 1977), Belford *et al.* 1985)
Savings from increased yields (drought)	Maximum of ~40% increase in yield	(AEA Energy & Environment and Universidad de Politécnica de Madrid, 2007)

The cost-effectiveness is categorised as being in category 3, significant cost.

The main driver of variation in cost-effectiveness is likely the variability in yield increase.

Given the limited private benefits of drainage, payments are likely to need to offset a significant proportion of the farmers' costs of implementing the operation. These costs should be sufficient to pay for the drainage system required.

Control and Verification
Compliance could be verified in a number of ways:

- Via provision of proof of purchase of installation of drainage or upgrading of drainage
- Via remote sensing or aerial photography
- On-site controls

Potential result indicators
Reduced waterlogging of fields.
Area (ha) with newly installed or upgraded drainage systems

Identified implementation challenges and barriers
Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Cost of drainage	
Availability of contractors with the correct equipment	
Assessment of the risk of downstream flooding	
Other key risks/uncertainties	
Effect on N_2O emissions uncertain	(Lilly *et al.* 2012)

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Fiche A7: Improved irrigation efficiency - ADAPTATION

Proposed RDP article and measure

	Article	Measure
2007-2013	20 (b) (I) (IV) (V), 29, 36 (a) (IV)	121: Modernisation of agricultural holdings 124: Cooperation for development of new products, processes and technologies in the agriculture and food sector and in the forestry sector 125: Improving and developing infrastructure related to the development and adaptation of agriculture and forestry; Cooperation for development of new products, processes and technologies in the agriculture and food sector and in the forestry sector 214: Agri-environment payments
2014-2020	28, 29, 46	Agri-environment-climate payments Investments in irrigation

Summary
The agricultural sector plays an important role in the use of water resources, although the impact that it has on these resources is complex and not always easy to analyse. Irrigation efficiency and water savings have become increasingly important because of climate-induced hydrological variability, rising of demand for food, fibre, biofuel and increasing freshwater demand for other uses. Hence the role of irrigation techniques is very important because there is potential to drastically reduce the water requirement while maintaining the same production efficiency and consequently promoting an active role in the adaptation of agriculture to climate change. In particular, by means of the conversion of water-saving systems, irrigation systems and technologies, including the creation of water reserve and the use of sustainable farming techniques in order to rationalize water use and the ability to improve irrigation efficiency.

Regulatory requirements that have to be met
The rationalization of water management is included in the Community Strategic Guidelines for rural development. It has been foreseen by the Water Framework Directive (2000/60/EC) (WFD) to establish a reference for actions in the field of water policy, which aims to prevent the deterioration of quality and quantity, to improve the status of water and to ensure a sustainable use, based on the long-term protection of available water resources.

The Good Agricultural and Environmental Conditions (GAEC) have included, after the Health Check review, a specific standard concerning the protection and management of water: the use of water for irrigation is subject to compliance with authorisation procedures.

General description of the action and operation
Irrigation efficiency and water conservation are key issues regarding the operations of adaptation to climate change, even in the face of growing demand for water for other uses. The concept of water efficiency in agriculture depends greatly on the spatial scales of reference and it is linked to the socio-political context in relation to plans to modernise irrigation on a large scale, implying the need to investigate aspects of water rights and allocation, benefits and beneficiaries of water-saving and important co-benefits and unintended consequences of modernisation and reform of agricultural policies (Lopez-Gunn *et al.* 2012). The optimisation of the water use efficiency,

defined as the ratio of crop yield over the water applied, implies a shift from the objective function to maximise the productivity per unit of crop area, to maximise the productivity per unit of water consumed. On the other hand, this requires minimising losses due to runoff, infiltration, evaporation and transpiration by crops through suitable farming practices and high-yielding species adapted to the soil and climatic conditions (De Pascale *et al.* 2011).

The efficient management of water for irrigation requires a full understanding of the water balance for the field, irrigation project, or catchment area in question, in relation to irrigation water consumed by crops on a farm (Jensen, 2007), and in this way the irrigation efficiency can be defined as a complex and useful measure of irrigation performance (Lankford, 2012). The reasons for the relatively low efficiency of water use in agriculture are numerous and complex relating to environmental, biological, engineering, management, social and economic aspects.

The complexity increases also with the myriad of local variations, requiring an overall conceptual framework of physical and biological processes as the underlying basis for analysing the current situation and quantify the efficiencies to plan and execute improvements. Hsiao *et al.* (2007) propose a framework based on the simple fact that the overall efficiency of each process can be viewed as a chain of sequential step ratio (output / input) of the individual components. This systematic approach can be applied to any process consisting of chains of sequential steps as farming systems. More precisely, the authors define an equation to quantify the impact of changes on the overall efficiency, concluding that generally this leads to more modest efficiency improvements in a few steps rather than making great efforts on one step. So the important thing is that improvements must be systematic and not overly focused on one or two components. This approach should allow monitoring the different levels of efficiency along the paths of water use in agriculture to identify any inefficiencies by comparison with known values of efficiency for each analysed component.

Improvements in irrigation can have unintended consequences when we consider larger scales and multiple uses of water (Lankford, 2013), presenting some paradox (Scott *et al.* 2014) for which: 1) *efficiency paradox* that occurs when, in the absence of an efficient policy to limit the expansion of irrigated area with "saved water", the efficiency can aggravate shortages, deteriorating the quality of the resources and endanger water catchment resilience through the loss of flexibility and redundancy; 2) *sectoral paradox* where savings are reallocated to alternative uses. In this way the water storage or groundwater, are not scheduled as a function of the irrigated area, but depend on other aspects; 3) *scale paradox* involved in terms of both spatial and temporal and occurs considering the natural water cycle, when for example the use of irrigation water alters the cycle of return flow in the catchment areas (e.g. pumping of groundwater intercepts return water basins), which has an impact in terms of appropriation of water and profits behind the investment. Therefore, neglecting the interrelationships that may occur on the socio-hydrological systems, these paradoxes can threaten the stability and resilience of water systems. In this context investing public resources to anticipate and compensate the effects of water scarcity (ex-ante) is an adaptive response to drought of more effective than ex post mitigation efforts.

From the above description then, the most important aspects in the definition of recommended actions and operations to improve irrigation efficiency in relation to adaptation to climate change are:

- to identify the issues relating to water rights and allocation to measure the benefits and beneficiaries of water saving;

- definition of systematic improvements and not overly focused on one or two components of the water system;
- investment of public resources to anticipate and compensate ex-ante for the effects of water scarcity;
- the use and selection of high-yielding crops adapted to the climatic and soil conditions;
- full understanding of the water balance at the farm level;
- investments at farm level to change inefficient irrigation systems with high-efficient equipment;
- definition of policy instruments to improve water management and investments in monitoring and control in regions where water scarcity is a crucial aspect (especially when the water price is low or water tariffs are not volumetric but per unit area, and particularly in areas where mostly groundwater from private boreholes is predominantly used).

Proposed general operation
In the current programming period operations involving the adoption of water saving technologies (e.g. efficient irrigation systems), water reserves and production techniques with low consumption of water have been provided in some MS. The achievement of these objectives is provided through measures and actions oriented to structural modernisation of farms, the growth of value-added agricultural products and forestry, agri-environmental payments and co-operation for the development of new products, processes and technologies in order to improve the ability to use water more efficiently and to increase water quality. Obviously the technologies must be linked to specific policies and management practices to avoid the increase of water consumption through the rise of the cultivated area or the cultivation of crops with higher water requirements.

The following operation is proposed:

- Investment aids for micro/precision irrigation equipment
- Support for the preparation of water use plan
- Farm advice on how to cope with water scarcity and efficient water use

In general a shift from the gravity irrigation to modern pressurised systems (e.g. drip and sprinkler irrigation) and improved conveyance efficiency provide an opportunity for reduced water demand in irrigation. Exposure to droughts may be reduced if water use decreases in the whole water basin. Drip irrigation may increase the efficiency of water use, and better crop productivity, reducing the amount of water used for irrigation.

Commitments, funding conditions and eligibility
When developing a specific operation, programming authorities (PA) should provide detailed conditions. Guiding principles are set out below.

Eligible activities
It would be desirable to provide a package of expert systems for the farm sustainable management with regard to management of soil, air and water similar to the regulations on integrated pest management, but that includes the management of irrigation and fertilisation plans.

Timing and duration
PA should define the appropriate period of farmer training and should provide a useful support to farm advice system on how to deal with water scarcity and water use efficiency by supporting investments in equipment, precision irrigation, support for the preparation of the plan for the use of water (e.g. by measure 121).

Location
PA should define the areas within which the operation is available, taking into account the following points:

- the hydrogeological system of the study area, often characterized by complexity with distinct territorial situations;
- the state of implementation of the WFD and related definition of the river basin district, as the territorial unit for planning and management of river basins;
- the difference between precipitation and evapotranspiration of reference, from which it is possible to configure heterogeneous climatic conditions and specifications of areas;
- irrigation systems and sources prevailing
- the demand for water in agriculture

Synergies - Incompatible operations and recommended combinations
M3 Improved N efficiency: In this case N application should be scheduled in the right time to improve the uptake of N and water by crops.
M7 Retain crop residues: Decreasing the potential evapotranspiration.
A1 Use of adapted crops: Drought-resistant varieties and low-water-demanding crops allows for the use of the most efficient irrigation systems.

Expected impacts on farm-level GHG emissions
The adaptation options for water includes local collection and use of rain water provided that this does not disturb the natural supply to the different groundwater layers; increases in irrigation efficiency and expansion of irrigated and rain- fed cropland (EEA, 2010). In agricultural sector, the main actions to cope with impacts from temperature increase (e.g. + 3°C) and rain decrease (e.g. > 50%) should be a combination of new genetic resources (in the longer term) and improved management techniques, as well as water efficient irrigation and precision agriculture (EEA, 2013). Some studies suggest possible adaptation scenarios of crop production related to climate change and adaption options of water use. For example Gerten *et al.* (2007), in a European scenario, suggests that productivity increases are small in northern latitudes and at high altitudes, because crop production in these regions is limited mainly by temperature and sun radiation rather than by water.

The effects of adaptation to climate change through improved irrigation efficiency imply the need to follow an efficient approach for implementing an integrated planning and scheduling of actions with respect to the specific problems of the different territories, with a view across sectors. Indeed, the identification of adaptation measures must be made from time to time on the basis of local conditions. In particular, the main lines of adaptation related to improved irrigation efficiency aim to conserve water in the soil or to manage more efficiently the water resource, taking account of local climatic conditions, such as:

- Choice of more efficient techniques of soil tillage (laser levelling of fields, minimum tillage, etc.).
- Innovation infrastructure investments for efficient irrigation systems;

- Irrigation schedule based on the actual irrigation requirements estimated by appropriate technical assistance services;
- Choice of irrigation systems that maximise the efficiency of water use and ensure the prevention of risks of soil salinization in arid areas;
- Recovery, restructuring and maintenance of hydraulic infrastructures;
- Crop diversification in agricultural holdings;
- Substitution of crops or varieties;
- Development of genetic improvement;

The quantification of irrigation efficiency and the effects on adaptation to climate change is site-specific and varies by type of soil, climate and cropping system. In this sense, even the use of GIS in the process of evaluation and monitoring can help optimise irrigation efficiency (Tromboni *et al.* 2014). The strategies include soil management in relation to water holding capacity of soils, irrigation of crops, coupling crop production with seasonal rainfall patterns and use of drought tolerant crop varieties (Debeake and Aboudare, 2004). For all these reasons irrigation efficiency should be contextualized in different situations not only from a territorial point of view but also in terms of management. In fact, several irrigation systems can achieve different levels of efficiency and vary with scale and time (Howell, 2003). The improvement of irrigation efficiency could be also indirectly relevant to mitigating GHG emission not only in terms of energy saving for irrigation but also for other related crop management practices. For example, soil moisture plays a key role in the GHG emission saving (increasing water saturation promotes N_2O emissions via low oxygen diffusion into the soil), creating greater aggregate stability and increasing in soil organic matter content. The improvement of biological activity could play a significant role in minimising emissions of GHGs from soils (Mangalassery *et al.* 2014). By reducing the total amount of water applied and optimising water distribution to root zones, irrigation efficiency gains can provide water savings as well as GHG benefits (GAS-OFF Project, 2013).

The table below summarizes some examples of study related to direct and indirect effects of the improvement of irrigation efficiency on emissions and different irrigation systems used.

Table 1. Example of mitigation effect and value of irrigation efficiency

Mitigation effect	**Effect type**	**Source**
Range of farm efficiency (%)	40 - 70% with surface irr. method 60 - 85% with sprinkler irr. method 77 - 94% with pivot irr. method 77 - 96% with lateral move irr. method 73 - 95% with microirrigation method 57 - 82% with water table control method	(Howell, 2003)
Increasing of soil water retention capacity	Irrigation systems (e.g micro irrigation, sprinkler systems, drip irrigation) can provide adaptation benefits by decreasing water distribution with a plant water localization and increasing soil water retention capacity. Modern irrigation technology, such as drip irrigation, micro sprinklers and solid set systems can deliver water much closer to the actual plant.	(Rowe *et al.* 2014; Tromboni *et al.* 2014)

Ancillary effects

The improvement of irrigation efficiency implies tactical decisions concerning tillage, type of crop and cultivar, sowing date and density, N fertilisation, irrigation timing, amount and frequency. Flexible crop management systems based on decision rules should be preferred to the recommendation of fixed packages of techniques (at least those that are not described in relation to weather and specific crop management). Timing, intensity, and predictability of drought (intermittent, terminal) are important features for choosing the cropping alternatives. The information derived from simulation models may help the farmer to select best-bet management options based on historical long-term weather records. Simple soil and plant indicators associated with real-time decision support systems should be developed to revise the initial management plan by integrating in-season weather information (Sakellariou-Makrantonaki *et al.* 2007). In particular, water sensors may be used to control irrigation such that the desired soil water capacity helping also to reduce the GHG emissions associated with crop irrigation (Lewis *et al.* 2010).

Table 2. Ancillary effects of the improvement irrigation efficiency

Positive effects		**Source**
On-farm GHG	Reduction in emissions arising from the use of a micro irrigation system and more efficient systems	(Heydari *et al.* 2014; Zou *et al.* 2013; Mosier *et al.* 2005)
N efficiency	Efficient irrigation systems may improve fertiliser-N use efficiency	(Wang *et al.* 2013)
Environment	Improved water availability for the plant via reduced runoff. Use sustainable irrigation equipment (mater-Bi) and leaching water and nutrients.	(Jia *et al.* 2014)
Negative effects		**Source**
Production	Possibility to loss of production if the water quantity is distributed in a wrong way Formation of a salt concentration detrimental to the development of the root system on the edge of the area irrigated Closure of the nozzles of irrigation systems	(Heydari *et al.* 2014)

Safeguards against maladaptation

No significant negative effects on adaptive capacity are anticipated. If effects do emerge, the operation is easily reversible.

Guidance on costs and payment calculations

Recurring costs arise from improvement irrigation efficiency operation, in particular by irrigation equipment, irrigation scheduling and reduction of production. Savings may be made from reduction of irrigation with savings on depreciation of equipment, labour and energy costs. Overall savings is found at the loss of costs linked to the optimisation of water resources, avoiding wastage of water (see Table 3).

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
Time saved by: • Irrigation scheduling • Water flow • Type of irrigation system (Reduces time to water distribution)		(Rowe *et al.* 2014)
Water saved by: • deficit irrigation scheme • reduction of water conveyance losses • precision agriculture	(0.17) €/m^3 (0.73) €/m^3 (0.28) €/m^3	(Panagopoulos *et al.* 2014)
Total cost of installation by: • deficit irrigation scheme • reduction of water conveyance losses • precision agriculture	€ 0 /ha € 400/ha € 106/ha	
Total cost of site-specific monitoring and control: • Control system (single board computer, wireless bridge, relay board, wires, GPS unit, enclosures, panels, solenoid valves, power supply/transformers and electric accessories) • Monitoring system (radio systems, pressure transducers, flow meters, soil moisture sensors, enclosures, wires and accessories)		(Chavez *et al.* 2009)

It is important to note that in the case of improving irrigation efficiency there are many methodological and technical solutions adapted to different situations distinguished by peculiar climatic conditions, agronomic, soil, etc. for this is not possible to configure cost values adapted to all situations.

The cost-effectiveness clarifies the benefits of improved efficiency, therefore any payments should favour not only the conversion and installation of efficient irrigation systems but also technical training for farmers needed for their proper use.

Control and Verification

Compliance could be verified from current monitoring programmes related to water abstraction in agriculture and % of UAA under management contracts.

Potential result indicators

P4B – *Improving water management*: % of utilised agricultural area (UAA) under management contracts improving water (ha)

P5 – *Water efficiency* - Water saved per unit of output due to supported projects

P5A – Increasing efficiency in water use by agriculture: water saved in agriculture in RDP supported projects (m^3)

Identified implementation challenges and barriers

Possible challenges for irrigation efficiency are the improvement of water infrastructures, eliminating the water flow infiltration and resulting in significant benefits in terms of water savings, costs and characteristics of the current irrigation management. The irrigation management and scheduling are crucial recommended operations. Irrigation scheduling, which is based on soil-water-plant relationships and efficiency considerations, assumes how farmers should cultivate and irrigate their lands and how much water required to be distributed during the irrigation period. For this reason the role of irrigation consulting and the type of irrigation system are fundamental. There are many types of irrigation systems. They include solid set, permanent, manual-move, lateral-move, side-roll wheel-move, center-pivot, hard-hose traveler, cable-tow traveler, drip or trickle, and sub- irrigation types. Most farmers have limited choices for their farm or field. Some systems use water and energy more efficiently, whereas others are designed to overcome limitations such as irregular field shapes, sloping land, or a limited water supply. All of these factors must be considered before selecting a system (Rowe *et al.* 2014). For this reason, consideration should also be given to capital cost; crops to be grown; farming practices; soils; acreage to be irrigated; availability of labour; the need for environmental modification, fertigation; and dealer availability and service.

A potential barrier can be represented by the pressure requirements of an irrigation system, which is linked with the amount of energy it consumes. Converting an agricultural irrigation system from high pressure to low pressure could reduce energy usage by approximately 50 percent. Irrigation can be very cost effective and it can lead to greater yields, improved crop quality, improved management capabilities, and perhaps fewer production uncertainties. But selecting the proper combinations of system components and managing the system for greatest efficiency can be complicated. An energy-efficient system is one that has been designed for a particular layout. It must have a pump properly matched to the power unit, the correct pipe sizes, and the proper pressure and water distribution uniformities. Efficiency is achieved by selecting a water- and energy- efficient system and then properly operating, maintaining, and managing it.

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Source**
Reduces of yield production due to water distribution	
Cost of irrigation equipment	(Rowe *et al.* 2014)
Other key risks/uncertainties	
Reduction of farmer income and rising of transaction costs.	

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Fiche A8: On farm rainwater harvesting and storage - ADAPTATION

Proposed RDP article and measure

	Article	Measure
2007-2013	20 (b) (i) 20 (b) (iv) 36 (a) (iv)	121: Modernisation of agricultural holdings 125: Improving and developing infrastructure related to the development and adaptation of agriculture and forestry 214: Agri-environment payments
2014-2020	17 (1) 28(1)	Investments in physical assets Agri-environment-climate

Summary

- Suggested operation: investment support for rainwater harvesting and storage on farm, support for the preparation of water use plans and for advisory services on on-farm rainwater harvesting and storage.
- The water can be used at a daily basis, requiring smaller investment (smaller storage, e.g. tanks), or can be stored to provide water supply in draught periods (needs bigger storage, e.g. lagoons and has higher capital costs).
- Larger scale, collective water harvesting installations should be also considered, especially in the southern regions of Europe.

Regulatory requirements that have to be met

In some European countries RDP already offers support for rainwater harvesting (e.g. Cyprus (Georgiou 2014), England (Environment Agency 2009), and Veneto Region, Italy)). Statistical data on the current level of implementation is not available. Additional uptake is possible especially in areas where summer droughts are just starting to become a problem.

General description of the action and operation

Action: Installation of facilities for rainwater harvesting from farm buildings, water storage, filtering and distribution.

Mechanism of adaptation: Climate change is going to have an effect on water availability across Europe. Increased risk of drought and water scarcity throughout whole Europe (except the Boreal zone) and the salinisation of water resources in coastal areas (due to sea level rise) together with increased temperature will pose challenges on agricultural water use (Iglesias *et al.* 2007). Summer precipitation is going to decrease in almost all European regions, and annual precipitation being reduced in the Atlantic south, Continental south and Mediterranean regions (European Environment Agency 2012).

The collection and storage of rainwater can, to some extent, alleviate these problems by helping to maintain a more constant water supply, i.e. by making water from winter precipitation available during the summer period (Iglesias *et al.* 2007).
The scale of rainwater collection can span from small installations collecting water from the rooftops of garden sheds to large scale solutions, like diverting the fast runoff of heavy rainfall into water ponds. These latter projects might have significant effect on the hydrology of the catchment, and would require collective action from the parties affected. This fiche presents the particularities of on-farm rainwater harvesting.

On-farm rainwater harvesting is the collection and use of rainwater falling onto buildings which would otherwise have gone down the drains, been lost through evaporation, or soaked into the ground (Environment Agency 2009). The water is directed to a tank or reservoir and used with or without treatment. The water collected can contribute to livestock drinking, milk cooling, cleaning of livestock buildings and irrigating vegetables and fruits. The amount in most cases would not be sufficient for large scale irrigation.

In the Atlantic north and central, Continental north and Alpine regions the potential for rainwater harvest in the winter is likely to stay relatively high, while in the Atlantic south, Continental south and Mediterranean regions winter precipitation is also going to be reduced, necessitating an even higher emphasis on improving water use efficiency.

To alleviate some of the summer drought problems by storing water from winter rainfall much larger storage facilities are needed (e.g. lagoons) than if the collected water is used at a daily basis. If the collected rainwater is used daily, then it is unlikely to provide relief to the mains water supply in times of water shortage (Environment Agency 2009). In the case of large storage facilities minimising evaporation losses should be considered.

Proposed general operation
In order to increase the amount of rainwater harvested on farms, the following operation is proposed:

Provision of financial support for capital investment in rainwater harvesting and storage from farm buildings.

The operation might also include financial support for the preparation of water use plans (including actions to reduce wastewater, to improve irrigation, to preserve soil moisture better, etc.) and for advisory services on on-farm rainwater harvesting and storage.

Commitments, funding conditions and eligibility
Eligible activities
- Capital investment in rainwater harvesting and storage facilities and financial support for the preparation of water use plans

Considering the roof area and the water usage of farms, on farm rainwater harvesting and storage is an operation most applicable to livestock farms where the animals are housed at least in part of the year and to farms growing protected crops (e.g. in polytunnels, glasshouses).

Timing and duration
Investment in on-farm rainwater harvest and storage can happen all year round, support for the operation should not be constrained within the year or within the RDP programming period.

Location
This operation should be made available to farms in areas where seasonal water shortages are expected to become more prevalent and the collection and storage of winter rainfall can help reducing the summer water shortage problems.

In the southern regions of Europe the adaptive capacity of larger, collective water harvesting installations are likely to be higher than individual rainwater harvesting facilities, therefore funds might be better directed towards such actions.

Synergies - Incompatible operations and recommended combinations
The suggested operation M14 'Climate proofing planned investments' can overlap with the current operation and therefore care should be taken to avoid double funding. The suggested operation M13 'Behavioural change towards better energy efficiency' can reduce the negative effects from the possibly increased energy use on greenhouse gas emissions.

Adaptation benefits
Table 1. Adaptation benefits of optimising glasshouse cultivation for a changing climate

Action	**Effect**	**Reference**
Rainwater harvest and storage from roofs	Reduced dependence on other water supplies	(Environment Agency 2009)
Rainwater harvest and storage from roofs	Improved soil structure and reduced erosion around buildings with large roof areas	(Environment Agency 2009)

Ancillary effects
Table 2. Ancillary effects of the operation

Positive effects		**Reference**
On-farm GHG	-	
Off-farm GHG	-	
Production	-	
Environment	-	
Negative effects		**Reference**
On-farm GHG	-	
Off-farm GHG	Electricity use might increase with rainwater storage and pumping (on-farm renewable sources can be supported to alleviate this effect).	(Environment Agency 2009)
Production	-	
Environment	-	

Safeguards against maladaptation
The small scale of on-farm rainwater harvesting secures that the hydrological cycle is not disturbed. Additionally, as it does not provide sufficient amount of water for implementing large-scale irrigation schemes, it also do not contribute to a lock-in effect regarding systematic changes in agricultural production.
On the other hand, where collective, large scale water harvesting is the preferred option, long-term climate change impacts of continuously increasing water scarcity have to be taken into account. This is to avoid sustaining crop and livestock systems with high water requirements instead of changing to alternative systems with lower water needs.

Guidance on costs and payment calculations
Cost elements at the farm include capital costs, and annual costs (maintenance and operation). Financial benefits arise as reduced water use from other sources, including mains water, the cost of which is going to further increase in the future. The capital investment required might include the following (Environment Agency 2009):

- gutters and pipes,

- water tank or reservoir,
- filtering/treating,
- distribution pumps and pipes.

Both the capital and the annual costs depend on the technology to be implemented (e.g. storage capacity required, one big roof or more, smaller roofs, filtering/treatment needed or not); the capital costs can vary widely, between €1,000 and €100,000 or more. The water storage facility is likely to be the most important cost element. Assuming consistent daily usage of the collected water (e.g. livestock drinking water), the water storage capacity should be 2-3% of the annual harvestable volume; if usage is less regular, a 5% capacity may be more appropriate (Dairy Co 2009). In case the main purpose is to store winter rainwater for summer use (e.g. irrigation of protected crops) the capacity has to be even higher, 20-30% of the annual rainfall.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings		**Total costs**	**Source**
Total annual cost of rainwater harvest	(UK)	0.21-0.55 €/m^3	(Dairy Co 2009)
Reduced water use	Mains water (UK)	(1.2)-(2.5) €/m^3	(Environment Agency 2009)
	Ground or surface water abstraction (UK)	(0.21)-(0.55) €/m^3	(Dairy Co 2009)
Installation – storage	Tank	180-360 €/m^3	(Dairy Co 2009)
	Lagoon	6-12 €/m^3	(Dairy Co 2009)
Installation – pipes and pumps	Gutters and pipes	18-36 €/m run if alteration needed (minimal on new buildings)	(Dairy Co 2009)
	Filters for down pipes	180 €/each	(Dairy Co 2009)
	Pumps	300-900 €/each	(Dairy Co 2009)
	Filters	600-1200 €/each	(Dairy Co 2009)
Running costs	Pumps	0.12-0.37 €/m^3 (assuming 0.12 €/kWh electricity)	(Environment Agency 2009)
	UV unit	15-17 €/year (assuming 0.12 €/kWh electricity)	(Environment Agency 2009)
Maintenance costs	total (filters, roofs, UV bulb, engineer check)	600 €/year	(Environment Agency 2009)

Example:
2000 m^2 roof area, 750 mm annual rainfall

A. Daily use of rainwater, storage: 30 m^3 tank (2% of harvestable water)
B. Rainwater stored for summer, storage: 450 m^3 tank (30% of harvestable water)

Capital costs	A: €8000, B: € 11000
Running and maintenance costs	1000 €/year
Savings on water costs	2000 €/year

Control and Verification

Compliance could be verified in a number of ways:

- Integrated into current farm monitoring.
- Via provision of proof of purchase of equipment.

Potential result indicators

- Result indicator 13: Increase in efficiency of water use in agriculture

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Reference**
Access to capital	
Other key risks/uncertainties	**Reference**
With the increasing variability in precipitation there is a risk that the storage capacity is underestimated and/or that the collected water contributes only marginally to the water use on farm.	

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Fiche A9: Optimising glasshouse cultivation for a changing climate - ADAPTATION

Proposed RDP article and measure

	Article	Measure
2007-2013	20 (b) (i) 20 (b) (iv) 36 (a) (iv)	121: Modernisation of agricultural holdings 125: Improving and developing infrastructure related to the development and adaptation of agriculture and forestry 214: Agri-environment payments
2014-2020	17 (1) 28(1)	Investments in physical assets Agri-environment-climate

Summary

- Suggested operation: implementation of active climate control and improved building design for climate control in glasshouses and making glasshouses more resistant to storm damage.
- The synergy in improving irrigation should be fully utilised, and improving energy efficiency and renewable energy generation is suggested to be complementing this operation.
- The adaptive capacity of active climate control is high in southern and possibly in central Europe, while very low in the northern regions. The adaptive capacity of better storm resistance is relevant all over Europe.

Regulatory requirements that have to be met

We are not aware of any existing regulations or policy incentives which would encourage farmers to adapt glasshouse production to the changing climatic conditions. Energy efficiency schemes and subsidies to modernise agricultural production might be already used by some growers to adapt their glasshouses.

General description of the action and operation

Action:

Improved climate control (including active control and improved building design) in glasshouses and making glasshouses more resistant to storm damage.

Mechanism of adaptation:

Glasshouses are mostly used to grow heat-demanding vegetable and ornamental species in cool circumstances and to protect crops from heat and radiation under hot circumstances, therefore either expanding their growing season (given a high demand for out-of-season cultivation) or the geographical area suitable for cultivation (FAO 2013). Depending on the growing conditions maintaining the optimal microclimate often requires either heating or cooling/shading (Figure 1). Besides the temperature and radiation control, optimising soil moisture and humidity are also determining factors in production efficiency.

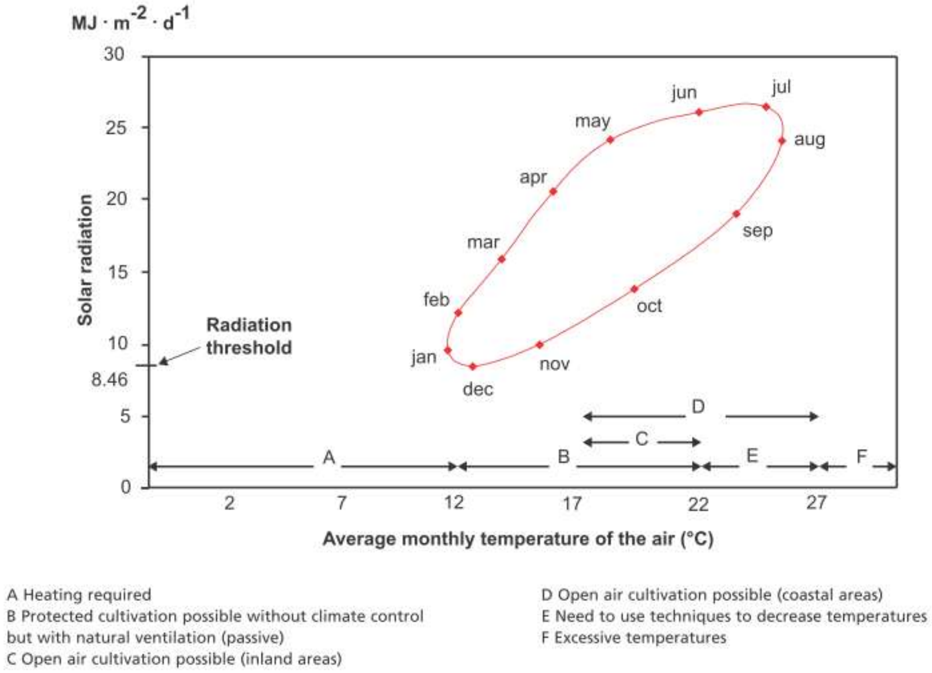

Figure 1. Illustrative diagram about the climate suitability for glasshouse crops. The shape and position of the curve depends on the location, while the width and position of the arrows depends on the crop (this example is for Almería, Spain, 37ºN, from 1988) (FAO 2013)

The changing climate is going to have a varied impact on glasshouse production in Europe. The main anticipated effectsare changes in the heating and cooling requirements (Olesen and Bindi 2002). In the northern regions the increased temperature will reduce the cost of heating, while in the southern regions the increased temperature and radiation will necessitate improved cooling and shading practices. The reduced water availability and increased likelihood of drought stress, especially in the southern regions, will require better water efficiency. In addition, to reduce infrastructural damage in the glasshouses caused by more frequent and more severe storm events (e.g. high winds, severe hail, cold winds, heavy snow cover, high rainfall), improved structures for storm protection will be needed (Iglesias *et al.* 2007). Given the huge range in the technical level in glasshouses from unsophisticated to high-tech installations, coping with these challenges will require different effort from different growers. Outside the limits of 12–22 °C in coastal areas and 12–17 °C in inland areas, glasshouse production requires active climate control (including heating, mechanical ventilation, shading, insulation, cooling, thermostats, moisture and humidity sensors and computerised system). As these areas are shifting towards the North due to the changing climate, parts of Europe where growing was possible with passive climate control and simple glasshouse design are experiencing the need for active climate control and improved structures.

Without improved indoor climate control the higher temperature creates a need for increased irrigation, which results in a severe increase in pests, infections and diseases, and as a consequence highly intensified use of pesticides (Iglesias, A., pers. comm.). Thus, improved indoor climate control in areas where summer temperature will increase above optimal level has multiple benefits in terms of higher yield, better product quality, decreased need for irrigation and decreased need for plant protection products.

The benefits of improved climate control would be enhanced by, and should come hand-in-hand with, improved irrigation control. As many aspects of irrigation and water use efficiency are described in other fiches ('Improved irrigation efficiency', 'Use of adapted crops', 'On farm harvesting and storage of rainwater'), these issues are not discussed here.

Changing from passive to active climate control is likely to have negative effects on greenhouse gas mitigation in terms of increased energy use – this can be alleviated by ensuring that the energy needs of the active climate control will be covered by installing farm-based renewable energy production.

Proposed general operation

In order to improve climate adaptation of glasshouses, the following operation is proposed:

Provision of financial support for capital investment in improving indoor climate control in glasshouses and in storm-proofing of glasshouse structures.

The operation might also include financial support for improved irrigation control and farm-scale renewable energy production. Also importantly, training could be supported in RDPs to provide good practice advice for newly built glasshouse, including information on the likely changes in weather and its anticipated impacts on structures and growing conditions.

Commitments, funding conditions and eligibility

Eligible activities

- Capital investment in active climate control, improved building structure/materials and storm-proofing of glasshouses. Payments can be made to support retrofitting existing glasshouses or to partially support new developments if they meet certain criteria.

Optimising greenhouse cultivation for a changing climate is an operation specifically applicable to horticultural farms, both for new glasshouse developments and for existing glasshouses.

Timing and duration

Investment in improved adaptive capacity for glasshouses can happen all year round, support for the operation should not be constrained within the year or within the RDP programming period.

Location

This operation should be made available to growers in those areas where the climate is going to change over the next 15-20 years (i.e. during the lifetime of the investment) so that:

1. temperature increase is going to push the temperature beyond what is optimal for passive glasshouses (likely in the southern regions of Europe), and/or
2. the severity of storm damage is likely to increase substantially.

Synergies - Incompatible operations and recommended combinations

The following proposed RDP operations do have synergies with this operation: A7 'Improved irrigation efficiency', A1 'Use of adapted crops', A8 'On farm harvesting and storage of rainwater', as they also improve the adaptation of glasshouse production. The co-implementation of these operations might be encouraged. On the other hand, the suggested operation M14 'Climate proofing planned investments' can overlap with the current operation and therefore care should be taken to avoid double funding. The suggested operation M13 'Behavioural change towards better energy efficiency' can reduce the negative effects from increased energy use on greenhouse gas emissions.

Adaptation benefits

Table 1. Adaptation benefits of optimising glasshouse cultivation for a changing climate

Action	**Effect**	**Reference**
Active climate control	Improved indoor climate	(Iglesias *et al.* 2007)
Improved building design and materials	Improved indoor climate	
Storm-proofing of glasshouses	Reduced material damage	

Ancillary effects

Table 2. Ancillary effects of the operation

Positive effects		**Reference**
On-farm GHG	-	
Off-farm GHG	-	
Production	Improved growing conditions increase yield and product quality.	
Environment	Decreased need for irrigation; decreased need for plant protection products	
Negative effects		**Reference**
On-farm GHG	The improved growing conditions provide a potential for increased yield which might necessitate increased nitrogen fertilisation, resulting in increased GHG emissions per farm, though this is likely to be offset by the improved production, having no or positive impact on the emission intensity of the products.	
Off-farm GHG	Electricity use might increase with installing active climate control systems. However, energy efficiency of production might improve, and on-farm renewable sources can be supported to alleviate this effect.	(Iglesias *et al.* 2007)
Production	-	
Environment	-	

Safeguards against maladaptation

A lock-ineffect might happen in those situations where investment is made into glasshouses optimisation without fully considering the potential weather changes during the whole lifetime of the investment and, therefore, over- or under-investing in indoor climate control and/or storm-proofing.

Additionally, wider environmental considerations would require a careful assessment of where glasshouse-based production should be supported this way, weighting the benefits from food production against the drawbacks form increased energy and water use.

Guidance on costs and payment calculations

The operation offers support for capital investment in active climate control and storm-proofing of glasshouses. Cost elements at the farm will also include operation (e.g. energy) and maintenance costs. These costs, especially the capital element, are highly dependent on the current status of the glasshouse in question and on the technology to be implemented.

Table 3. Costs/savings of the operation (figures in brackets are savings)

Costs/savings	**Total cost**	**Source**
no information is available		

Control and Verification

Compliance could be verified in a number of ways:

- Integrated into current farm monitoring.
- Via provision of proof of purchase of equipment.

Potential result indicators

- Result indicator 5: % of agricultural holdings supported to manage risks

Identified implementation challenges and barriers

Table 4. Potential barriers to uptake and key risks/uncertainties

Barrier to uptake	**Reference**
Access to capital	
Increasing energy prices	(Iglesias *et al.* 2007)
Volatility in product prices	(Iglesias *et al.* 2007)
Other key risks/uncertainties	**Reference**
Changes in future climate impacts as of the impacts of elevated temperature and increased climate variability on glasshouse growing conditions	

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Mainstreaming climate change into rural development policy post 2013 – Annex 2

Summary tables for combinations of measures

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Table of Contents

Introduction

This Annex contains summary tables of suggestions for possible combinations of measures for the different focus areas under Piority 4 and Priority 5 of the EAFRD Regulation. The method used to select the combinations of measures is explained in Chapter 3 of the main report.

The priorities and included focus areas are the following:

Priority 4: Restoring, preserving and enhancing ecosystems dependent on agriculture and forestry, with a focus on the following areas:

- restoring and preserving biodiversity, including in Natura 2000 areas and high nature value farming, and the state of European landscapes (with effects on climate objectives as a side effect);
- improving water management;
- improving soil management.

Priority 5: Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors, with a focus on the following areas:

- increasing efficiency in water use by agriculture;
- increasing efficiency in energy use in agriculture and food processing;
- facilitating the supply and use of renewable sources of energy, by-products, wastes, residues and other non-food raw material for purposes of the bio-economy;
- reducing nitrous oxide and methane emissions from agriculture;
- fostering carbon sequestration in agriculture and forestry.

The following guiding notes include recommendations on how to identify potentially effective combinations. These guiding notes address the most important aspects that need to be considered when planning a combination of measures to enable its effective implementation.

Guidelines for the identification of effective measure combinations

- *Identify the additional benefit of a combined implementation of measures for climate actions compared to single measures. The logic behind the combination has to be clearly defined.*
- *Measures have to be complementary. The synergies and expected benefits as well as potential barriers and disadvantages for measure combinations have to be considered.*
- *Define the adequate level for the measure combination (e.g. RD programme, sub-programmes, single or multiple beneficiaries, regional or local level).*
- *Decide on compulsory or voluntary measure packages: examine if it is more useful to establish the measure combination on a voluntary basis depending on the particular case or obligatory as a part of a "package". If two measures do not make sense as stand-alone measures, an obligatory combination is recommended. However, in some cases an obligation could decrease the acceptance and thereby the application of a measure. Voluntary combinations leave more flexibility and may be more suitable for differing conditions. In case of voluntary combinations, providing beneficiaries with the capacity for the selection of beneficial measure combinations would be essential (e.g. by training or use of carbon navigators).*
- *Assess the impacts on programming of the combined implementation of measures: If the combination is associated with high additional programming and administration efforts it might not be advisable to consider it (e.g. avoid double counting and exclude overcompensation or overlapping support).*
- *Reflect on capacities associated with a potentially higher uptake due to the combination of measures (e.g. advisory services, knowledge transfer, and training). The sufficient amount of service providers (e.g. public or private agencies) with adequate knowledge on measure combinations need to be available.*

Priority 4: restoring, preserving and enhancing ecosystems related to agriculture and forestry

Measure 1	Measure 2,3,4 …	Explanations
4a Restoring, preserving and enhancing biodiversity, including in Natura 2000 areas, and in areas facing natural or other specific constraints, and high nature value farming, as well as the state of European landscapes		
A5 Optimising adaptation benefits of shelterbelts and hedges (Art. 22 and 28)	Land management planning	**The combination of these measures provides a spatially more targeted support at landscape level and thereby increase adaptation benefits and improve ecosystem services such as biodiversity.** The investment support for the establishment of shelterbelts and hedges can be complemented by the development of a land management plan at local or regional level. This supports the effectiveness of the adaptation measure by identifying target areas with high potential for soil sequestration and soil erosion prevention. A positive ancillary effect is also the improvement of ecosystem services, e.g. when considering landscape connectivity through the establishment of shelterbelts and hedges.
M9 Investments for restoration of wetlands (natural heritage) (Art. 20. 1f Basic services and village renewal in rural areas)	Land consolidation (Art. 17c) Extensification on organic soils (AEMs) (Art. 28) Pilot Projects for Paludicultures (Art. 35)	**Wetland restoration can only be achieved with a combination of measures and the collaboration of different land-users and is therefore a measure combination per se.** Wetlands have an important habitat function and contain a high biodiversity. Measures addressing single farms are not effective as wetlands cover a larger land area. Therefore, the measures should be implemented as collective action (see Chapter 5 *Climate Action under the Cooperation Measure*). Activities that are necessary to restore wetlands vary according to the site-specific conditions and might include studies to support the planning process, e.g. impact assessments regarding hydrology and land-use, land purchase and land consolidation by the public sector, investment support for setting up of infrastructure for water management (raising the water table), agri-environment-climate measures to support extensive wetland-use, pilot projects for improvement of wet use of organic soils / paludiculture, and training and advisory services for land owners.

4b Improving water management, including fertiliser and pesticide management		
Measure 1	**Measure 2,3,4 …**	**Explanations (Criteria)**
M4 Precise N application (Art. 17)	M2, A2 Catch crops, Cover crops/ reducing bare fallow (Art. 28) Buffer strips (Art. 28)	**The combination reduces ammonia and indirect N_2O emissions as well as nutrient run-off and leaching into water bodies.** Investment support for precise N application reduces the N surplus and can be combined with the implementation of catch and cover crops as well as buffer strips which reduce N leaching and soil erosion. Through the increased coverage of bare soil, soils are protected from erosion and applied N is used by the plants which reduces the N losses in the soils.
M3 Improved N efficiency (Art. 14,15,28)	M16 Carbon audit (e.g. Art. 15) Advisory Service/Training (Art. 15)	**To improve N efficiency a result-oriented approach should be supported by training and nutrient accounting and thus requires a measure combination**. Measures directing at improved fertilisation planning, management and application could be considered. The farmer is responsible for the selection, implementation and control of the measures and therefore more flexible and actively involved. He can decide what activity is most suitable for the condition at his farm, which facilitates a learning process. This operation should always be accompanied by technical advice and/or training operations in order to identify weaknesses and potentials of the farms and to identify where additional knowledge or improved management and technologies are necessary. Also the combination with a carbon audit tool as an initial analysis and advice helps to identify the needs at the farm and facilitates directed support.

4c Preventing soil erosion and improving soil		
Measure 1	**Measure 2,3,4 …**	**Explanations (Criteria)**
A3 Training and advice to draw up a soil erosion control plan (Art. 14, 15)	A2, M2 Cover crops/reducing bare fallow (Art. 28) M6 No-tillage technologies (Art. 17) A5 Establishment of shelterbelts and hedges (Art. 22, 28)	The soil erosion control plan is established to identify suitable measures that have the objective to reduce or avoid soil erosion at farm level. Therefore, a variety of combinations of measures is possible including appropriate tillage and cultivation, application of cover crops, buffer strips, planting hedges and sowing a mixture of cereals in order to control soil erosion. **The erosion control plan should help to identify useful activities and to select the optimal combination of measures to improve the situation at the farm level.** Training and advice could improve the knowledge and experience of farmers to use and establish soil erosion measures.
A3 Soil erosion control plan at regional level (15, 18)	A5 Optimising adaptation benefits of shelterbelts and hedges (Art. 22, 28)	A soil erosion control plan can also be established at regional level in order to optimize the overall soil management of a region. To focus on erosion control at farm level might not have the desired effects as activities of many land users are necessary. **The effectiveness of the implementation of shelterbelts and hedges could be improved when target areas are selected by a soil erosion control plan.** Further, the acceptance of land-users can be increased as there is the need for collaboration of multiple beneficiaries.

Priority 5: promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors

5a Increasing efficiency in water use by agriculture		
Measure 1	**Measure 2,3,4 …**	**Explanations (Criteria)**
Investment in regional irrigation infrastructure (e.g under 17c)	A7 Farm equipment for more efficient irrigation (Art. 17a)	**Combination of complementary investment into irrigation facilities at regional and at farm level increases the overall effectiveness for climate adaptation.** If support is limited to single farms, the effectiveness of the measure might be insignificant. More beneficiaries can be addressed when the regional infrastructure is improved and collaboration between them is increased. Indirect effects such as leakage are reduced.
A8 On farm harvesting and storage of rainwater (Art. 17, 28)	A7 Improved irrigation efficiency (Art. 17,28, 29, 46)	**The combination with improved irrigation efficiency helps to optimize the water use of the farms and save water quantities.** To address the issue of water scarcity, the efficiency of water use should be addressed at all activities of the farm. Therefore, the establishment of on farm harvesting and storage of rain water should be combined with further activities that increase efficiency of water use. Water losses are reduced.

5b Increasing efficiency in energy use in agriculture		
Measure 1	**Measure 2,3,4 …**	**Explanations (Criteria)**
M16 Carbon Audit/Climate Check (e.g. under Art. 15)	M13 Behavioural change towards better energy efficiency (Art. 14,15,28)	**Undertaking a carbon audit helps to target the support towards better energy efficiency by identifying farms with significant emissions from energy use.** The carbon audit provides an initial analysis of potential mitigation activities at farm level. The combination with behavioural change towards better energy efficiency would help to use the resources more efficiently and targeted as potentials for energy reductions are identified.
M14 Climate proofing of planned investments (Art. 17)	M13 Behavioural change towards better energy efficiency (Art. 14,15,28)	**The combination allows a foresighted, climate-friendly investment support and the optimal management (in terms of climate protection) after realisation of the investment.** The planning of climate-friendly investments can be combined with training and advice for better energy efficiency. This would facilitate the correct and energy efficient use of new machineries or establish strategies for further energy reductions in new buildings. The effect of the measures is increased.

5c Facilitating the supply and use of renewable sources of energy, of by-products, wastes and residues and of other non food raw material, for the purposes of the bio- economy		
Measure 1	**Measure 2,3,4 …**	**Explanations (Criteria)**
M16 Carbon Audit/Climate Check (Art. 15, 18, 28)	M14 Climate Proofing of planned investments (Art. 17) M12 Solar fodder driers(Art. 17)	**This combination links the identification of reduction potentials through the climate check with investments supporting further GHG emission reductions.** The identified sources for emission reductions are addressed with directed investment support. Investments are proofed to be climate friendly and their mitigation potential can be calculated. An example could be the establishment of solar fodder driers at livestock farms.
A5 Shelterbelts / agroforestry: planning regional concepts for renewable energies	M14 Climate Proofing of planned investments (under Art. 17)	**The combination enables the integrated support of the whole "biomass chain" considering the planting, harvesting and use of biomass for renewable energies.** Combining the establishment of shelterbelts or agroforestry schemes with the planned investments for climate objectives would integrate the use of the harvested biomass (e.g. shelterbelts with fast growing trees) in the regional concept for the use of renewable energies. Facilities for the use of wooded biomass for energy purposes can be established in areas with high prevalence of shelterbelts and agroforestry schemes. This would increase the efficient use of harvested biomass from these schemes and reduce a waste of renewable resources.

5d Reducing greenhouse gas and ammonia emissions from agriculture		
Measure 1	**Measure 2,3,4 …**	**Explanations (Criteria)**
M3 Increased N efficiency (Art. 14,15,28)		**To improve N efficiency by a result-oriented approach includes several measures and can be considered a measure combination on its own**. For example, the participation in farm advice or training can be part of the support. Several activities might be necessary to improve the N efficiency. Activities directing at improved fertilization planning, management and application could be considered. The farmer is responsible for the selection, implementation and control of the measures and therefore more flexible and actively involved. He can decide what activity is most suitable for the condition at his farm which facilitates a learning process.
Advice on manure handling (Art. 15)	M14 Climate Proofing planned investments (Art. 17) Precise N-application (Art. 17)	**In this case the obligatory combination is recommended because all ammonia emissions saved along the manure management chain (e.g. through investments into storage covers) can be lost later during manure application.** Therefore, emissions at all stages of the manure management should be addressed. The combination of complementary measures that are directing the whole manure chain has a much higher GHG emission reduction potential than single, separate measures. The combination with advisory service is recommended as it facilitates the correct implementation of improved N application techniques.

5e Fostering carbon conservation and sequestration in agriculture and forestry		
Measure 1	**Measure 2,3,4 …**	**Explanations (Criteria)**
M9 Investments for restoration of wetlands (natural heritage) (Art. 20. 1f Basic services and village renewal in rural areas)	Land consolidation (Art. 17c) Extensification on organic soils (AEMs) (Art. 28) Pilot Projects for Paludicultures (Art. 35)	**Wetland restoration can only be achieved with a combination of measures and the collaboration of different land-users and is therefore a measure combination per se.** Wetlands are an important carbon sink. This measure shall help to reduce GHG emissions from decomposition of peat by avoiding the drainage of wetlands and restoring the natural water table of drained wetlands. Measures addressing single farms are not effective as wetlands cover a larger land area. Therefore, the measure is potentially important as collective action (see Chapter 5 *Climate Action under the Cooperation Measure*). Activities that are necessary to restore wetlands vary according to the site-specific conditions and might include studies to support the planning process, e.g. impact assessments regarding hydrology and land-use, land purchase and land consolidation by the public sector, investment support for setting up of infrastructure for water management (raising the water table), agri-environment-climate measures to support extensive wetland-use, support of farm investments in adapted machinery, pilot projects for improvement of wet use of organic soils / paludiculture, and training and advisory services for land owners.
A4 Reduced tillage/minimum tillage	A5 Optimising adaptation benefits of shelterbelts and hedges (Art. 22, 28) A2/M2 Catch crops (Art. 28)	**This combination links the improvement of the soil quality with decreasing bare soil surfaces and thereby further increasing the conservation and sequestration of soil organic carbon.** Reduced tillage is associated with the improvement of soil quality, through enhancing soil aggregate stability, reducing the risks of N leaching, soil erosion prevention and improving the soil water holding capacity. The combination with covering the soil with biomass by the establishment of shelterbelts and hedges or catch crops can further increase the soil organic carbon.

Mainstreaming climate change into rural development policy post 2013 – Annex 3

Best Practice Examples of 2007 – 2013 LEADER Projects

This Annex 3 is part of the Technical Guidance produced in the project "Mainstreaming climate change into rural development policy post 2013".

This project was funded by European Commission, DG Climate Action, Contract No. CLIMA.A.2/SER/2013/0010.

The main report of the project may be located under the following citation:

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Table of Contents

Introduction

Annex 3 presents project factsheets for best practice examples of climate action LEADER projects. The method used to identify climate action LEADER projects and selecting best practice examples is explained in Chapter 4 of the main report.

The information included in each project factsheet is based on the questionnaires which were sent to each project and completed by project representatives. Additional information derived from final reports, project brochures, and evaluations was incorporated where available.

The consortium would like to thank the following persons for their strong contribution to the LEADER project analyses and individual project factsheets.

- Emma Platt – Carbon Buster Clusters
- Jennifer Hewitson – Cheviot Futures
- Peter Plaimer – CO_2 Recycling
- Gráinne Kennedy – CSmart Organisations
- Dr. József Nagy – 1 Village – 1 MW
- Tibor Szabó – Local Traditional Orchard Programme
- Dr. Ing. Giancarlo Moro – Est Sesia
- Simonetta Calasso - OFT "Forestry Organisation of the Territory”
- Jean François Pecheur – L’arbre en Champ
- Gerard Meijers – Connection Runde
- Henk Egberts – Solar Panels for farmers in Northeast Overijssel
- Job Stierman – Texel Energie
- Daniela Retzmann - Development of energy self-sufficiency for the LEADER region 'Westlausitz'

The following projects examples are included in this Annex:

No	Thematic area	Name of the project	Country
1	Capacity Building	Carbon Buster Clusters: A School Transition Project	UK
2	Capacity Building	Cheviot Futures - United in a Changing Rural Landscape	UK
3	Renewable Energy – Agricultural Waste	CO_2 Recycling – Climate Protection through Soil, Humus, and Habitat Management	Austria
4	Capacity Building	Creating CSmart Organisations	UK
5	Renewable Energy	The Hungarian Virtual Micronetwork Balance Circle Cluster – 1 Village – 1 MW	Hungary

No	Thematic area	Name of the project	Country
6	Agroforestry	Zala Termálvölgye Association: Local Traditional Orchard Programme for Sustainable Agriculture	Hungary
7	Water	Est Sesia – Maintenance works for the improvement of water infrastructures at Sartirana, Cavo Corsica	Italy
8	Forest Management	OFT "Forestry Organisation of the Territory"	Italy
9	Agroforestry	'L'arbre en Champ' – Agro-forestry Audit on the Farm and Mobilisation of Innovative Models	Joint Project – France & Belgium
10	Landscape / Resource Efficiency	Connection Runde – Integrating peat restoration and protection with river restoration in Southeast Drenthe	Netherlands
11	Renewable Energy – Solar Energy	Solar Panels for farmers in Northeast Overijssel	Netherlands
12	Renewable Energy	Texel Energie	Netherlands
13	Energy Efficiency	Development of energy self-sufficiency for the LEADER region 'Westlausitz'	Germany
14	Renewable Energy	'Shadows and Sun' and 'Catching the Sun' – Improving the use of renewable energy	Slovenia

The best practice LEADER project factsheets are structured in the following way:

- Project background
- Project objectives and drivers
- Links to local development strategy
- LEADER funding
- Project outputs
- Benefits resulting from the project
- Actors
- Success factors and barriers
- Project as an initiator of future activities in the region

Carbon Buster Clusters: A School Transition Project

Project Background

Basic information and contact

Project duration: July 2012-August 2013

Thematic area: Capacity Building

Country: UK

Project Coordinator: Ms. Emma Platt

Email Address: e.platt@carboncentre.org

Phone: +44(0)1387 702348

Website: www.carboncentre.org

The Carbon Buster Clusters: A School Transition Project was launched in July 2012 by the Crichton Carbon Centre. It was funded by the Dumfries and Galloway Local Action Group (LAG) LEADER Programme, the Robertson Trust, and the Crichton Carbon Centre. The project promotes carbon emissions reductions and resource efficiency within school clusters of primary and secondary schools from the Dumfries and Galloway region.

The year-long project included capacity building training sessions for the local teachers to gain the skills needed to teach climate change within their school curriculum. Many workshops were also delivered by Crichton Carbon Centre staff members to increase the pupils' awareness of the:

- causes of climate change, including from human sources (e.g., food and energy production / consumption, transport, and waste)
- consequences and impacts of climate change on people and biodiversity at the local and global level in both the short and long term
- ways to mitigate their climate impacts, in particular by reducing their carbon footprint through behaviour change and resource-saving devices.

These principles were then continually integrated into the schools' curricula throughout primary and secondary levels. Each school, and the wider community through the pupils' take-home messages in "Home Packs", was encouraged to act towards reducing its carbon footprint, ultimately changing and adapting the school ethos and practice to become more sustainable. The schools were supported in creating an individualised Carbon Management Action Plan, sharing information and best practices, and implementing practical actions, both within and between the clusters. Practical actions included planting trees and crops, behaviour change (e.g., turning off electronic devices when not in use, saving water), and recycling or reusing waste. Additionally, energy- and water-saving devices were installed in all of the schools. Finally, trees and food crops (seasonal, fast-yielding crops, e.g., courgettes, raspberries, strawberries, herbs, rhubarb, leeks) were planted at some of the participating schools in order to improve the local environment and habitats.

Project objectives and drivers

Objectives: the objective of the Carbon Buster Clusters project was to provide a cohesive environmental education programme that bridges the transition from primary to secondary education, and to demonstrate and promote a greener lifestyle at an individual, local, and regional level. Specifically, the project aimed to encourage the school cluster community (a secondary school and its associated community of primary schools) to work together to reduce their carbon emissions and improve their resource efficiency with the assistance of the Crichton Carbon Centre.

Drivers: The Crichton Carbon Centre carried out research in 2011, through telephone and online surveys targeting teachers, to establish what type of environmental education was happening in the regional schools, and to identify any gaps and improvements which could be made. The results showed that a lack of continuity existed in environmental education in the transition years from primary to secondary education, and the enthusiasm engendered amongst primary school pupils did not continue into secondary level. It also revealed that many teaching staff did not feel confident in teaching the subject of climate change to pupils due to lack of knowledge and training. This finding and subsequent feedback from schools directly led to the design of the Carbon Buster Clusters project.

Links to local development strategy

The Dumfries and Galloway LAG's local development strategy established that local LEADER projects should "Demonstrate and promote a greener lifestyle". Thus, the Carbon Buster Clusters project aligns with this priority, having been designed to complement and strengthen a number of other programmes, initiatives and strategies relating to sustainable development education in schools. These include the:

- Curriculum for Excellence, implemented in Scotland since 2010
- Learning for Sustainability Scotland (LfSS), which recognises Scotland as a UN University's Regional Centre of Expertise (RCE) in Education for Sustainable Development
- Scottish Government's 2010 plan 'Learning for Change'
- World Wildlife Fund concept of 'One Planet Schools', adopted by the Scottish Government in their 2011 manifesto
- Eco-Schools and Forestry Schools (funded by the Scottish Government under the Keep Scotland Beautiful initiative and the Forestry Commission)
- Local Authority's carbon reduction policy
- Scottish Government's carbon reduction targets for 2020 and 2050.

LEADER funding

Table 1 Sources of funding for the Carbon Buster Clusters project

Funder	Amount
Dumfries and Galloway LAG (50 %)	£17,459.87
Robertson Trust (24 %)	£8,500.00
Crichton Carbon Centre (26 %)	£8,959.87 (£1,069.14 provided in-kind)
Total project costs	**£34,919.74** [approx. 44,100.00 EUR]

Project outputs

Carbon Buster Clusters targeted awareness raising and capacity building on climate change through multiple activities within the regional schools. These various activities were aimed at impacting as many target beneficiaries as possible. Table 2 details the Beneficiaries and Outputs achieved throughout the project.

Table 2 Project outputs and beneficiaries

Activity	Number of activities	Number of beneficiaries
Climate change pupil workshop	99 workshops	564 pupils
Climate change teacher training	7 training sessions	56 teaching staff
Cluster review meetings post-workshop to gain teacher feedback on delivery	3 review meetings (1 per participating cluster)	All workshop participants due to fine-tuning of delivery
Carbon Management Action Plans developed	19 schools	620 people, plus the wider communities
Energy-saving devices installed	5 devices per school (19 schools)	620 people, plus the wider communities
Water-saving devices installed	5 devices per school (19 schools)	620 people, plus the wider communities
Trees planted	Approx. 3 per school	620 people, plus the wider communities
Food crops planted in school gardens	5 crops per school	620 people, plus the wider communities
Exploratory meetings with schools	3 clusters – 24 schools (eventually 19 school administrations agreed)	620 people, plus the wider communities
Development of lesson plans and a programme of activity	19 schools	All workshop participants and teachers

Benefits resulting from the project

The Carbon Buster Clusters project, in aiming to reduce carbon emissions from local schools, produced mitigation benefits in addition to adaptation, other environmental, social, economic, and cultural heritage benefits. Table 3 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3 Benefits and impacts of the project

Theme	Benefits	Quantitative results	Project impact
Mitigation	Energy savings in electricity	19,000 kwh/yr (1,000 kwh/yr per school engaged)	Medium
	Avoided / Saved GHG emissions in tonnes CO_2 equivalent	114 tCO_2e (6 tCO_2e/yr per school engaged)	Medium
Adaptation	Increased awareness of adaptation needs	620 people	High

Theme	Benefits	Quantitative results	Project impact
	Increased awareness of adaptation options	620 people	High
Other environmental benefits	Maintenance of habitats	100 m^2	Medium
	Reduced water consumption	19 m^3 (1 m^3 per school engaged)	Medium
	Follow-up initiatives	19 (1 initiative per school engaged)	High
Social	Increased community cooperation	3 communities	High
	Improved environmental awareness	620 people	High
	Capacity building	620 people, 19 schools, 106 workshop and training sessions	High
Economic	Jobs created	1	Medium
Cultural heritage	Number of people benefiting from enhanced wildlife, landscape, visual amenity	300 people	Medium

Mitigation: The quantitative measures for the mitigation benefits achieved by the project were estimated based on the behaviour change adopted by the schools to save energy / improve resource efficiency and installation of energy-saving devices in the school buildings as part of their Carbon Management Action Plan.

Adaptation: Participants of the project, totalling 620 pupils and teaching staff, were made aware of climate change adaptation needs and options in a global and national context through the workshops and training sessions. Additionally, adaptation elements were incorporated into the Carbon Management Action Plans (e.g., selection of the type of crops most suited to the climate in the schools gardens).

Other environmental benefits: Planting of trees and food crops was carried out within the grounds of some of the schools that participated in the project, improving the quality of habitat/landscape on the school grounds. The quantitative measurement in the reduction of water consumption was estimated based on the behaviour change adopted by the schools to reduce water use and installation of water conservation devices, such as *water hippos*, in the school buildings as part of their Carbon Management Action Plans. Additionally, all the schools that participated in the project were given resources and information to continue with climate change and sustainable development education, allowing follow-up initiatives to take place once the course of workshops was delivered by the project.

Social: Schools from three cluster communities were supported in sharing information, best practices, and implementation of practical actions, both within and between the clusters, which increased cooperation between the communities. A total of 106 workshops and training sessions were provided through the project, which helped to build capacity and improve environmental awareness for 620 people across 19 schools.

Economic: A full-time job for a Schools Project Officer was created as part of the project.

Cultural heritage: Improved quality of habitat contributed to the availability of benefits and enjoyment of the local inhabitants from enhanced wildlife and landscape.

Actors

The Carbon Buster Clusters project involved coordination with many different actors in order to implement the number of workshops and trainings conducted throughout the project. Table 4 details the actors involved in planning, coordinating, and delivering the project.

Table 4 Actors involved in the Carbon Buster Clusters project

Actor	Role in the project
Schools	Implementation of Carbon Management Action Plans and joint coordination of workshops for teachers and pupils
Orchard and Wild Harvest Project	Implementation of planting trees and food crops with schools
Local expert on sustainable development and outdoor education	Advice on the creation and implementation of Carbon Management Action Plans
Eco-schools	Information provision on eco-schools assessment criteria to support the schools in achieving the green-flag award
Crichton Carbon Centre	▪ Coordination of the project ▪ Design of the workshop materials and curriculum ▪ Delivery of the trainings and workshops ▪ Marketing and recruitment of participating schools ▪ Meetings with teachers and partners ▪ External project fundraising

Success factors and barriers

Various factors were identified which contributed to the overall success of the project.

Good relationship with project participants – the Crichton Carbon Centre found that the exploratory meeting held at the beginning of the school engagement was a useful time to learn about the individual school and to find out what their motivations were for participating in the project. By taking the extra time to learn what the school was already doing within their curriculum, how they could benefit from external input, and understanding the key ethos of the school, a more comprehensive set of workshops were able to be designed and delivered. Combined with the frequent communication between the project team and the school staff, it increased the chances of the school successfully completing the workshops course. By providing the staff with training and resources, the likelihood that they would continue to teach the subject and implement the Carbon Management Action Plan in the coming years was also improved.

Flexible engagement and planning – the project required careful planning with the Head and key teachers to incorporate the set of workshops delivered by the Crichton Carbon Centre into the school timetable. Individual lesson plans and a programme of activities had to be worked out on a case-by-case basis rather than through one-size-fits-all lessons in order to accommodate the individual school and pupils' requirements, as well as to suit the varying class sizes and the audience age groups. Additionally, the design attempted to ensure as many aspects of the Curriculum for Excellence, to which Scottish curricula are aligned, were covered as feasible. This flexible engagement and delivery structure proved extremely important for the success of the project since the additional project material fit with the curriculum already being delivered at the schools and was well received by the staff and pupils. This alignment also provided clear guidance as to the schools' expectations and outcomes from the workshops.

School commitment – as part of the project, each school was asked to identify a key teacher(s) who would organise and lead the project, including implementation of the energy-saving devices and methods for each individual school. This proved a great success, as by assigning key personnel with direct responsibility, accounts, and contact points within the Crichton Carbon Centre, those individual teachers were more likely to implement activities and be directly accountable for the outcomes. The key teacher(s) at each school was offered additional training and material on top of the general teacher training session, which provided them with the required skills to manage and monitor the schools' actions in reducing their carbon footprint.

In the feedback provided by the staff at review meetings, many noted that they had found it extremely useful to have an awareness raising and skills session, as well as being supported externally from the Crichton Carbon Centre in the sustainable development education provided to the school. This highlights the importance of engaging with the staff and was a definite key success factor of the project.

Barriers were also encountered when implementing Carbon Buster Clusters. Table 5 below outlines the barriers which were encountered and the solutions which helped the project overcome them.

Table 5 Barriers to the Carbon Buster Clusters project and solutions

Barrier	Solution
School timetable – some schools struggled to find a suitable timeframe to carry out more than one pupil workshop session due to time pressure and commitment to other activities already scheduled prior to engagement with the Carbon Buster Clusters project.	Early recruitment at the beginning of the school year was essential in order to ensure suitable time slots were scheduled for the workshop delivery, as well as a flexible approach in the number of sessions made available to the schools by the project.

Barrier	Solution
Pupils' disabilities or individual differences in learning styles.	Each cluster school was contacted before the workshop and asked if there are any children with learning difficulties / disabilities; and if so, what they were. An understanding of the pupil's specific difficulties and how they may affect the pupil's classroom performance enabled the Schools Project Officer to adapt teaching methods and strategies to help the learner be successfully integrated into the classroom environment. Research was undertaken into those disabilities identified and the lessons and activities modified, if necessary, to remove any barriers. Generally, all material followed the Royal National Institute of Blind People (RNIB) clear print guidelines to ensure that any printed and electronic materials adhered to the Disability and Discrimination Act (2005).

An important lesson learnt during the Carbon Buster Clusters project was based on feedback from the school staff early in the project. They noted that more hands-on activities for the pupils in the workshop delivered by the Crichton Carbon Centre would benefit the project. Within the timeframe of a single classroom period, which is typically between 1 to 1.5 hours, and with a relatively large amount of information to be taught in each session, it was hard to strike a balance between information transfer for learning and activities for knowledge application. However, upon gaining more experience through implementation, the project team was able to adjust and amend the workshop material as the project progressed and a good balance was found between the interactive presentations and the hands-on activities in each of the sessions provided. These refinements of the project activities also received ongoing support through feedback from the teachers as the project progressed.

Project as an initiator of future activities in the region

The Carbon Buster Clusters project Phase 2 was launched in January 2014 and continues through September 2014. It is managed again by the Crichton Carbon Centre, and is being funded by the Dumfries and Galloway LAG, the Robertson Trust, Barfil Charitable Trust, Heritage Lottery Fund, and the Crichton Carbon Centre. In its second phase, the project focuses on involving more school clusters in the region to provide a transitional environmental education programme with hands-on activities and improved opportunities for pupils to learn about climate change in a real world context.

Schools that were engaged in the project will also continue to deliver climate change education, utilising the learning resources and teaching skills provided by the project, and they will continue to reduce their school emissions through the energy-saving devices.

Cheviot Futures – United in a Changing Rural Landscape

Project Background

Cheviot Futures is a joint project supported by LEADER through the Scottish Borders local action group (Scotland) and the Northumberland Uplands local action group (England). Focusing on the Cheviot Hills and the Northern catchments ((Till, Glen, Bowmont, Breamish, Wooler Water and the Teviot catchment), the project includes awareness raising, adaptation- and sustainability-focused land management strategies, best practice support, and diversification and building resilience of rural businesses.

Basic information and contact

Project duration: February 2009 until February 2012

Thematic area: Capacity Building

Country: UK

Project Coordinator: Ms. Jennifer Hewitson

Email Address: jennifer.hewitson@nnpa.org.uk

Phone: +44 (0) 1669 622071

Website: www.cheviotfutures.co.uk

Two phases of the project resulted in different activities implemented within the project area. Phase 1 involved establishment of activities within the Northumberland Uplands LAG area, such as soil erosion wind breaks, sustainable bridge restoration, and the design of a strategically located wildfire water resource. Phase 2 of the project expanded practical actions into the Scottish Borders LAG area as well, resulting in transnational cooperative actions that focused on trials of climate adaptation strategies for land managers as well as knowledge and information sharing within the local sector. Table 1 below shows some example activities which were undertaken to respond directly to various climate threats and build resilience within the project area.

Table 1 Adaptation actions implemented to build resilience to various climate threats

<table>
<tr><th>Climate threat addressed</th><th>Description of the threat in the area</th><th>Project activities implemented</th></tr>
<tr><td>Wildfire</td><td>Increased risk of wildfire as a result of reduced summer rainfall and increased temperatures</td><td>▪ Breamish Valley wildfire water resource (fire pond)
▪ Wildfire management in partnership with the Northumberland Fire Group
▪ Automatic wildfire detection system</td></tr>
<tr><td rowspan="3">Flood Risk and Associated Management Issues</td><td>Increased flood risk as a result of more extreme weather events and/or increased winter rainfall</td><td>▪ Netherton natural flood management approach to intercepting high flows and surface runoff. Development of a series of features – grassed swale, ditch bund, floodplain storage, farm pond and sediment traps
▪ Bowmont Valley engineered log jams (ELJ) as part of a catchment scale approach to natural flood management: bar apex floodplain ELJs, bank protection ELJs, grade control ELJs
▪ Re-meandering works as part of the Eddleston water project
▪ Upland cleugh/gully planting, large woody debris features, transverse hedge planting
▪ Sustainable riparian management (floodplain specification fencing, riparian planting, replacement water supply)</td></tr>
<tr><td>Flood risk associated with surface water management</td><td>▪ Trialling of flood protection products – agricultural ‘flood snake’ on farms</td></tr>
<tr><td>Increased incidence of riverbank erosion as a result of more extreme weather and/or increased winter rainfall</td><td>▪ Ingram Riverside timber croys and tree planting
▪ Glendale Showfield – riparian planting works and woody debris measures
▪ Riverbank erosion protection works demonstration site – trialling and comparison of multiple techniques
▪ College Burn sustainable erosion protection works (in partnership with EA)
▪ Strategic native hedgerow planting for bank stabilisation
▪ Sustainable methods of protecting bridge abutments from erosion</td></tr>
</table>

Climate threat addressed	Description of the threat in the area	Project activities implemented
Resource Destruction/ Depletion	Increased winter rainfall and associated surface water management and diffuse pollution risk issues	▪ Ground reinforcement mesh trials to reduce poaching around supplementary feeding sites ▪ Grassland management – demonstration and advisory events and development of equipment availability. Specific reference to value of management techniques, e.g., aeration and sward lifting to alleviate compaction ▪ Filtrexx compost-based filtration system for reducing nutrient load from yard water
	Extreme weather events	▪ Strategic hedgerow planting for shade/shelter/windbreak ▪ Strategic native planting as windbreak feature to alleviate soil losses by wind erosion ▪ Beetle banks and tall grass strips to provide low-level protection and targeted tree and scrub planting along exposed boundaries ▪ Weather station and satellite broadband installation as early warning system for extreme weather events
Alternative Water Supplies	Reduced summer rainfall, increased temperatures and extreme drought conditions	▪ Trailer-mounted portable solar-powered (alternative) water supply ▪ Dual PAPA pump system and pasture pump supply ▪ Mains-connected trough supply
Water Provision for Irrigation	Reduced summer rainfall, increased temperatures and extreme drought conditions	▪ Water quality monitoring works in support of winter water storage reservoir proposals for securing irrigation supplies ▪ Grassland irrigation potential using the innovative Kline system - demonstration event venue
Other	Changes in pest and disease pressure as a result of combined effects of climatic changes	▪ Heliosec demonstration site – alternative to biobed/biofilter approach to managing sprayer washings, etc. ▪ Research collation undertaken by the Scottish Agricultural College (SAC) on behalf of Cheviot Futures
	Large-scale management changes	▪ Global positioning satellite (GPS) tracking of livestock using remote data collection on collars to assess behaviour of newly introduced livestock in an upland situation ▪ Resilient cropping research collation undertaken by SAC on behalf of Cheviot Futures ▪ Farm Resilience Plans

Project objectives and drivers

Objectives: As stated in the project application for the second phase, the aim of the project is to "*support the development of long term resilience measures for the environment, economy and local community against the impacts of a changing climate. The approach will reflect the needs of land managers and ensure the emphasis continues to be on practical solutions to real problems. The project aims to demonstrate benefits that will encourage other land managers to invest in adaptation measures because their value is proven*."

Drivers: The project was initiated by the Environment Agency in 2007 in order to model the impacts of climate change within the project area and explore options for land managers to adapt. Local flooding in 2008 had devastating impacts and increased the urgency for action.

Links to local development strategy

Cheviot Futures, as a cross-border project, is aligned with both the Scottish Borders LAG's local development strategy (LDS) and the Northumberland Uplands LAG's LDS. It contributes to four LDS objectives in particular: Innovation, Economic Growth, Social Cohesion and Protection of the Environment.

- Innovation: As part of the ethos of the project, Cheviot Futures aims to trial innovative projects in order to enhance learning for land managers, rural businesses, project partners, agencies and policy makers. Knowledge transfer is accomplished in order to put research into action.
- Economic Growth: Cheviot Futures was designed to build resilience for rural businesses in order to avoid damages from climate change. For instance, the extreme flooding in 2008 was predicted to have caused a total loss of 1.5 million GBP in the local farming sector and at least 500,000 GBP in damaged infrastructure. Additionally, the project has attracted investment in the area and local business opportunities have improved and expanded. Land managers were also encouraged to think about ways they could take advantage of any possible opportunities arising due to climate change.
- Social Cohesion: Rural livelihoods and traditions are often dependent on the land, so the negative impacts from climate change can greatly affect the social fabric. The project aimed to build resilience for people and communities living in vulnerable areas and allow them to adapt their way of life to a changing climate.
- Protection of the Environment: Cheviot Futures aimed to provide multiple benefits to the local area through various capital works.

LEADER funding

Table 2 Sources of funding throughout different project phases

	Funder	Amount
Phase 1	Northumberland Uplands LAG	£45,000
	Environment Agency Local Levy Fund	£45,000
	Phase 1 Total costs	**£90,000** [approx. 113,800 EUR]
Phase 2	Northumberland Uplands LAG	£82,375
	Scottish Borders LAG	£112,625

	Funder	Amount
	Environment Agency Local Levy Fund	£80,000
	Tweed Forum	£85,500
	Scottish Environment Protection Agency	£30,000
	Scottish Borders Council	£30,000
	Phase 2 Total costs	**£420,500** [approx. 531,800 EUR]
Phase 2a	Northumberland Uplands LAG	£12,982
	Northumberland National Park Authority	£12,472
	Phase 2a Total costs	**£25,454** [approx. 32,200 EUR]

Project outputs

Cheviot Futures produced a number of different outputs, often with the actual number of beneficiaries exceeding the target (e.g., the number of males aged 25 and over benefiting from the project was 10 times the target number). Table 3 details the Beneficiaries and Outputs achieved throughout the different phases of the project.

Table 3 Project outputs and beneficiaries

Phase 1 (Northumberland Uplands area)	Beneficiaries	**Phase 2** (Northumberland Uplands and Scottish Borders areas)	Beneficiaries	**Phase 2a** (Project Coordinator role extended to March 2014)	Beneficiaries
Micro-businesses supported	6	Males age 25 and over; Females age 25 and over; Young people (aged 14-25)	466 194 156	Jobs safeguarded	0.5
Businesses using bio-energy	1	Micro-Businesses	135	Individuals benefitting	42
Jobs safeguarded	2	Jobs created	1		
Young people benefitting from advice and training	500	Training courses delivered	12		
		Transnational projects	1		
		Environment-focused projects (i.e., physical resilience schemes established on the ground)	28		
		Awareness raising events	50		
		Publications produced	18		

Benefits resulting from the project

Cheviot Futures not only resulted in qualitative and quantitative adaptation benefits, but it also produced multiple mitigation, other environmental, social, economic, and cultural heritage benefits. Table 4 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 4 Benefits and impacts of the project

Theme	Benefits	Quantitative results	Project impact
Adaptation	Farm resilience plans	21 farms	High
	Improved water retention at catchment level (Bowmont Catchment (numerous farms) and Elilaw Catchment (which has attracted additional funding to work on other local farms))	2 large flood alleviation projects. Research is being carried out on these projects so that further information will be available in the future.	High
	Improved water quality (e.g., reduced runoff and sediment loading, better filtration from tree planting)	Improved water quality has been an element of many projects completed through Cheviot Futures – a positive of the multi-benefit approach. One specific example of a water quality project is where an innovative material was also trialled as part of a filtration system on one farm.	High
	Reduced vulnerability and increased resilience	21 farms	High
	Increased awareness of adaptation needs and options	21 farms	High
	Wildfire prevention and resource protection	2.5 m deep in the main part of the pond – 100 m x 70 m (although not a uniform shape)	Medium [1]
	Increased awareness and options for combating pests and diseases		Medium
	Improved water utilisation through alternative sources		Medium
Mitigation	Increased carbon sequestration and fewer GHG emissions through tree planting and better landscape management	41 ha of direct tree planting	Medium

[1] However, this will be very high if a wildfire event occurs.

Theme	Benefits	Quantitative results	Project impact
Other environmental benefits	Increased farmland biodiversity	37 ha of floodplain areas under sustainable management and 100+ ha of riparian habitat improved – which will have a positive impact upon biodiversity	High
	Improvements in soil fertility, incl. grassland management and soil aeration	Demonstrated to 70+ farmers	Medium
	Reduced loss of soil through strategic native planting projects to prevent erosion		High
	Creation of new habitats	32.5 ha of BAP habitat created 41 ha of tree planting	High
	Maintenance of habitats	37 ha of floodplain areas under sustainable management and 100+ ha of riparian habitat improved	High
	Increased connectivity of habitats	See above	High
	Improved air quality		Low
Social	Increased community cooperation, incl. farmers, farmers groups, businesses, and even the project structure (joint action between two LAGs)	See beneficiaries table	Medium
	Improved environmental awareness and capacity building through awareness raising, demonstration events, etc.	See beneficiaries table	High
	Improved quality of life	See beneficiaries table	Medium
Economic	Jobs created	1.5	Medium
	Jobs diversified	3	Medium
	Value of damage avoided from climate change, flooding, or other natural hazards through resilience building	Approximately £2 million in damages from one flooding event, so resilience building can eliminate huge losses. A wildfire of 350 ha costs approximately £210,000 to fight.	High

Theme	Benefits	Quantitative results	Project impact
Cultural heritage	Increase in traditional practices, such as willow spiling, log piling on riverbanks, and riparian tree planting for riverbank control and erosion prevention		Medium
	People benefitting from enhanced wildlife, landscape, visual amenity		Medium

Actors

Members of Cheviot Futures' core group were the Northumberland National Park Authority, Tweed Forum, and Environment Agency. Additional actors composed the project steering group, which was fundamental in securing the continuation of Cheviot Futures through LEADER and other sources.

- Scottish Environment Protection Agency
- Natural England
- Various farmers and landowners
- Catchment Sensitive Farming
- Tyne Rivers Trust
- Forestry Commission
- Northumberland Community Flooding Partnership
- Newcastle University
- Northumberland County Council
- Scottish Borders Council
- Scottish Natural Heritage
- National Trust
- Northumberland Wildlife Trust
- Northumberland Fire Group
- ClimateNE

Success factors and barriers

Various factors were identified which contributed to the overall success of the project.

- Having dedicated project staff with knowledge and skills within the scope of the project's objectives was crucial to attain forward progress and engage local stakeholders.
- A cross-border steering group was established, which helped foster exchange of lessons learnt between the countries, their respective policy frameworks, and farming communities.
- Maintaining a positive and flexible approach to projects under Cheviot Futures allowed innovative projects to be implemented and trialled (i.e., opportunities and solutions were looked for rather than problems).
- Covering a broad scope of climate change predictions and adaptation actions maintained interest in the project since it was at the forefront of various areas of climate change.
- Cheviot Futures employed a bottom-up approach, including listening to land managers' problems and needs and helping them develop projects to address specific situations.

Barriers were also encountered when implementing Cheviot Futures.

- Administration linked to a transnational cooperation project. As a cross-border project, two sets of rules and regulations, claim forms, and procurement procedures applied. Simplifying this process could encourage more cooperation projects.
- Top-level LEADER rules requiring three quotes for procurement of all items purchased could potentially stifle innovation (e.g., only one option may be available for an innovative idea).
- Scepticism of land managers regarding climate change required dedicated staff to communicate messages in a way which was relevant, understandable, and encouraged action, e.g., "extreme weather events" rather than "climate change". Listening to different viewpoints from farmers and fully engaging them and their ideas in the project was essential to overcome resistance.
- Climate change and its impacts are long-term issues, but Cheviot Futures is a short-term project. Thus, working with land managers to implement actions that might have longer-term benefits but not demonstrate any immediate results, or perhaps incur costs, is a challenge.
- Innovative projects can often take time to implement and provide results, and problems may occur along the way. Project planning should anticipate these issues and be flexible – as should funders.
- Projects may encounter regulatory challenges that effectively eliminate implementation, such as licensing requirements for winter storage reservoirs under Cheviot Futures. The scale of the individual project and capacity of the implementing actors can significantly vary in terms of meeting regulatory requirements.
- Acquiring future funding to carry on with the project activities and develop further initiatives.

Project as an initiator of future activities in the region

Cheviot Futures has initiated many different climate-related projects beyond the scope of the project.

- The organisation Natural England has implemented the farm resilient planning process further afield.
- Under the RDP agri-environment measure, flood specification fencing is being considered for future capital works.
- Additional funding has been secured to implement more natural flood management works in Northumberland.
- The James Hutton Institute will continue monitoring the catchment scale approach to natural flood management in the Scottish Borders.
- The Northumberland National Park Authority has purchased an innovative solar trailer as an alternative watering unit, which it will test on farms along Hadrian's Wall.
- Many wildfire projects and demonstrations will take place in the future.
- Cheviot Futures has been used as a case study for best practice cooperation projects.

CO_2 RECYCLING – Climate Protection through Soil, Humus, and Habitat Management

Project Background

CO_2 Recycling was a transnational LEADER project implemented within eight communities of the Südkärnten region of Austria and Italy. The project was focused on closing the local carbon cycle and creating a regional circular economy by planning and coordinating green waste collection between the communities for composting on local farms and land application to increase humus levels in the soil. Humus allows for carbon sequestration, benefiting the climate by providing a carbon sink as well as increasing soil quality and fertility. The project also involved awareness raising, nature protection and biodiversity enhancement, habitat management, youth engagement, and creating job opportunities within the local economy.

The project activities included three main elements:

Basic information and contact

Project duration: February 2012 – January 2014

Thematic area: Renewable Energy-Agricultural waste

Country: Austria

Project Coordinator: Mr. Peter Plaimer

Email Address: peter.plaimer@lag-uk.at

Phone: +43 664 5026257

Website: http://www.rm-kaernten.at/lag-unterkaernten/projekte/

- A feasibility study conducted by a local research institute to determine how green waste could be collected from the various communities and delivered to cooperating farmers
- Creation of a pilot plot for demonstration of humus accumulation with a local agricultural school
- Workshops for local farmers to raise awareness about humus benefits and to determine their level of interest in cooperating with the project to produce humus on their cropland.

Additionally, the project secured farmers' cooperation to allow for traditional willow trees to be planted, hedges to be restored, and a previously drained moor to be re-flooded on their farmland within the region. This initial phase of planning and coordination provided the necessary information to design a structure for the biowaste recycling project to continue, but the structure and future activities are awaiting administrative approval at the municipal government level.

Project objectives and drivers

Objectives: The overall objective was to combat climate change and to foster climate adaptation through an integrated approach considering agriculture, waste management and nature conversation.

The main targets were:

- Closing the regional carbon cycle by enhancing biowaste management and humus accumulation on cropland
- Management of wetlands as carbon sinks and hot spots of biodiversity

- Raising public awareness for different target groups on these issues
- Providing job opportunities deriving from local resources (composting biowaste).

Drivers: The region Südkärnten is a member of the "Alliance in the Alps", a cross-border association of alpine municipalities promoting sustainable development in line with the Alpine Convention. Since 2010, the region has also been part of the programme for Energy and Climate Model Regions established by the Austrian government.

At a lower district level, small regions create regional development strategies which are then linked to the local action group's (LAG) local development strategy. The Südkärnten regional development strategy established that carbon sinks and soil protection was a major concern and should be a focus during the following years due to the intensive local agricultural activities. The eight municipalities are situated in the Klagenfurt basin where agriculture was dominated by maize production. Due to intensive cultivation methods, the percentage of humus in the cropland soils was very low. In addition, the waste management for biowaste in the region was poor. Most of the green waste was burned together with other waste in a waste incineration plant located 100 km away in Arnoldstein. The strategy identified this as a key loss in the local carbon cycle.

Links to local development strategy

The project is linked with the regional and the LAG's local development strategies mainly in the fields of agriculture and landscape. The specific issues which it engages with are the use of biomass, encouraging renewable energies, public awareness for nature protection, and protection of natural landscapes.

There are three district-level members of the smaller regional association "Regionalentwicklung Südkärnten". The executive board of the association and also the board of the LAG discuss each project application and evaluate the added value with regards to the regional development strategy.

LEADER funding

Table 1 Sources of funding for the CO_2 Recycling project

Funder	Amount
ELER Funds	14,607.00 EUR
Bundesmittel BMLFUW (National funds)	9,235.80 EUR
Landesmittel Kärnten (Regional funds)	6,157.20 EUR
Total project costs	**30,000.00 EUR**

Project outputs

CO_2 Recycling resulted in a number of outputs which directly benefited over 150 people from the region, in addition to providing indirect benefits to the wider population. Table 2 details the Beneficiaries and Outputs achieved throughout the project.

Table 2 Project outputs and beneficiaries

Activity	Number of Activities	Number of beneficiaries
Feasibility study and concept on biowaste management	1	8 municipalities
Pilot plot for humus accumulation managed by the local agricultural school	1	Pupils and teachers of the school
Humus accumulation workshops for local farmers at the agricultural school	2	About 70 local farmers
Habitat management measures relevant to climate issues in wetlands and agriculture land	6	6 farmers
Workshops in secondary schools: Soil Protection is Climate Protection	3	About 70 pupils
Brochure about the project	1	

Benefits resulting from the project

CO_2 Recycling resulted in a number of varying benefits, including mitigation, adaptation, other environmental, social, and expected economic benefits. Table 3 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3 Benefits and impacts of the project

	Benefits	Quantitative results	Project impact
Mitigation	Volume of carbon stored/ sequestered in tonnes CO2 equivalents	8 tonnes CO2-eq (carbon storage due to accumulated humus in the pilot plot)	Low
Adaptation	Water retention and reduced flood risk from humus accumulation	Pilot project too small to determine	Low
Other environmental benefits	Increased farmland biodiversity	4.5 ha	Low
	Creation of new habitats (see text below table)	4.5 ha	Low
	Follow-up initiatives: ▪ co-operation with the school of agriculture (humus-friendly cultivation) for additional 5 years ▪ planting traditional willow trees (Kopfweiden) on one farmer's private farmland	1 ha	Medium

	Benefits	Quantitative results	Project impact
Social	Increased community cooperation	Including farmers, environmentalists, and waste management association	Medium
	Improved environmental awareness	70 pupils	High
	Capacity building	70 farmers	High
Economic	Jobs created	Possible in the future if the administrative approval is secured – the initial planning phase was to design the regional biowaste composting scheme, whereas the implementation phase could create employment opportunities to carry out the scheme	

The following habitat measures were carried out:

- re-establishment of open zones (without bushes) in moors
- transformation of cropland into extensively used grassland
- planting hedges in a cropland area
- establishing a natural pond in a cropland area which originally had been a moor

Actors

Many actors from the Südkärnten region were involved in the CO_2 Recycling project. Table 4 outlines the various actors and their roles in developing or implementing the project.

Table 4 Actors in the CO_2 Recycling project and their roles

Actor	Role in the project
Association of organic farmers	▪ Expertise in humus accumulation techniques on cropland ▪ Organisation of workshops to demonstrate humus accumulation
Agricultural school Goldbrunnhof	Implementation of the humus accumulation measures on the pilot plot
Association for nature conservation in Carinthia (Arge Naturschutz)	Expertise for habitat management measures
Waste management association (Völkermarkt / St. Veit)	Expertise for waste management in the region
Secondary schools in Eberndorf and Bleiburg	3 classes participated in the workshop "Soil Protection is Climate Protection"

Success factors and barriers

The CO_2 Recycling project's successful implementation can be attributed to a number of factors. The project fit extremely well into the development scheme of the region and the issue was up-to-date. Thus, the project was promoting the right idea at the right time. Most of the local players, such as the teachers at the agricultural school, were highly motivated. Also, most of the involved networks worked well. For example, the organic farming association (Bio Austria) was able to motivate a lot of farmers to join the workshops on humus accumulation. Finally, cooperation with a private planning office for the design of the biowaste management scheme was crucial.

Barriers were also encountered when implementing the CO_2 Recycling project. Table 5 below outlines the various problems and solutions devised to overcome them.

Table 5 Barriers to the CO_2 Recycling project and solutions

Barrier	Solution
Important institutions, like the department for EU subsidies in Carinthia, were skeptical about the integrated approach of the project and the idea of humus accumulation	After several meetings, the project developer was able to convince the agency
The change of the system of fees for households' waste is a pre-condition to implementation of a successful biowaste collecting and composting system. The willingness of the politicians of the region to change the system is limited.	This obstacle has not been overcome yet. But two municipalities will start a step-by-step process. First step will be the collection and composting of green waste from gardens.

Through implementation of the CO_2 Recycling project, a number of lessons learnt emerged.

- Integration of schools was relevant to further the objectives of the project
- Motivating teachers is important
- Increasing public awareness is complex
- Waste management and controlling must be better organised
- Public responsibility in the environmental field is still low.

Project as an initiator of future activities in the region

The CO_2 Recycling project has initiated activities within the Südkärnten region, which it will continue to foster as well as create new activities.

- Increase the Climate- and Energy-Model region (to include all 13 municipalities of the district)
- Realise a decentralised green waste management system
- Support the management of protected areas
- Continue cooperation with educational institutions.

Creating CSmart Organisations

Project Background

Basic information and contact
Project duration: April 2009-April 2011
Thematic area: Capacity Building
Country: UK
Project Coordinator: Mr. Mark McKenna
Email Address: info@carboncentre.org
Phone: +44(0)1387 702 091
Website: www.carboncentre.org

The Creating CSmart Organisations project was launched in April 2009 by the Crichton Carbon Centre (CCC) and concluded two years later. It was funded by the Dumfries and Galloway Local Action Group (LAG) LEADER Programme and the Crichton Carbon Centre. The project promoted carbon emissions reductions from local rural businesses in the Dumfries and Galloway region.

In aiming to create 'carbon smart' organisations, the project included an interactive innovative process aimed at influencing a change in the businesses' culture to become carbon conscious. Throughout the course of the project, 24 rural small- and medium-sized enterprises (SMEs), social enterprises and public organisations were provided guidance over a 4-6 month period – termed the "carbon journey". A carbon management policy was developed to establish the commitment to reduce carbon emissions within the organisation and to guide behaviour. This was followed by a set of awareness raising activities amongst the staff and volunteers aimed to get everyone involved and invested in the organisation's carbon journey. Specifically, a Carbon Champion was selected for each organisation in order to have one person responsible for coordinating with the CCC and continuing to drive carbon emissions reductions within their organisation. Each organisation conducted a carbon footprint assessment to measure their carbon emissions and have a basis from which to make reductions. Steps to accomplish this were discussed during the 90-minute 'Carbon Opportunities Workshops' held for each organisation' staff members to gain an understanding of carbon emissions and various ways to improve them and to contribute suggestions to a carbon management action plan. Implementation and monitoring of each organisation's sustainability efforts took place over the following 6 months with assistance from a CCC project officer.

Project objectives and drivers

Objectives: The main objective of the CSmart project was to engage rural organisations in carbon smart behaviour that would result in the participants becoming more resource efficient. This objective would be achieved by providing each organisation with the training and skills needed to measure their carbon footprint along with the skills needed to identify and plan actions which could reduce their emissions.

Drivers: The main driver behind the project was a desire to reduce carbon emitted from rural organisations and to provide those organisations with the skills they need to continually assess and reduce their carbon footprints. A global reduction in carbon emissions of 3% per annum from all areas of society is needed if we are to avoid a global temperature rise of 4^0C this century.

Links to local development strategy

The project activities tie in with the fifth goal of the Dumfries and Galloway Development Strategy, which is to create a greener Scotland. The CSmart programme gave participants the skills and knowledge needed to create and promote greener lifestyles in the region.

LEADER funding

Table 1 Sources of funding for the Creating CSmart Organisations project

Funder	Amount
LEADER funding	£45,133
Crichton Carbon Centre	£45,133
Total project costs	**£90,266 [approx. 114,200 EUR]**

Project outputs

Creating CSmart Organisations targeted carbon emissions reductions from local rural organisations through a number of different activities to engage all levels and actors within the organisations. Overarching carbon management policies were set in order to provide a framework for the actions of each organisation, as well as employee engagement workshops to directly gain their feedback and ideas as to how the organisation could reduce emissions. Table 2 details the Beneficiaries and Outputs achieved throughout the project.

Table 2 Project outputs and beneficiaries

Activity	Number of activities	Number of beneficiaries
Organisation recruitment via telephone calls	28 contacted	24 organisations
Exploratory meetings	1 per organisation	24 organisations
Carbon Management Policy	1 per organisation	23 organisations
Carbon Champions selected	1 per organisation	24 organisations
Carbon Footprint	1 per organisation	23 organisations
Feasibility studies for renewable energy installations	1 report per organisation	3 organisations
Carbon offsetting	2	1 local tree planting scheme with a number of schools.
Community Events	2	1,700+ members of the public
Carbon Management Course	1 per organisation	16 organisations
Carbon Opportunities Workshop	1 per organisation	16 organisations
Funding Report	1 per organisation	9 organisations
Staff Training	1 per organisation with individual needs addressed	22 organisations

Activity	Number of activities	Number of beneficiaries
Short briefing notes for carbon reduction options	24 notes developed and, depending on client requirements, distributed to participants	24 organisations
Long-term carbon footprinting tool	1 per organisation	8 organisations

The above steps were offered to all participants but were not accessed by all. Clients were also able to access tailored advice which was outside the scope of the steps above. For example, Blackaddie Hotel developed a visitor leaflet in conjunction with the CCC, while Marthrown of Mabie was issued a sustainability assessment of possible accommodation types.

The CCC developed tools, such as carbon and water footprint calculators and survey templates, for each client to use after completion of the programme.

Benefits resulting from the project

The Creating CSmart Organisations project, in aiming to reduce carbon emissions from local rural organisations, produced mitigation benefits in addition to providing other social and economic benefits to the local area. Table 3 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3 Benefits and impacts of the project

	Benefits	Quantitative results	Project impact
Mitigation	Electricity generated from renewable sources (kWh/yr)	284 kWh/yr from solar energy generation 21,667 kWh/yr from proposed hydro scheme	Low
	Energy savings in heat (MJ/yr)	Inadequate information for calculation[2]	High
	Energy savings in electricity (kWh/yr)	48,068 kWh to 96,136 Kwh for the organisations that provided data	High
	Volume of carbon stored/ sequestered in tonnes CO_2 equivalents	Eden festival operates a tree planting scheme with local schools as well as within the festival itself	Low
	Avoided / Saved GHG emissions in tonnes CO_2 equivalents	Conservative estimate of 38 tonnes of CO_2	Medium

[2] Insulation was increased in 8 of the 24 facilities; however, the organisations did not specifically account for how much insulation was added or calculate the increased thermal efficiency of their buildings.

	Benefits	Quantitative results	Project impact
Social	Increased community cooperation	7 community groups committed to prioritising sustainability within their organisation's operations	High
	Improved environmental awareness	Promotion of sustainable behaviours in participant organisations and their surrounding communities, impacting more than 2,000 people	High
	Capacity building (e.g. N° of people or schools involved, N° of trainings)	23 organisations, including 12 voluntary groups/public services, received training, advice and a carbon footprint measurement	High
Economic	Job diversification	Individuals from 24 organisations received sustainability training and became Carbon Champions	
	Rural population benefiting from improved services / infrastructures	Three community initiatives assisted in sustainable planning	Medium

Mitigation: All participants in the programme received advice on how to reduce their energy and water demands. Eight feasibility studies were completed on the adoption of renewable energy for heat and electricity. Additionally, two participants received guidance regarding carbon offsetting their activities. Advice received related to both local offsetting of emissions and the purchase of carbon credits through the voluntary carbon market. Local offsetting was encouraged by project officers as it was felt to be a better option for the local economy. For example, the Eden Festival, following the CSmart programme, instituted a programme of tree planting with local schools.

Although they were unable to put in place a number of the recommendations throughout the duration of the programme, the community groups involved have ambitions to put these recommendations in place once public funding becomes available, thereby reducing emissions from their community in the future.

Social: A network was developed between the Crichton Carbon Centre (CCC), the participants, and other projects such as the Carbon Buster Clusters project, which works within schools, and the Galloway Carbon Action project. This network allowed for the distribution of information and the promotion of a low carbon economy throughout all areas of society.

Staff from each organisation received training on carbon footprinting, making them aware of their organisations' impact on the environment and providing them with the tools to reduce that impact. A number of businesses improved the efficiency of their operation by improving their buildings' quality through increased insulation, draught proofing, etc.

All training and materials were delivered in a way that the information could be disseminated by the participants to clients, other staff members, and general members of the public. Materials were made available through the CCC website and a large number of participants attended staff awareness workshops run by CCC.

Economic: Through the Creating CSmart Organisation project, participants were able to examine their resource use, remain competitive, and protect existing jobs by avoiding waste in their organisations.

One organisation invested its own funds and accessed public funding to develop a proposal for a 4.12 Kw community micro-hydro scheme, which will hopefully provide energy security for the area.

All Carbon Champions appointed through the project witnessed a diversification in their role as they became responsible for driving sustainable changes within the organisation. The roles of these individuals before the programme did not include any sustainability focus, so under CSmart they received training and support to help them fulfil this role.

Actors

The Creating CSmart Organisations project involved coordination with many different actors in order to implement the various activities aimed at reducing the carbon emissions of rural businesses. Table 4 details the actors involved in planning, coordinating, and delivering the project.

Table 4 Actors involved in the Creating CSmart Organisations project

Actor	Role in the project
Social Enterprises (5)	Participants
Hotels and Restaurants (3)	Participants
Public Services (5)	Participants
Food Producers (5)	Participants
Tourism Destinations (7)	Participants
Carbon Buster Clusters project	Networking partner in schools
Galloway Carbon Action project	Networking partners in Dumfries and Galloway
Crichton Carbon Centre	Planning, development, and coordination of the project

Success factors and barriers

The main factors that led to the success of the project were an ability to build good relationships with the clients, a flexible engagement strategy, and getting the organisations' full commitment. The programme was provided at no charge to participants to allow access for both small businesses and community groups.

Good relationships with the clients allowed the CCC assessors to formulate a clear picture of the participant's carbon footprinting and advice requirements, along with building the trust needed for the participants to put the assessor's recommendations into practice.

Through the engagement strategy, each participant received a tailored service that met their needs and contributed to their sustainability goals. The materials and training provided differed depending on the businesses' requirements.

The organisations' commitment was crucial to the success of this programme. Organisations were recruited by CSmart project officers, who explained the possible benefits that would be reaped by becoming more resource efficient. Commitment was secured in the first instance from management and filtered down to all staff/volunteers. Each organisation participating in the scheme reinforced this commitment by developing and incorporating internal policies, which engrained a low carbon culture throughout the organisations' structure.

Barriers were also encountered when implementing the Creating CSmart Organisations project. Table 5 below outlines the barriers which were encountered and the solutions which helped the project overcome them.

Table 5 Barriers to the project and solutions

Barrier	Solution
Data collection for the carbon footprint	Increased assistance from CCC officers
A lack of income to invest in recommended measures	Low / no cost resource efficiency measures were identified for each participant. For resource efficiency improvements that required investment funding, reports were issued to participants, which provided information on the revenue streams available from external sources and subsidies. Recommendations made included payback periods where possible.
Low environmental awareness	Provision of workshops, training, and materials for all volunteers/staff
Time restrictions on the part of the clients	Emphasis on what the project input will be from the participants at the beginning of the project

Important lessons were learnt during the implementation of the project.

- Recruitment – Data collection can result in time pressures for the participants so the time commitment must be laid out at the beginning.
- Data collection – Participants who do not already monitor their utility bills often need a large amount of assistance.
- Involving all levels of staff in carbon reduction activities – Feedback from the workshop showed the importance of involving staff and indicated that this should be a mandatory stage of the project.
- Assisted implementation – Time to dedicate to each organisation and project cost were highlighted as the main barriers to implementation in earlier CCC projects. In the Creating CSmart Organisations project, a funding report was issued to nine participants. Following the presentation of these funding reports, a number of participants still needed assistance in going forward with their applications. A lack of consultancy time was therefore seen as a barrier to implementation.

Project as an initiator of future activities in the region

A significant output of the Creating CSmart Organisations project was the development of short briefing notes regarding carbon reduction options. They were written to give a practical introduction to organisations about various actions which could be taken to reduce carbon emissions, such as 'Writing a Carbon Management Policy', 'Heating Controls', 'Condensing Boilers', and 'Solar Thermal Energy'. These briefing notes provide a resource for other organisations to use in the future and determine where they could potentially implement actions to reduce their carbon emissions.

A three-year project called the SPI project has been developed which will expand the CCC's carbon reduction activities to work intensively with 90 small- and medium-sized enterprises (SMEs) in the Lowland and Upland Regions of Scotland and to promote the low carbon economy message to an additional 11,000 SMEs. Overall, the SMEs are provided with educational pieces through the SPI website along with a periodic mailing on topical issues, while 90 SMEs will receive 10 days worth of consultancy time to help them measure and reduce their business' carbon footprint. The SPI project is funded by a combination of ERDF and private funding.

1 Village – 1 MW Programme for Energy Self-Sufficiency

Project Background

1 Village – 1 MW Programme is supported by the Bükk-Térségi LEADER Association. Focusing on 44 settlements of the Miskolc sub-region (Northern Hungary), the project focuses on:

- increasing the use of renewable energies
- increasing energy efficiency
- contributing to sustainable and green economic growth
- reducing CO2 emissions
- creating working places for local residents lacking formal education
- increasing the energy self-sufficiency of the villages and inhabitants.

Basic information and contact

Project duration: 2004 – 2010 (Design phase)

May 2010 – December 2013 (Phase 1 and 2 implementation)

Thematic area: Renewable Energy

Country: Hungary

Project Coordinator: Dr. József Nagy

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Phase 1 resulted in investment in 27 "energy yards for village communities", involving the installation of 24 solar (3-5 kW) PV modules, five mini 5-15 kW power plants using plant oil, two solar parabolas (60 kW each), and two 120 kW pellet boilers. The installations were fully financed by grants from LEADER. In addition, a control system called MIKROVIRKA (Smart Grid Control and Energy Information System) based on a wireless mobile internet connection was built. MIKROVIRKA gathers the energy availability data and sells surplus energy to the national energy grid.

In Phase 2 a special barter scheme was developed: a local person may deliver biomass (organic waste or a dedicated agricultural by-product) to the biogas station of Bükk-Térségi LEADER and receive money, an electricity bonus, or a bottle of biomethane or hydrogen. It is based on a model from India[3] and allows for the management of small amounts of biomass. Eleven biomass suppliers are planned, involving stakeholders such as small renewable energy system (RES) users like non-profit organisations and parish churches, six compressed biogas (CBG) manufacturers, power plants, biomass collectors and integrators. The Bükk-Térségi LEADER biogas system includes a waste boiler, a small water power plant, a RES-hydrogen system, plus the control and coordination system. This stage was funded by the Environmental and Energy Operative Programme (EU structural funds). A pilot project is also under realisation, called the "Hydrogen village", following a new rural settlement model. This micro-network is an independent, self-supplying energy system which provides inhabitants with cheap, green energy of good quality. The project was promoted locally and regionally. National and international presentation of the project also took place at the RENEXPO Conference in 2010 held in Budapest.

Table 1 below shows some example activities which were undertaken to respond directly to various climate threats and build resilience within the project area.

[3] Bamboriya, M.L. (2013). Biogas generation, purification and bottling: Development in India. Kshay-Urja, Vol. 7, Issue 2&3.

Table 1 Adaptation and mitigation actions to address various climate threats

Climate threat addressed	Description of the threat in the area	Project activities implemented
Flood Risk and Associated Management Issues	Increased flood risk as a result of more extreme weather events and/or increased winter rainfall	Establishment of grassland on hilly landscapes Sustainable riparian management (riparian planting)
Renewable energy production	Unavailability of heat and electricity at reasonable/affordable prices	Installing heat and electricity producing units based on diverse technology platform (wind turbine, PV, geothermal, biomass) Establishment of local energy regulation infrastructure
Sustainable land use	Vulnerability of farming system due to more extreme weather events (drought)	Diversifying farming activity to build resilience Local food processing using renewable energy (solar drying of fruits and mushrooms)
Other	Large-scale management changes	Resilience plan for long-term sustainable farming
	Unsustainable local mobility	Design a zero-carbon-footprint, hybrid public transport network Installation of hybrid car charging stations

Project objectives and drivers

Objectives: To make the settlements self-sufficient in terms of electricity by building decentralised community power plants using RES with the active involvement of community members. The communal energy generation and distribution programme under the Networked Meter-Balancing Account of Hungarian Virtual Micro-Networks was given the name "1 Village – 1 MW". The target groups were local governments, local NGOs, and the local residents lacking formal education.

Drivers: Three main drivers led to the start of the project:

- environmental concerns (industrial and surface mining activities causing negative effects and requiring compensation / improvement by the companies)
- long-term energy price expectations instilling the belief that a move towards self-sufficiency is necessary
- desire to serve as an educational "demonstration" example.

Links to local development strategy

RES represents the top priority in the local development strategy of the Bükk-Térségi local action group (LAG). RES installation to facilitate energy efficiency is encouraged during the LEADER project selection process through the provision of additional points. The development of RES initiatives and the generation of related projects was facing the irresolvable challenge of not being able to access financing through different funds and the avoidance of double financing. Finally, the decision to use RDP funding under the LEADER programme was made in most cases.

LEADER funding

Table 2 Sources of funding throughout different project phases

Phase 1	**Total project costs** = 277 million HUF [approx. 1 million EUR] (100% RDP-LEADER funding)
Phase 2	**Total project costs** = 1.8 billion HUF [approx. 6.5 million EUR] (100% Environmental and Energy Operative Program funding)
Phase 3	**Total project costs** = 277 million HUF [approx. 1.2 million EUR] (100% RDP-LEADER funding)

Project outputs

The 1 Village – 1 MW Programme produced a number of different outputs. These project activities also served as an example for other related activities in the region, so its demonstration value should also be acknowledged. Several part-time jobs of approximately 10-15 hours per week were created under the project as well for maintenance and management purposes. Table 3 details the beneficiaries and outputs achieved throughout the different phases of the project.

Table 3 Project outputs and number of beneficiaries

Phase 1		Phase 2		Phase 3	
Solar PV modules (3-5 kW each)	24	Biomass collection "package" (mower, trailer)	17	Solar PV modules (0.5-12 kW each)	23
Plant oil-based micro power plants (5-15 kW each)	5	Plant oil-based micro power plants (5 kW each)	12	Solar garage	3
Solar parabolas (60 kW each)	2	Biogas production unit (60 kW each)	6	Biomass boiler (150 kW each)	2
Pellet/wood-chips boilers (120 kW)	2	Solar power plant (121 kW)	1	Biomass storage facilities	18
Wind turbine (1.7 kW)	1	Hydrogen storage and distribution unit	1	Hybrid car charging stations	23
Small PV (2 m2 each)	18	Fuel-cell storage	2	Geothermal system	1
Workshops	5	Network remote administration unit	1	Vertical wind turbine (5 kW)	1
		Workshops	3		

Benefits resulting from the project

Due to limited human resources available for the management of the project, evaluation activities were carried out only to a limited extent, focusing on providing obligatory information requested by the Managing Authority (MA) through monitoring. Since monitoring questions are tailored in order to fit most situations, however, they were often irrelevant or not specific enough to RES-related projects implemented in a LEADER setup. There was no formal evaluation or assessment of the results / outputs, only financial performance and other formal administrative obligations, which are checked through administrative means and on-the-spot control. However, despite these deficiencies, the LAG plans to process a formal, more exhaustive impact evaluation in the near future. Table 4 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 4 Benefits and impacts of the project

Theme	Benefits	Quantitative results	Project impact
Adaptation	Farm resilience plans completed for 4 farms (switching from arable farming to extensive, year-round grazing livestock farming with Hungarian Grey cattle)	100 ha	High
	Improved water retention at catchment level (grassland establishment and establishment of multiple lakes)	Indirect flood alleviation	Low
	Improved water quality (e.g., reduced runoff and sediment loading, better filtration from tree planting)	Improved water quality is an increasingly important issue and considered as a new topic in the coming programming period. Similar to the energy issue, reaching on-site self-sufficiency and sustainable use are envisioned as goals.	Low
	Reduced vulnerability and increased resilience, awareness of adaptation needs and options	25-30 local decision makers, entrepreneurs	High
Mitigation	Increased carbon sequestration and fewer GHG emissions through grassland establishment and better landscape management	100 ha of grassland established	Medium
	Installed RES units	See Table 3	High
Other environmental benefits	Increased farmland biodiversity	100 ha hilly landscape switched from arable farming to extensive grassland management	Medium
	Improvements in soil fertility, incl. grassland management and soil aeration	Demonstrated to 50+ farmers	Medium

Theme	Benefits	Quantitative results	Project impact
	Maintenance of habitats	100 ha of floodplain areas under sustainable management and 20+ ha of riparian habitat improved	High
	Increased connectivity of habitats	120 ha	High
Social	Increased community cooperation, incl. farmers, farmer groups, businesses	20 communities wherein 15,000 people reside	High
	Improved environmental awareness and capacity building through awareness raising, demonstration events, etc.	20 communities wherein 15,000 people reside	Medium
	Improved quality of life	20 communities wherein 15,000 people reside	Low-Medium
Economic	Jobs created	10-15	Medium
	Jobs diversified	3	Medium
	Increased food self-sufficiency	15-20 households	Low
	Improved services/infrastructure	10 communities	Low
Cultural heritage	Increase in traditional practices, such as external livestock production, wild berry and mushroom picking and drying, folk song association meetings, wood-carving open days	5-10 activities per year for the local communities	Medium
	People benefiting from enhanced wildlife, landscape, visual amenity and recreation opportunities	8 villages wherein 10,000 people reside	Low-Medium

Actors

The most important stakeholders were the mayors of the settlements and also directors of public institutions. However, the support of these key decision makers was achieved through the support of the community, which required very intensive communication and consideration of the decision making in this context. The integration of the different stakeholders was crucially important to the overall success. As the results of the effort were more and more visible, external stakeholders also joined and generated further initiatives with the cooperation of local actors.

- University of Miskolc
- University of Debrecen

- Károly Róbert College
- Szent István University
- Hungarian Academy of Science, Centre for Energy Research
- Climate change sensitive farmers and landowners
- Climate change sensitive public bodies
- NORDA (North Hungary Regional Development Council)
- The Institute for Logistics and Production Engineering (BAY-LOGI)

Success factors and barriers

Various factors were identified which contributed to the overall success of the project.

- The Bükk-Térségi LEADER Association employed an experienced project management staff member who played a pivotal role in the process to involve local and national stakeholders.
- The bottom-up approach requires patience in terms of progress since different stakeholders need different amounts of time to develop trust and reach the stage of supporting the project.
- The scaling-up of the project was very important: new topics were piloted and then applied to wider audiences.
- Planning was considered the most important step and enough time was allocated at the beginning to develop all details.
- The project followed the fundamental bottom-up LEADER approach, considering all relevant views and acknowledging specific issues. This was an important step in the process of understanding the "why" for the project.

Barriers were also encountered when implementing the 1 Village – 1 MW Programme:

- Administrative and legal barriers linked to planning and implementation of the RES project were faced. There were several significant changes during the project's lifetime, and that uncertainty discouraged significant potential final beneficiaries. Simplifying this process could encourage more cooperation projects.
- Climate change is not taken notice of by all local stakeholders, or even if it is, they are not aware of the possible adaptation and mitigation actions that could benefit them. This needs special attention from the project management, in order to relate climate issues with local circumstances. Organising moderated workshops for discussion turned out to be a very useful tool for raising awareness and garnering acceptance of the project.
- Since climate change and its impacts are long-term issues, some of the benefits could not be reflected in the timeframe of the project.
- Projects may encounter regulatory challenges that effectively prevent implementation, such as licensing requirements for wind turbines or sell-buy metres. Also, the individual capacity of the implementing actors varies, which requires careful planning in terms of the regulatory requirements.
- The development of the entire system to reach a sustainable stage requires further funding to carry on with the project activities and develop further initiatives.

The main lessons learnt were that success is only possible if the establishment and maintenance of incentives and interest at the end turns into trust by the local stakeholders. Moreover, integration of complex views is necessary in all facets of the project. This is particularly true in the case of innovative projects.

Project as an initiator of future activities in the region

The Bükk-Térségi LEADER Association as the appointed LAG executive organisation fosters many different climate-related projects beyond the scope of the activities indicated.

- Establishment of a Renewable Education Centre
- Additional funding has been secured to implement larger RES infrastructure investments
- The National Academy of Science will monitor RES productivity and network performance
- Innovative low-cost solar dryers installed in order to produce value-added products from wild berries and mushrooms
- Several innovative RES applications will offer demonstrations
- RES-focused rural tourism developments (RES trails, interactive learning facilities, etc.)
- 1 Village – 1 MW Programme has been used as a case study for best practice cooperation projects.

Zala Termálvölgye Association: Local Traditional Orchard Programme for Sustainable Agriculture

Project Background

The Local Traditional Orchard Programme project was completed during two consecutive rounds with three successful individual projects implemented in 2011 and eight in 2013. The program was initiated by the Zala Termálvölgye Association – the implementing organisation of the designated LAG - as part of the local rural development strategy. The project promoted the establishment of orchards of Carpatian basin origin due to their better adaptation capacities as well as the advantages they provide for local traditional processed products, such as jams or spirits.

Basic information and contact

Project duration: Two rounds (2011 and 2013)

Thematic area: Agroforestry

Country: Hungary

Project Coordinator: Mr. Tibor Szabó

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Under the local economic development framework, the establishment and development of traditional cultivar orchards was promoted. Those cultivars were selected for their better water/drought-stress resistance, insect tolerance, low input needs, and their ability to be sustainably cropped for biodiversity enhancement. The low-input cropping employed under the project is also suitable for organic farming. Vegetables were interspersed as companion crops and weed control was primarily accomplished through a mechanical approach. The selection of fruit trees was based on the traditional local cropping history and the characteristics of the specific site. Processing of the fruit using traditional methods was also promoted.

The project also included regular practical workshops and on-site presentation of certain activities by a specialist, which contributed to the reconfirmation of traditional orchard culture of the region. These model gardens were open to visitors, guided by a local expert, and served as a place for "experiments" with "new" practices (e.g., pruning or soil cover techniques). Capacity building trainings for local farmers helped them gain the skills needed for breeding, favourable mixing of breeds, and inter-till cropping. Practical workshops were held regarding pruning and nursing to develop the best tree crown formation as well as processing of the harvested crops. These workshops among existing and potential orchard owners also provided the opportunity for sharing information and best practices. Participants were encouraged to develop their fruit and product mix to best match their particular site. Promotional activities in the local communities were organised to promote the participating farmers and their activities. In relation to the program, a primary school curriculum was prepared for grade 7 pupils in order to highlight the benefits and operations of the local traditional orchards.

Project objectives and drivers

Objectives: The aim of the Local Traditional Orchard Programme project was to provide comprehensive, sustainable examples of local farming based on traditional cultivation and production of final products sold locally in relation to agritourism. Although strongly based on traditional methods, the approach is also open to suitable innovations aimed at renewing and further developing these methods in order to gain the maximum amount of benefits. Establishment of these orchards was a small-scale diversification activity that is mainly suitable as a complementary activity for those with other jobs and could be achieved with relatively small investments, but could potentially grow over time in size and income potential.

Drivers: The Zala Termálvölgye Association developed the local rural development strategy in 2011 and 2013. This process uncovered that there had been a decline in the use of hilly, fragmented sites in the micro region and traditional horticultural cropping methods mainly intended for private consumption. At the same time, key local knowledge specialists were identified who could provide the necessary support to reintroduce these activities in line with the needs and possibilities under the current circumstances. The review of the existing situation also highlighted the awareness of the community regarding environmental pressures and the experience of environmental changes at local level, such as increasing numbers of extreme weather events and the appearance of new pests. These findings and subsequent feedback from local farmers led directly to the design of the Local Traditional Orchard Programme.

Links to local development strategy

The Local Traditional Orchard Programme was designed to fit with the local development strategy's aim to preserve local traditions and support economic and environmental development at the local level based on local resources. The project complements and strengthens a number of other programmes, initiatives, and strategies relating to sustainable local economic development. These include:

- wine tourism-related developments
- micro-enterprise development
- local food product development.

LEADER funding

Table 1 Sources of funding for the Local Traditional Orchard Programme

Funding in 2011	**Total programme budget = 9.6 million Ft** (approx. 35,000 EUR) ▪ 3 supported projects ▪ Individual projects between 0.9 and 4.8 million Ft (approx. 3,400 EUR to 17,345 EUR)
Funding in 2013	**Total programme budget = 34 million Ft** (approx. 123,540 EUR) ▪ 8 supported projects ▪ Individual projects between 1.2 and 6.5 million Ft (approx. 4,300 EUR to 23,600 EUR)

Project outputs

The Local Traditional Orchard Programme targeted the establishment and further development of orchards, including the related infrastructure and machinery needs for their cultivation and processing. Local specialists conducted practical workshops and trainings, which supported the participating farmers and promoted the program to interested farmers. Table 2 details the Beneficiaries and Outputs achieved throughout the programme.

Table 2 Project outputs and beneficiaries

Activity	Number of activities	Number of beneficiaries
Establishment of orchards	Site preparation, tree planting, machinery, fencing, demonstration sites (model gardens)	2011: 3 orchards 2013: 8 orchards
Public processing facility	Establishment of processing facility	under implementation
Workshop on traditional orchard benefits and practices	10 workshops	200 participants
Training on traditional orchard practices	5 training sessions	60 farmers
Primary school curriculum	80 page curriculum about what are the benefits of local traditional orchards	200 pupils in the region

Benefits resulting from the project

The Local Traditional Orchard Programme aimed to establish low-input, traditional, Carpatian basin cultivars and regional fruit-based orchards, sparsely cropped with companion horticulture as well. The rows not used for horticulture were managed with natural grassland for biodiversity enhancement. Fruits were sold both locally and processed using traditional processes. All of these provided adaptation, other environmental, social, economic, and cultural heritage benefits. Table 3 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3. Benefits and impacts of the project

	Benefits	Quantitative results	Project impact
Adaptation	Increased awareness of adaptation needs	200 residents and 60 farmers	High
	Increased awareness of adaptation options	200 residents and 60 farmers	High
Other environmental benefits	Maintenance of habitats	12 ha	Medium
	Mosaic landscape management	11 orchards/parcels	Medium
Social	Local food production	10 communities	Medium
	Improved environmental awareness	60 farmers	Medium
	Primary school curriculum development	200 primary school pupils (grade 7)	Medium

	Benefits	Quantitative results	Project impact
Economic	Jobs created	4 full-time employment positions	Low
	Follow-up initiatives	Public food processing facility; model garden	Medium
Cultural heritage	Wildlife, landscape, visual amenity, traditional products	5,000 local residents	Medium

Mitigation: Although not assessed on a site-specific basis, it could be assumed that reduced input use (both fertiliser use and spraying) and minimum-till cultivation contributed to less GHG emissions from the project compared to intensively managed orchards.

Adaptation: Project beneficiaries, local farmers, and interested residents totalling 260 people were made aware of climate change adaptation needs and options in a global, national, and local context through the workshops and training sessions.

Other environmental benefits: The orchards were established with wide spacing between the trees, and in the first years the tree crowns were shaped to a minimum extent by pruning in order to achieve as close to a natural standing as possible. Moreover, the spaces between the rows were cultivated using suitable vegetable crops and/or natural grassland. All of these contributed to the maintenance and enhancement of the local natural habitat. These land use practices also contributed to water savings (retention through all-year cover) and erosion avoidance. All orchards were established on a maximum 2 ha site in order to achieve the mosaic landscape that is emblematic of the region.

Social: The fruits, and often the vegetables, grown were primarily sold on a local basis, resulting in less dependence on external factors. The workshops which were held for interested farmers provided the opportunity for non-beneficiaries to improve their environmental awareness. Schools from the LAG area (34 communities) were supported in sharing information, best practices, and implementation of practical actions by an 80-page curriculum prepared to present the programme and the related activities (local food processing, model gardens).

Economic: The orchards required a workforce with great seasonal variance. Pruning and harvesting were the most labour-intensive operations that required external workers. In relation to the established orchards, several supplemental activities resulted: creation of a public food processing facility and model gardens, for instance.

Cultural heritage: This traditional form of orchard provided multiple cultural benefits: enhanced local wildlife, mosaic landscape, visual amenity, and traditional products.

Actors

The Local Traditional Orchard Programme involved coordination with several different actors in order to establish/develop the orchards and in order to implement the workshops and trainings conducted throughout the project. Table 4 details the actors involved in planning, coordinating, and delivering the project.

Table 4 Actors involved in the Local Traditional Orchard Programme

Actor	Role in the project
LAG Zala Termálvölgye	Development of LEADER support proposals/fiches
Farmers (orchard owners)	Implementation of site-specific orchards
Schools	Use and feedback on the school curriculum
Local Expert	Advice on the creation and implementation of the Local Traditional Orchard Programme
Local entrepreneurs	Embedding products and further utilisation possibilities (e.g., processing) into their activities

Success factors and barriers

Various factors were identified which contributed to the overall success of the project.

- Professional advice provided by a local expert with great external networking capacities was a crucial basis for the project and a continuous source of support for the programme - from planning throughout the implementation. The opportunity to see the orchard establishment process in practice and receive practical advice was a major influence for several subsequent beneficiaries.
- The traditional inheritance practice of very small landholdings, or "everyone has his own hill", still exists in the region. Such an inheritance is a good basis for local residents to re-establish farming activities at a manageable scale, mainly to meet their own needs but with the possibility to grow to the size of a professional producer.
- Marketing activities of the LAG – presenting local food producers at various fairs, preparing printed factsheets about local producers –provided an important impetus for local residents to buy local fruits and food products.
- The parallel appearance of related activities, such as rural tourism and traditional fruit processing (jam or pálinka), presented a wider market basis that could contribute to more diverse opportunities.
- Development of the primary school curriculum emphasised the importance of promoting traditional local food production at an early stage.

Barriers were also encountered when implementing the Local Traditional Orchard Programme. Table 5 below outlines the barriers which were encountered and the solutions which helped the programme to overcome them.

Table 5 Barriers to the Local Traditional Orchard Programme and solutions

Barrier	Solution
Preparation of mandatory project fiches meeting national requirements	Close cooperation by the LAG project management team with agricultural experts, in addition to the information gained from local residents through the workshops (identifying "needs"), led to the development of successful project fiches. These are in line with the national LEADER requirements, based on the selection criteria and guidance as to which project items should be supported, and they also reflect the willingness and interest of local residents.
Finding the balance between private and public interests in relation to food processing	Public processing facilities could act as competitors to private ones and could potentially lead to the failure of both. Recognising this potential problem led to the stakeholder workshops discussing potential communication and common action that could coordinate production and utilisation in order to serve both interests.

Feedback from supported project beneficiaries indicated that the administrative burden of project application and implementation could operate as a barrier to project development. Because the primary scope of the project was based on self-sufficiency production in terms of access to local produce and/or processed, traditional local food products, finding the suitable scale for the project was essential. This required careful planning of the project fiches and other supported project items in order to achieve sustainable development of the orchards. The community or public's relationship to the project should also strike a balance with the private economic factors, such as profitability and workforce opportunities.

Project as an initiator of future activities in the region

Two successful implementation periods of the programme for 11 orchards serves as a strong basis for further related developments. One of the promising initiatives is the short food supply chain (SFSC), which includes a broad range of food production-distribution-consumption configurations, such as farmers' markets, farm shops, collective farmers' shops, community-supported agriculture, solidarity purchase groups. If a larger production area is established, more and more fruit could be processed into value-added products that are less perishable and easier to transport. The education and demonstration aspect, through teaching materials for pupils and information leaflets for the general public, is set to continue and contribute to the success of the programme. Schools that were engaged throughout the project will also continue to deliver climate change education within their schools, utilising the curriculum prepared during the programme.

Est Sesia – Maintenance works for the improvement of water infrastructures at Sartirana, Cavo Corsica

Project Background

Est Sesia – Maintenance works for the improvement of water infrastructures at Sartirana, Cavo Corsica is a project supported by LEADER through the Local Action Group (LAG) Lomellina in the municipality of Sartirana Lomellina (Lombardia).

Basic information and contact

Project duration: December 2012 – January 2013

Thematic area: Water

Country: Italy

Project Coordinator: Dr. Ing. Giancarlo Moro

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Phone: +039 0384 - 820212

Website: www.estsesia.it

The Irrigation Association Est Sesia is an irrigation consortium in the area of "Sartirana Lomellina". This area, bounded by the rivers Sesia, Ticino and Po, has a total land area of ca. 210 ha, of which 88-ha are located in Piedmont and 122 ha are in Lombardy.

The objective of the project was the improvement of water infrastructures, thereby eliminating the water flow infiltration and resulting in significant benefits in terms of water savings, costs and characteristics of the current irrigation management system. Moreover, the improvement of water infrastructures will lead to the reduction of water losses. Indeed, the project aimed to improve the distribution infrastructure of the irrigation network in the irrigated area with problems of flow losses. Furthermore, the project wanted to improve the actual irrigation methods. through the choice of an appropriate irrigation system (sub-irrigation) to increase water savings and also create new job opportunities.

The RD measure implemented through the project was the sub-measure 125 A (Water management and protection of irrigated land).

The project activities included a better management strategy for water infrastructures, best practice support and the maintenance of the irrigation network. Over 220 metres of infrastructure were recovered, restructured and maintained in this project. Innovative systems for increased efficiency were installed, aimed at meeting the actual irrigation requirements of the plants estimated by appropriate technical assistance services. This also targeted reductions in the risk of soil salinisation from excessive irrigation. Finally, demonstration and advisory events were held to improve surface water management, and equipment was made available to decrease the water flow infiltration of the current irrigation systems.

Project objectives and drivers

The main drivers and reasons behind the development of the project were:

- adaptation of the irrigation infrastructure
- protection of the local natural resources through the improvement of water supply and elimination of water deficits
- water savings and increasing the water use efficiency through implementation of appropriate irrigation systems in the Lomellina area
- maximising the use of water infrastructure that avoid the water losses but also provides a number of additional co-benefits.

Links to local development strategy

The activity of Est Sesia is linked to the local development strategy in several ways.

The local development strategy identified water as a concern for the local context (e.g., water scarcity or inappropriate irrigation management leading to poor agricultural performance in the region). The choice of an appropriate irrigation system was therefore crucial. On this basis, a shift from gravity irrigation to modern irrigation systems (e.g., drip and sprinkler irrigation or sub-irrigation infrastructure) and improved conveyance efficiency provided an opportunity for reduced water demand in irrigation. For example, the use of sub-irrigation systems may increase the efficiency of water use and improve crop productivity by reducing the amount of water used for irrigation and losses during critical crop growth stages.

The improvement and greater efficiency of the water infrastructure system has resulted in significant water-savings benefits and therefore cost-savings. Additionally, the project contributed to the objective of the local development strategy to create job opportunities. Upon further analysis, the investment in water infrastructure created jobs which do not require high levels of formal education but just few hours of training, so they are accessible to people with varying levels of skills in the rural area.

Moreover, the project activities contributed to two LDS objectives in particular: Innovation Technologies Infrastructures and Protection of the Environment.

- Innovation Technologies Infrastructures: as part of the ethos of the project, the project aimed to trial innovative projects in order to enhance learning for land managers, rural businesses, project partners, agencies and policy makers. Knowledge transfer is accomplished in order to put research into action.
- Protection of the Environment: the project aimed to provide multiple environmental benefits to the local area through implementation of an improved infrastructure network (220 meters).

LEADER funding

Table 1 Sources of funding throughout the Est Sesia project

Funder	Amount
LAG Lomellina (LEADER regional contribution)	38,261 EUR
Other	10,739 EUR
Total project costs	**49,000 EUR**

Project outputs

The specific activities carried out during the project were focused on decreasing the water flow infiltration and associated surface water management and increased water availability through better management of the existing water systems and the development of new or alternate supplies (e.g., storm water or wastewater reuse)

The outputs of the project were:

- An intervention in the channel irrigation system, which involves about 200 metres of prefabricated channels in the city of Sartirana, Lomellina.
- Adaptation of the irrigation infrastructure and protection of the territory with the promotion of water conservation through the improvement of water supply from

a quantitative point of view. High benefits were achieved as well in terms of water savings, costs and characteristics compared to the current irrigation management system.

The beneficiaries and people involved in the project were the local community, associations, and farmers in the Lomellina area.

Benefits resulting from the project

Regarding the activities planned, there were important operations designed for the territory that had positive results in terms of improvement of irrigation efficiency. Water efficiency has been improved also in terms of economic performance of agricultural sector, in particular for cereal farms (medium-sized farms) which are typical in the area.

Making smart and strategic investments in water infrastructure can provide cities and communities with the kind of economic, environmental and social benefits that are urgently needed. Quantitative results were not available for the project, but the project coordinator was able to qualitatively assess the project's impact for some benefits. The project activities have resulted in high adaptation impacts in terms of improved water retention at catchment level (e.g., reduced run-off and sediment loading). Medium impacts have been realised in terms of adaptation, social and economic benefits, including reduced vulnerability and increased resilience, increased community cooperation, improved environmental awareness and capacitz building, and jobs created and diversified. Other environmental benefits from the project were low, such as increasing farmland biodiversity and creating or maintaining habitats. Overall, the full array of benefits will only be realised if such investments are made within a highly sustainable framework.

Actors

The principal actors involved in the project and their involved in the development, design, and implementation of the project are detailed in Table 2 below.

Table 2 Actors involved in the Est Sesia project

Actor	Role in the project
Irrigation Association Est Sesia	Determination of the needs of the local farmers through their representatives
LAG Lomellina	Project design, activity planning and monitoring
Lombardy Region	Coordination of the project during the various phases

Success factors and barriers

Lessons learnt throughout the project, which contributed to its success:

- dialogue should be constant and open among partners involved in the project
- flexibility is necessary regarding possible changes to the project's schedule or plan
- there should be some type of evaluation of the possible risks to completion of or incomplete implementation of activities

- evaluators play an important role as facilitators between the community and other stakeholders
- institutions should be highly involved in the project.

Project as an initiator of future activities in the region

Based on the experience of the project, there are several climate actions that should be supported by LEADER projects, such as: implementation of agronomic and hydraulic management of the areas where there is a lack of developed water infrastructure.

The improvement of water infrastructures works to restore, preserve, or mimic natural hydrological systems. It utilises the ability of natural systems to absorb and filter water. Combining traditional infrastructure (such as deep tunneling and pipe rehabilitation) with improved water infrastructure technology can help communities drastically improve their management of water systems.

Regarding irrigation equipment, it is crucial to invest in irrigation efficiency / precision irrigation, improved irrigation scheduling, and reconstruction and upgrading of drainage systems. Both activities, maintaining water infrastructures already in place and improving irrigation systems, are crucial for better water management in the area.

The actual project has directly led to development of similar activities in the same region, including improvement of water infrastructures and elimination of water flow infiltration in Borocotta e Grande Di Rosacco, which are two locations close to Sartirana, Cavo Corsica.

OFT "Forestry Organisation of the Territory"

Project Background

The project OFT, or "Forestry Organisation of the Territory", provided a new and original organisation and structure for the regional forestry activities. OFT was a joint project supported by LEADER through the Italian local action group (LAG) VEGAL (Veneto). Environmental and hydraulic issues were addressed by the project activities, and participation by the local communities, groups, private companies, institutions, associations and local authorities was fostered.

This project aimed to organise and promote the implementation of forestry measures in the project area to improve the quality of life in rural areas and to encourage a different and environmentally sound type of land management. The project also created new areas for restoration and protection of wildlife.

Basic information and contact

Project duration: February 2005 – February 2010

Thematic area: Forest Management

Country: Italy

Project Coordinator: Ms. Simonetta Calasso

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The RDP measures also promoted through the LEADER project were:

- 221 First afforestation of agricultural land
- 226 Restoring forestry potential and introducing preventive actions

Through implementation of these measures, the project aimed to support local community groups, companies, institutions, associations, and local authorities in establishing a management structure for the forest which integrated environmental and hydraulic concernscreate agroforestry systems combining extensive agriculture and forestry systems.

The project activities included awareness raising, adaptation- and sustainability-focused land management strategies, best practice support, diversification and afforestation of agricultural land and rural businesses.

Project objectives and drivers

The main drivers behind the development of this project were related to a study conducted during the 1980s by the Veneto Regional Administration, which evaluated the forestry sector and the impact that forests can have on society. Three categories were identified for the different types of utility that forests can have:

A) Protective Utility

- ecological natural function
- hygienic function
- landscape planning function
- anti-erosion function

B) Productive Utility

- consumption of wood products
- use of the non-wood products
- opportunity for hunting

C) Touristic Utility

- widespread tourism
- intensive tourism

The tourist sector is the main economic activity in this area. Jesolo, Caorle and Cavallino-Treporti are famous seaside resorts, where their abundant holiday facilities host several million tourists every year. The presence of tourists could generate additional economic benefits for the rural areas close to the seaside, if the countryside is prepared to attract visitors. Improving the agricultural landscape (mainly characterised by arable crops) with forestry, which could serve as a tourist attraction, is one of the objectives of the project.

Forests provide a wide range of production inputs, environmental goods, food, fuel, household equipment, building materials and raw materials for industrial processing. Forests support agriculture by providing materials for farm implements. Moreover, in the last few years, the touristic utility of forests in local areas has increased thanks to improvements in the landscape and restoration of forests. For a number of reasons, the roles that forests are expected to play in local and regional development have changed dramatically over time.

Links to local development strategy

The project OFT proposed an original formula for territorial forestry organisation to provide the local community groups, companies, institutions, associations, and local authorities with a land use planning system that integrates environmental and social concerns. OFT experimented with this new model among the rural areas where it was implemented. Wood elements (forestry) solved specific problems in terms of environmental improvement and ecological water savings, while at the same time contributing to economic and social development. OFT set up a consultation board of 20 local actors (e.g., public officers, trade associations, and private stakeholders) to compare the knowledge and needs of the beneficiaries of the project. The municipalities involved in the project were Caorle, Meolo, Quarto d'Altino, San Michele al Tagliamento, and Torre di Mosto.

The project OFT, as a cross-border project with Slovenia, was specifically aligned with the VEGAL Local Development Strategy (LDS) and the "Municipal Development Plans" of the municipalities involved in the project. The project contributed to three LDS objectives in particular: Infrastructure Innovation, Economic Growth, and Protection of the Environment

- **Economic Growth**: OFT was designed to organise and promote the implementation of forestry measures in the project's area of intervention. Investing in resilient forest recolonisation can represent a good opportunity to drive economic growth and improve the health of local communities. With this in mind, it is important to examine the composition of the available workforce, as well as the quality and accessibility of the jobs that would be created. Understanding these opportunities aids the development of sustainable rural management and economic growth for the area; in particular, improvements in workforce development. In line with these objectives, the OFT project was designed to organise and promote the implementation of forestry measures in the project's area of intervention; to improve the feasibility, safety and quality of forestry management; as well as to create new areas for restoration and protection of wildlife. Additionally, the project has attracted investments in the area and local business opportunities have improved and expanded.

- **Protection of the Environment**: OFT aimed to provide multiple benefits to the local area through the support to farmers to create agroforestry systems and combining extensive agriculture and forestry systems
- **Infrastructure Innovation**: OFT aimed to trial innovative projects in order to enhance learning for land managers, rural businesses, project partners, agencies, and policy makers.

LEADER funding

Table 1 Funding for the OFT project

Total funding for one-year project	Project costs = 28,299.90 EUR

Project outputs

The project produced the following activities and outputs:

- **First report** "Environmental and territorial surveys" in the municipality of San Michele al Tagliamento. In this report, the main tools for environmental planning in the areas of interest (the Regional Territorial Plan of Coordination and the Provincial Territorial Plan) were assessed.
- **Second report** "Elements of critical analysis" in the municipality of San Michele al Tagliamento. In this report, territorial and environmental surveys were assessed by a working group at the University of Padua (external). This report presented a comprehensive framework for forestry assessment and a variety of environmental situations within the region, highlighting the importance of the natural, social and economic elements of critical analysis.
- **Conference** "OFT: The Organisation of the Forest Land, a new tool for environmental policy"- 80 participants
- **Workshop** for 14 public and private stakeholders involved in the project: Municipalities of San Michele al Tagliamento and Caorle, Province of Venice - Department of productive activities and agriculture, CIRF – Italian Centre for River Restoration, Forestry Association of Eastern Veneto, Provincial Coordination for Treviso and Venice, Regional Directorate for forests and the mountain economy – forest service from Treviso and Venice, Federation of Farmers of Venice, ASCOM "Confcommercio Bibione" – San Michele al Tagliamento, Bibione Society beach, Bibione Society Pro site, and International Tourist Village Agricultural Cooperative Bibione.
- 60 ha of trees were planted in the same land use systems and will be grown in combination with agriculture in the region.

Table 2 Project outputs and beneficiaries

Activity	Number of activities	Number of beneficiaries
"The Organisation of the Forest Land, a new tool for environmental policy" workshop	2 workshops	14 public and private stakeholders involved in the project: Municipalities of San Michele al Tagliamento and Caorle
Conference "OFT: The Organisation of the Forest Land, a new tool for environmental policy"	1 conference	80 participants
Planting trees on agricultural lands to create agroforestry systems	Number of different planting activities on agricultural land use systems	60 ha

Benefits resulting from the project

The OFT project not only resulted in qualitative and quantitative adaptation benefits, but it also produced multiple mitigation, other environmental benefits, social, economic and cultural heritage benefits. Table 3 below shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3 Benefits and impacts of the project

Theme	Benefits	Quantitative results	Project impact
Adaptation	Reduced vulnerability and increased resilience	60 ha of forest	High
	Increased awareness of adaptation needs and options		High
Mitigation	Increased carbon sequestration and fewer GHG emissions through tree planting and better landscape management	60 ha of direct tree forest planting	High
Other environment al benefits	Increased farmland biodiversity through the support to farmers to create agroforestry systems combining extensive agriculture and forestry systems	60 ha of direct tree planting are Grown in combination with agriculture on the same land.	High
	Improvements in soil fertility, incl. grassland management and soil aeration		Medium

Theme	Benefits	Quantitative results	Project impact
	Reduced loss of soil through strategic native planting projects to prevent erosion		Low
	Creation of new habitats		Low
	Maintenance of habitats	Transplanting new tree in the area can increase the habitats maintenance	Low
	Increased connectivity of habitats		Low
Social	Increased community cooperation, incl. farmers, farmers groups, businesses	10 farms involved in the project area, communities and institute that take part to the full project activities (around 50 peoples)	High
	Improved environmental awareness and capacity building through awareness raising, demonstration events, etc.	In concert with traditional technologies, restore forest can help in the building of a structure that guarantees clean environment, reduces air pollution, avoid soil erosion, minimizes energy costs, and increases green space in our communities	High
	Improved quality of life	Better landscape management, restoration areas for rural development and social issues.	Medium
Economic	Jobs created	University of Venice and Padua were involved in the project. Two Forest organizations and Institutes. More than 100 new job created There is no question that forest investments will result in new jobs. But in order to truly maximize this opportunity, we must guarantee equitable access and shared prosperity for all communities with the communities (institutions, association, universities) involved in the project	High
	Jobs diversified		Medium
	Value of damage avoided from climate change, flooding, or other natural hazards through resilience building		High

Theme	Benefits	Quantitative results	Project impact
Cultural heritage	People benefiting from enhanced wildlife, landscape, visual amenity		Medium

The main benefits assessed from the forest restoration completed during the project were related to the environmental, economic and social benefits.

Environmental impacts can result from run-off (such as soil erosion and associated phosphate losses) or subsurface movement of diffuse agricultural pollutants through drainage channels (such as dissolved nitrates). Trees and other associated habitats play a role mitigating the impact of agricultural practices on water quality, thereby providing other environmental benefits in addition to climate change mitigation, through enhanced above- and below-ground biomass for carbon storage, and adaptation, through improved flood prevention.

Others benefits of the project were related to the improvement of quality of life (both for inhabitants and tourists). Another important aspect was the creation of an association during the project ("Forest Association of Oriental Veneto"), which has continued on after the project ended.

Lastly, one of the major benefits of the project is the increase in total forest area. The extent of forests in the plains of the local area had declined in recent decades. However, forests are a natural feature of healthy, functioning watercourses. Riparian forestlands can aid sediment removal and provide erosion control, as well as protect water quality by buffering pollutants and nutrients.

Actors

Different actors have been actively involved throughout the several stages of planning and full implementation of the project. Members of the OFT core group were:

- Municipalities of San Michele al Tagliamento and Caorle
- Province of Venice – Department of productive activities and agriculture in collaboration with the University of Padua as an external contractor
- CIRF - Italian Centre for River Restoration
- Forestry Association of Eastern Veneto
- Provincial Coordination for Treviso and Venice
- Regional Directorate for forests and the mountain economy – forest service from Treviso and Venice
- Federation of Farmers of Venice
- ASCOM "Confcommercio Bibione" - San Michele al Tagliamento
- Bibione Society beach
- Bibione Pro site
- Society and International Tourist Village Agricultural Cooperative Bibione

Success factors and barriers

The main factor that led to the success of the project can be found in the link between the different sectors: agriculture, ecology (environment) and tourism. The inclusion of each of these factors in the project increased the scope and interlinking benefits of the project.

Replicability is another success factor of this type of project. The forest management structure and agroforestry activities can be applied to other forests and agricultural land systems. Investments in forest restoration require the use of existing financing strategies, such as regional or foundation funds. It is important that financing funds are all used for projects through stable and fair means and they should promote green growth.

Project as an initiator of future activities in the region

Better implementation of future activities connected with "forest restoration" in the region will increase the number of forest areas. The decision as to what tree density is appropriate will be based on the pedoclimatic conditions of the area selected. By responding to multiple challenges the region faces through uptake of activities which provide multiple benefits, future initiatives will have a higher impact on society. Moreover, the beneficiaries should not be limited to local community groups, institutions, associations, and local authorities, but through inclusion of agroforestry, will also include farmers.

'L'arbre en Champ' - Agro-forestry Audit on the Farm and Mobilisation of Innovative Models

Project Background

The 'L'arbre en Champ' - Agro-forestry Audit on the Farm and Mobilisation of Innovative Models was a cooperative project between three Belgian and two French territories where mostly polyculture, but some monoculture agricultural production was practised. The following local action groups partnered in the project:

- Pays des Condruzes (Strée, Belgium)
- Botte du Hainaut (Froidchapelle, Belgium)
- Cévennes (Ales, France)
- Pays d'Armagnac (Eauze, France)
- Racines et Ressources (Belgium)

Basic information and contact

Project duration: December 2011 December 2013

Thematic area: Agroforestry

Country: France and Belgium

Project Coordinator: Mr- Jean François Pecheur

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Phone: +32 85 27 46 10

Website: http://www.agroof.net/agroof_projets/agroof_transgal.html

The project promoted the development of agro-forestry within the local areas by identifying, exchanging, and disseminating best practices. Technical factsheets were developed in order to facilitate the knowledge transfer. Legal and contractual expertise was provided regarding agro-forestry regulation and land ownership issues. Questionnaires, surveys, and feasibility studies were conducted with farmers in the territories, from which some were selected to undergo further agro-forestry audits. Demonstration sites were selected to showcase agro-forestry on-farm, and workshops were held to discuss possible new markets for agro-forestry products. A written guide and accompanying video were developed to support agro-forestry implementation. Finally, a Belgian-French agro-forestry association was developed, which was not included in the original project action plan but evolved out of the project collaboration.

Project objectives and drivers

Objectives: The overall objective was to diffuse innovative models and best practices in agro-forestry. In striving to accomplish this objective, the project aimed to improve the agricultural productivity and competitiveness of the territories through diversification of agricultural production and development of new local value chains for agro-forestry products. Integrating more trees into the local landscapes was also aimed at increasing local biodiversity and soil quality, thereby improving the quality of life in these rural areas.

Drivers: The cooperation measure encourages cooperation and collaboration between LEADER projects. The LEADER project participants for this joint action project met through INTERREG activities. The availability of knowledge and competencies within participating organisations, as well as the resources to develop further expertise and competencies and develop new tools were key drivers of the project.

Links to local development strategy

The project's participating territories had an agriculture focus but also went further in terms of biodiversity (generally required now), in particular within ecological corridors. Agro-forestry was in the original local development strategies of many Local Action Groups (LAGs). Other linkages with strategies include: managing fertilisers/pesticides; reducing soil erosion; developing wood products; greenhouse gas (GHG) reduction (in the form of feasibility studies regarding the potential for biomethanation plants)

LEADER funding

Table 1 Sources of funding for the 'L'arbre en Champ' project

Funder	Amount
Chaque LAG	60,000 EUR: LEADER 45%; Belgian region 45%; local council 10%
Armagnac LAG	60,000 EUR: LEADER 44%; French region 36%; local council 20%
Total project costs	**300,000 EUR**: 180,000 EUR for Wallonia; 120,000 EUR for France

Project outputs

'L'arbre en Champ' resulted in a number of outputs which directly benefited over 250 people in the French and Belgian project regions, in addition to providing indirect benefits to the wider population. Table 2 details the Beneficiaries and Outputs achieved throughout the project.

Table 2 Project outputs and beneficiaries

Activity	Number of Activities	Number of beneficiaries
Dropbox; Google drive to facilitate communication	2 online information-sharing accounts set-up to improve inter-regional communication	Partners
Development of an expert information sheet for internal capacity-building	20 sheets (14 factsheets in 2 years)	15 people
Contract to evaluate legal and regulatory issues of agro-forestry (in particular regarding land ownership)	1 (Focused on Wallonia)	To be disseminated to other LAGs and agro-forestry networks
Farm-based assessments (questionnaires, field-trips, feasibility studies/audits)	235	235 farmers

Activity	Number of Activities	Number of beneficiaries
Guide for supporting agro-forestry implementation (targeted to support meetings with farmers) Accompanying web documentary (to illustrate the implementation process)	1	Partners Dissemination through agro-forestry networks, agricultural organisations, schools and life-long training organisations, decision makers
Workshop with farmers to discuss potential to develop new markets (wood-energy vs wood construction)	1	Not completed yet (scheduled for 9 September 2014)
Meeting with researchers and companies to identify alternative business models and market potential	1	Not completed yet (scheduled for 9 September 2014)
Planting trees	11	11 farms
Support/participation to broader networking and dissemination activities (e.g., networks on agro-forestry)		Results of the workshop and meeting with stakeholders above to feed into this

Benefits resulting from the project

The project 'L'arbre en Champ' is expected to result in various kinds of benefits, including mitigation, adaptation, other environmental, social, economic, and cultural heritage benefits. Indicators have been developed as well, but they were mainly to follow up on activities and the results of the project. No indicators on the benefits / impacts were developed, partly because the project is not yet finished but also because the benefits of an agro-forestry project will occur more in the long term (approx. 30 years). Thus, it is difficult to quantify those expected benefits easily and needs collective reflection.

Long-term benefits from the agroforestry activities conducted under the project can be seen at the landscape scale, encouraging cooperation and collaboration between actors and across administrative boundaries. For instance, the project contributes to river basin management (under the Water Framework Directive, which is based on watersheds and hydrological functioning) and multiple benefits targeted under the Rural Development Programmes (RDPs).

However, the joint action project involving cooperation between LAGs from two different countries has focused more on developing knowledge through training and educational activities as well as establishing bases for implementation of agro-forestry. This has involved exploration of how the various territories can integrate agro-forestry into the local landscape and farms' business models as well as analysis of the combined social and economic effects and legal structures for implementing agroforestry activities. Broader development of the local economy (e.g., bioenergy production from wood, job creation) as well as climate change mitigation from more above- and below-ground biomass for carbon sequestration and adaptation through flood and drought prevention (increased infiltration and water retention) are some of the longer-term benefits which are expected to result from the project.

Until now, the focus of the project has been more on implementing activities since resources are limited rather than assessing the results. This could be a task for an academic, and to some degree such analysis is already occurring in parallel to the project with projects in France, such as National Institute for Agricultural Research (INRA) projects.

Actors

Many actors from the LAG regions were involved in the 'L'arbre en Champ' joint action project. Table 4 outlines the various actors and their roles in developing or implementing the project.

Table 4 Actors in the project and their roles

Actor	Role in the project
LAGs	In Wallonia: all is internalised In France: most activities were contracted to operators (e.g., agricultural chambers, consultants)
Network for rural development in Wallonia	Networking
Agriculture Ministry	Administrative
Federation of forest owners	Networking
Farming syndicates/organisation	Little support given thus far
Academia (agronomy departments in Gembloux, Bruxelles, Louvains, etc.)	Conceptual, evaluation
Local municipalities, associations in energy, civil society	Implementation

Success factors and barriers

Success factors: Within the LAG areas, there was significant interest by project developers to work on innovative ideas. There were good personal relationships between the participants. During the proposal stage, each LAG invested significant resources and preparation was significant. There are also high-quality competencies existing in each LAG.

Another success factor was the creation of a structure / association to support the development of the project which included a large range of actors: partners but also farmers, foresters, academics, environmental NGOs, etc.

Additional available resources for agro-forestry through the rural development programmes – especially with new RDPs being developed for the 2014 – 2020 programming period – will also help direct efforts to result in real change on the ground.

Barriers: Barriers were also encountered when implementing 'L'arbre en Champ'. Table 5 below outlines the various problems and solutions devised to overcome them.

Table 5 Barriers to the 'L'arbre en Champ' project and solutions

Barrier	Solution
Innovation & cultural differences (difficult to shift from a productivist to a sustainable mindset)	Need to be constructive and in "teaching-mode"; need to help build new (lost) competencies
Different target groups: move from family-based farming to specialised, large-scale farming systems	New market outcomes; aim to influence a change in overall policy (both public and private)
Farm ownership / legal arrangements: more difficult if dealing with tenants	Study to examine how to overcome legal issues; work with owners (large landowners)
Inter-personal issues between partners	Use diplomatic skills
Some administrative issues in France to find co-financing	Easier in Belgium because less fragmentation in the co-financing requirements

Through implementation of the 'L'arbre en Champ' project, some lessons learnt have emerged.

- One must not expect significant changes when dealing with innovations but rather be less ambitious in the short term and focus on gradual change
- Find a common language to communicate effectively
- Think long-term
- Need to support innovation uptake and make sure it is part of a global effort (across a territory, finding economic/market outputs).

Project as an initiator of future activities in the region

The 'L'arbre en Champ' project has initiated activities within the Belgian and French regions, which it will continue to foster as well as create new activities.

- Intend to continue development of training in schools and lifelong education, focusing on sharing practices and training in agro-forestry implementation with technicians and engineers.
- Develop cooperative structure under this project to streamline and upscale through new projects, building on different funding sources as well (INTERREG and other RDP measures).
- Support businesses aiming to provide consultancy services on agro-forestry.
- Develop more global solutions (e.g., at the larger river basin level), including cooperation across boundaries as this leads to issues being addressed in a more comprehensive way and a greater number of benefits (landscape, water, biodiversity, economy, social). See AGREAU project for an example of wider scale production of wood energy.
- Reach out to other countries for knowledge sharing and training, in particular those in Eastern Europe.

Connection Runde – Integrating peat restoration and protection with river restoration in Southeast Drenthe

Project Background

The Connection Runde – Integrating peat restoration and protection with river restoration in Southeast Drenthe project has been implemented from 2008-2014 by the Province of Drenthe in the Netherlands (and approved for funding by the LAG Southeast-Drenthe).

Basic information and contact

Project duration: 2008 – 2014 (ongoing)

Thematic area: Landscape/ Resource Efficiency

Country: Netherlands

Project Coordinator: Ms. Karen Beukema

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The Drenthe region has led the efforts to restore and reconstruct the Runde, an ancient stream running through this peatland area. This is one example of several different approaches being employed in the Southeast Drenthe region to mitigate the effects of and adapt to weather events with high rainfall intensities which have been occurring more frequently in the area, potentially related to climate change. Such events are expected to lead to large flooding problems, especially in the area between the Bargerveen and the A-37 highway. Serious weather events, such as the flooding of October 1998, resulted in major consequences, e.g., inundation of agricultural areas where mostly potatoes and sugar beets are cultivated. Subsequently, the province approached the water board and municipality with the idea for the project, meetings were held and a plan was drafted, the costs were estimated and analysed, the citizens and stakeholders were consulted on the plan, and funding allocation was determined.

Restoration of peatland areas also provides mitigation benefits from increased CO_2 storage and reduced methane emissions. By using a specialised national land instrument which allows farmers to exchange land in order to reduce fragmentation of landholdings and by participating in various European cooperation projects, a mega project was developed called "From Bargerveen towards the Dollard". In this project they used the land exchange process (or tool) to install buffer zones around peat areas in order to increase water levels. Additionally, the 1998 floods showed that there was a lack of capacity to adapt to heavy rainfall events, so old riverbeds were restored by digging them out and new river stretches were created to enhance drainage capacity. Thus, the Connection Runde project is a subproject of the larger peatland restoration project with activities focused on just a small river region in the larger project implementation area.

The larger project, not funded by LEADER, will also create a 4-5 ha green, recreational structure along the river Runde in the village of Emmer-Compascuum. The structure will contain a playground, swimming pool and several other elements for the local community. More than half of this area is included within the same territorial scope as the Connection Runde LEADER project. These features will be completed by the end of 2014 at the latest (this area is now under construction).

Project objectives and drivers

Objectives: The main goals are:

1. Further linking and restoring the Runde as a robust and resilient water body and as a driver for further development of natural and recreational areas.
2. Allow the free flow of water from the Bargerveen (via the Runde and Ruiten Aa) to the Dollard.
3. Create an ecological corridor along the Runde and Ruiten Aa, which connects the Bargerveen and the Ecologische Hhoofdstructuur (EHS – protected areas aimed to be connected within the Netherlands) areas Westerwolde and Dollard, permitting free migration and exchange of plants and animal.
4. Strengthen the recreational and tourist value of the area.

Drivers: The rural area of the Netherlands where this project was centred is a relatively poor area; thus, the project was aimed at improving the quality of life for residents within the area. Specifically, water quality conditions were quite low before implementation of the project due to eutrophication problems caused by farming effluents. This was a driver for the project to contribute toward improving the Runde through restoration and creating buffer zones in order to enhance natural water treatment processes and increase the river's flow. These actions resulted in positive effects on water quality, thereby benefiting the local agriculture and inhabitants. In order to increase awareness of water quality issues in the area as well, youth were identified as a stakeholder group which should be targeted under the project. Thus, a playground for the children of the village was created so they can learn 'about water by doing' through hands-on activities, such as crossing the river using ropes, jumping from stone to stone, watching fish on the fish stairway, and reading information panels.

Links to local development strategy

Socio-economic revitalisation is one of the most important focuses of the local development strategy (LDS). The project aims to improve the socio-economic status of the project area by increasing the recreational and tourist value through enhanced natural resources. In accordance with the LDS, the project must also be structured to involve the local inhabitants and the local schools. Public consultation meetings were held for local inhabitants and civil society representatives (associations, schools, etc.), at which stakeholders were invited to give input and state their opinions. Restoration of the water quality of the area aimed to benefit all the local inhabitants, and the establishment of the local playground benefited the local schools as an interactive tool for education about water quality. The LDS requires that projects contain an element of renewal of local facilities, which this project directly aimed to do through improvement of the local water body and construction of green facilities.

LEADER funding

Table 1 Sources of funding for the project

Funder	Amount
Municipality of Emmen	400,000 EUR
Water board – Hunze en Aa's	360,000 EUR
National fund for fish	126,000 EUR

Funder	Amount
National fund for water quality	213,000 EUR
INTERREG	110,000 EUR
Province of Drenthe	400,000 EUR
LEADER	348,508 EUR
Total project costs	**1,957,508 EUR**

Project outputs

The Connection Runde – Integrating peat restoration and protection with river restoration in Southeast Drenthe project resulted in a number of outputs. Many activities were carried out to improve the local natural resources, in particular the Runde river was restored and renaturalised (reviving old stretches in some parts and digging out completely new riverbeds in other areas), and other physical improvements were made to the local community in terms of recreational and building facilities through the overarching project. Table 2 details the Beneficiaries and Outputs achieved throughout the project.

Table 2 Project outputs and beneficiaries

Activity	Number of activities	Number of beneficiaries
Creation of a foot and cyclist path along the river Runde	4 km	Many inhabitants and tourists
Construction of a playground	1	Inhabitants
Construction of a football field	1	Inhabitants
Green structure along the river Runde	4 ha	Inhabitants
Ditches widened for improved flood resilience capacity	For the Connection Runde project funded by LEADER – one-half ha (300 ha total with the larger project)	All inhabitants, including communities further afield
New section of river dug out	1 km	Local water board, farmers and nature organisations

Benefits resulting from the project

The activities completed during the first part of the Connection Runde – Integrating peat restoration and protection with river restoration in Southeast Drenthe project have been formally assessed and the second part of the project will be assessed at the end of 2014. The project produced a number of adaptation, other environmental, and economic benefits. Table 3 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3 Benefits and impacts of the project

	Benefits	**Quantitative results**	**Project impact**
Adaptation	% Reduction in flood risk	75 %	High
Other environmental benefits	Increase in farmland biodiversity (Ha or species involved)	25 ha	Low
	Maintenance of habitats (Nr of ha involved)	5 ha	High
	Reduced availability of water for use (in m3)	100,000 m^3 sand excavated	High
	Increased connectivity of habitats (Nr of ha involved)	5 ha	High
	Follow-up initiatives	>10	High
Economic	Nr of jobs created (full-time equivalent)	15	Medium
	Nr of new business start-ups	5	Medium
	Effects on wider economy (tourism, inward investments) (EUR)	500,000 EUR	High
Cultural heritage	Number of people benefiting from enhanced wildlife, landscape, visual amenity	10,000	High

Additional mitigation benefits are expected to be achieved from restoration of peatlands within the area due to their enhanced capacity for carbon storage and reduced greenhouse gas emissions. Such carbon sequestration and avoided emissions from maintaining high water table levels in peatlands is difficult to quantify, especially within the short-term duration of a LEADER project. However, avoided methane emissions have the potential to contribute significant mitigation benefits due to their extremely high heat-trapping impact in comparison to CO_2 emissions.

Actors

Different actors were involved throughout the project's implementation. Local stakeholders were involved in consultation but did not participate in implementation of the project, except for the farmers and landowners who exchanged / sold their plots of land for the creation of buffer zones and for river restoration. Table 4 details the actors involved and the roles they played in coordinating, approving, and delivering the project.

Table 4 Actors involved in the project

Actor	Role in the project
Deputy of the province of Drenthe	Decision maker
Alderman of Emmer-Compascuum	Decision maker
Local authorities	Key players in garnering support for the project (e.g., heads of associations or public organisations)
Inhabitants	Users and participants in the public consultation during project development
Landowners	Users and active players in the exchange / sale of land in order to create buffer zones around the Runde
Nature offices	Users
Water board	Developer / decision maker / owner of river in terms of public responsibility to maintain the secondary water system (e.g., smaller rivers such as the Runde)

Success factors and barriers

The successful implementation of the Connection Runde – Integrating peat restoration and protection with river restoration in Southeast Drenthe project can be attributed to various factors. In identifying a contextually appropriate project, it was important to listen to the local inhabitants regarding the problems faced by the area. Focusing on the main problems for which solution were needed and possible was key to developing the project idea. Presenting the anticipated socio-economic effects from the government's actions to the local inhabitants increased the acceptance and support for the project, as did involving them in the project development phase.

Different barriers were encountered in the implementation of the Connection Runde project as well. Table 5 below details the various barriers and the solutions which were found to solve the problem.

Table 5 Barriers to the Connection Runde project and solutions

Barrier	Solution
Opponents to creation of buffer zones through land transfer	Listen to the points of view of the farmers and landowners within the area which the project intended to transform. Through meetings and advocacy of local stakeholders regarding the benefits of the project (improved water quality and quantity, etc.), the former opponents became supporters and voluntarily exchanged their land in exchange for compensation or, in most cases, other pieces of land in suitable locations.
Project goals set by the project rather than by the farmer individually	Set reachable goals

Barrier	Solution
Costs	Look for partners, such as the municipality and the water board with money in the first development stage of the project. Their participation was particularly influenced by the province initiating the planning and approaching them with the project, as well as offering financial support to enhance the quality of life in the area and to increase protection against floods.

An important lesson learnt during the course of the project was to maintain communication with the local stakeholders in order to generate support for the project.

Project as an initiator of future activities in the region

The Connection Runde – Integrating peat restoration and protection with river restoration in Southeast Drenthe project is one of 15 clusters in an overarching larger peatland restoration / green infrastructure project for the area. The other clusters will continue past this project's timeframe and focus on restoration of other parts of rivers and peatlands, local economic development, green buffer zones along rivers, and climate adaptation in both the Netherlands and Germany. These activities are needed in order to reach the current project's goals.

Below is a figure detailing the larger project area in which the Connection Runde LEADER project (cluster 7/8a) fits.

Figure 1 Map of the Southeast Drenthe sites involved in the larger project "From Bargerveen towards the Dollard"

Solar panels for farmers in Northeast Overijssel

Project Background

The Solar panels for farmers in Northeast Overijssel was a project initiated and implemented by Stimuland (a private foundation working in the agricultural sector as an intermediary between public authorities and farmers). The Northeast Overijssel local action group (LAG) – in their advisory role to the Managing Authority – thought it would be a fitting project for the region because it promoted carbon emissions reductions through increasing the use of renewable energy in the local rural area.

Basic information and contact

Project duration: February 2013 – April 2014

Thematic area: Renewable Energy/ Solar Energy

Country: Netherlands

Project Coordinator: Mr. D.H. Roetert

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Questionnaire and interview: GHBH.Egberts@overijssel.nl

Phone: +31 (0)529 47 81 80

Website: www.stimuland.nl

In the scoping phase of the project, individual farmers in the region were approached and presented with information regarding installing solar panels on their farms. Potential cost savings which could result from installation and energy cost reductions were presented, and once the farmer indicated their interest in participating in the project. Stimuland submitted project proposals on behalf of the farmers. A number of solar panels were installed during the course of the project. Additionally, permits were acquired to install charging stations for electric bicycles in the region so that longer distances could be covered by recreational users without the fear of running empty of electric charge.

Project objectives and drivers

Objectives: The main objective of the project was to increase the amount of renewable energy used on farms in the region and thereby reduce the energy costs for the farmers who participated in the project. A further objective was to stimulate energy efficient electric cycling by creating posts where electric bicycles could be charged.

Drivers: The main driver for the participating farmers was reducing the costs of their energy bill by placing solar panels on their stable roofs. Those cost savings can be directed toward other innovative adaptations within the business, preferably aimed at making the business more (cost-)efficient.

The participating farmers were familiar with renewable and durable energy available through the use of solar panels. The province Overijssel is one of the front-runners with regards to renewable and durable energy and until 2012 had a programme where farmers could get a grant when they replaced their stable roofs containing asbestos with new roofs and solar panels.

The participating farmers in the current project collectively chose which panels to use. Before asking for quotes from five different companies, they established the quality requirements on which to judge the quotes.

Links to local development strategy

The local development strategy (LDS) played a pivotal role in determining whether the project received funding. In order to approve a project, the LAG must check if the project meets the criteria listed in their LDS. In the case of this project, one of the focuses of the LDS is durability of the local region, which was to be enhanced by development of renewable energy generation and energy self-sufficiency. Thus, the LAG was able to approve the project and provide funding for the related activities.

LEADER funding

Table 1 Sources of funding for the project

Funder	Amount
Province of Overijssel	36,745 EUR
City of Dalfsen	36,745 EUR
LEADER funding	73,490 EUR
Participating farmers	220,470 EUR
Total project costs	**367,450 EUR**

Project outputs

The project activities included installation of solar energy panels and resulted in increased solar energy generation on individual farms in the project area. Additionally, electric bicycle charging stations were installed in the local area in order to enhance recreational opportunities for the general public. Table 2 details the Beneficiaries and Outputs achieved throughout the project.

Table 2 Project outputs and beneficiaries

Activity	Number of activities	Number of beneficiaries
Installation of solar panels	15	15 farms
Placement of electric bike chargers	2	For public use

Benefits resulting from the project

The Solar panels for farmers in Northeast Overijssel project produced mitigation benefits from the renewable energy sources it promoted, in addition to providing other economic and cultural heritage benefits. The benefits of the project have not been formally assessed since they can only be measured after a longer period of time following installation of the solar panels. At the start of the project, however, an indication of the estimated benefits farmers could gain in terms of cost savings by installing solar panels was used to present the option to farmers. By using a 20 kWp (20,000 Wp) solar panel installation, they could save up to 50 percent on their energy bills.

Table 3 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3 Benefits and impacts of the project

	Benefits	Quantitative results	Project impact
Mitigation	Electricity generated from renewable sources (kWh/yr)	270,000 kWh/yr	Low
	Energy savings in heat (MJ/yr)	65 MJ/yr	Low
	Energy savings in electricity (kWh/yr)	270,000 kWh/yr	Low
	Avoided / Saved GHG emissions in tonnes CO2 equivalents	183 tonnes CO2-e	Low
Economic	Total investment in renewable energy production (€)	367,450 EUR	Low
	Cost-savings from energy use reduction	Estimated up to 50% of each farmer's energy bill	High
Cultural heritage	Creation of recreation opportunities	2	Low

Actors

Different actors were involved throughout the project's implementation. Table 4 details the actors involved and the roles they played in coordinating, approving, and delivering the project.

Table 4 Actors involved in the project

Actor	Role in the project
Farmers	Beneficiaries
Stimuland	Project management and development
City Council of Dalfsen	Permit for placing the charge points for electric bicycles
Northeast Overijssel LAG	Selected project for funding

Success factors

The willingness of farmers to invest in renewable energy as a means of extra income was the key factor leading to successful implementation of this project. Another important component was the cooperation of the City Council of Dalfsen in issuing permits for the two electric bicycle charge points. Their forward thinking and belief in the possibilities of renewable energy has helped create more tourism opportunities, not simply for the elderly but others as well.

An important lesson learnt during the Solar panels for farmers in Northeast Overijssel project was that it requires a lot of work to convince farmers that it is beneficial to invest in renewable energy. Such investment involves a risk to their farm business if it does not pay off, which is a reason the cost-savings estimates from installation of solar panels were an important tool in promoting the project idea.

By calculating that farmers’ investment could potentially make a 50% reduction in their energy bills and showing results of projects developed elsewhere, Stimuland was able to convince farmers to assume the risk. Using the participating farmers in the project development stage elsewhere and having them tell about the success of their investment has also increased the willingness of other farmers to participate.

Project as an initiator of future activities in the region

There are several similar projects planned and or running in other regions of the province of Overijssel following the conclusion of this project. Some of these projects are also LEADER funded. Installation of more solar panels on farms as well as several more charge points for electric bicycles are planned.

Stimuland also plans to start a project where solar panels will be leased to farmers with the possibility to buy after a five- or ten-year leasing period. The funding for this project may come from the province of Overijssel, local councils, or other government grants.

Texel Energie

Project Background

The Texel Energie project was founded by the inhabitants of the island of Texel, located in the province of North Holland in the Netherlands. The local action group (LAG) Kop van Noord-Holland provided funding from the province under the LEADER scheme. The project worked towards establishing a sustainable energy supply for the island Texel.

Basic information and contact

Project duration: April 2008 - September 2009

Thematic area: Renewable Energy

Country: Netherlands

Project Coordinator: Mr. Brendan de Graaf

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Questionnaire and interview: jobstierman@texelenergie.nl

Phone: +31 (0)222 314 939

Website: http://www.texelenergie.nl/

An energy cooperative was established as a non-profit organisation, and any benefits resulting from its activities are invested in initiatives to increase small and local renewable energy production on Texel. The cooperative was set up to provide green energy to the islanders, with the ultimate goal to supply the island with energy which is mainly created on the island. Currently, only a small part of the energy which is sold by Texel Energie is generated on Texel itself (mostly by solar panels purchased by private households or wood incineration). Texel Energy has a strong innovative character and aims to offer a space to experiment, research, and build knowledge. In 2007 prior to the beginning of this LEADER project, Texel Energie prepared a business plan including a feasibility study. The cooperative has planned the following energy production installations for the future: thermal storage batteries, harvesting wind energy through kite technology, and a tidal power plant. Texel Energie also had plans to install windfarms on the island, but the province was unwilling to grant the necessary licenses.

The target groups under the project were the residents and households on the island of Texel, who are both members of the cooperative and its customers/beneficiaries, as well as companies and other organisations on the island. In the past years, Texel Energie has attracted many visitors who are interested in the setup and functioning of the cooperative.

Project objectives and drivers

Objectives: The aim of the project was to create decentralised renewable energy, energy self-sufficiency, and additional jobs on the island of Texel. The broader theme for this objective is that the energy should be produced in a sustainable manner.

Drivers: The cooperative was initiated by the island residents and businesses due to the conviction that renewable energy contributes to the future of the island of Texel and its inhabitants. The local community had previously set a target for Texel to be completely energy neutral by 2020, so the energy cooperative was established to contribute to this target.

Links to local development strategy

One of the main themes of the local development strategy is 'renewable energy and new technologies'. The project activities focused strongly on both elements by promoting renewable energy development within the region. Specifically, the project incorporated new technology through solar panel installation on over 200 private homes.

LEADER funding

Table 1 Sources of funding for the project

Funder	Amount
Co-financing by communities in the 'Kop van Noord-Holland'	31,897.00 EUR
Cooperative Texel Energie	37,648.50 EUR
LEADER funding	58,045.50 EUR
Total project costs	**127,591.00 EUR**

Project outputs

The project activities included planning, development, and continuation of an energy cooperative focused on providing sustainable, renewable energy to the island residents and producing as much energy as possible on the island itself. Table 2 details the Beneficiaries and Outputs achieved throughout the project.

Table 2 Project outputs and beneficiaries

Activity	Number of activities	Number of beneficiaries
Start-up and reinforcement of the cooperative	1	1 cooperative and 400 members (at the start)
Expansion of the cooperative's membership	Ongoing	>3,000 members
Installation of solar panels on private homes (financed privately)	200+ homes	Entire cooperative (>3,000 members)
Wood incineration by cooperative for energy generation	Ongoing	Entire cooperative (>3,000 members)

Benefits resulting from the project

The Texel Energie project produced mitigation benefits from the renewable energy sources it promoted, in addition to providing other social benefits. Table 3 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3 Benefits and impacts of the project

Theme	Benefits	Quantitative results	Project impact
Mitigation	Electricity generated and/or purchased from renewable sources (kWh/yr)	A couple of hundred households installed solar panels	High

Theme	Benefits	Quantitative results	Project impact
Social	Increased cooperation & cohesion in community	>3,000 members of the cooperation	High

Actors

Different actors were involved throughout the project's implementation. Table 4 details the actors involved and the roles they played in coordinating, approving, and delivering the project.

Table 4 Actors involved in the project

Actor	Role in the project
Inhabitants of Texel	Act as members and customers of the cooperative
Initiators	Took the initiative to start up Texel Energie, selecting suitable power plants, buying and selling electricity, promotion and installation of solar panels, implementation of projects on energy saving, etc.
LAG Kop van Noord Holland on Texel	Approved project for LEADER funding
Province of North Holland	Distributed licenses and subsidies

Success factors and barriers

The Texel Energie project's successful implementation was due to the high level of community support (e.g., inhabitants, companies, etc.) and the ambition of the municipality of Texel to be self-sufficient in energy production by 2020.

Barriers were also encountered whilst implementing the Texel Energie project. Table 5 below details the main barrier to renewable energy establishment and the solution adopted to confront the challenge.

Table 5 Barriers to the Texel Energie project and solutions

Barrier	Solution
Impossible to obtain licenses from the province for the construction of windmills or other sustainable energy generation	Focused on more promising types of energy production, such as solar energy, and for the future: thermal storage batteries, harvesting wind energy by using kite technology, and a tidal power plant.

Project as an initiator of future activities in the region

The project led to the establishment of the cooperative, but through the activities and outcomes of the project, it led to the development of numerous other projects and new initiatives on renewable energy. Texel Energie started new initiatives to raise awareness and obtain subsidies for establishing solar panels on the island, promoting electric cars, achieving energy savings, and improving heat use and storage.

Development of energy self-sufficiency for the LEADER region "Westlausitz"

Project Background

Development of energy self-sufficiency for the LEADER region "Westlausitz" is one of the flagship projects funded by the Westlausitz e.V. local action group (LAG) in Saxony. The project was launched in 2012 by the planning office 'Schubert' and will finish in 2015. Working in close cooperation with the Energy Agency of the Saxony SAENA GmbH, the project aims to develop local energy self-sufficiency for the Westlausitz region.

The project supports the municipalities of the Westlausitz region in improving the energy efficiency of buildings (heat and electricity) and the use of renewable energies. It trains, advises, and raises the awareness of the local energy managers so that they can gain the necessary skills to continue promoting energy improvements in the future.

Basic information and contact

Project duration: 2012-2015

Thematic area: Energy Efficiency

Country: Germany

Project Coordinator: Ms. Susanne Stump

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Questionnaire and interview: Daniela.Retzmann@pb-schubert.de

Phone: +49 (0)3528 4196 0

Website: www.energie-westlausitz.de

Since the start of the project, the following activities have been carried out:

2012:

Selection of two pilot municipalities
Selection of a suitable energy controlling software
Meetings of the energy managers and the project team
Creation of record sheets on building energy performance
System technology and metering
Prioritisation and selection of reference buildings (large in size and of public relevance, e.g., schools, a town hall)
Starting a software training programme – "Energy Manager Kommunal®" – for the energy managers
Instruction on how to examine and optimise various heat generating plants in the municipalities
Compilation of data on municipal properties in the software and the start of regular monthly consumption recording

2013:

Opening event in the pilot municipality Pulsnitz with the mayors and energy managers
Ongoing support on system optimisation
Specialised workshops: "Energy efficient street lighting" and "Maintenance of heating systems and optimisation of maintenance contracts"

Further compilation of data on municipal properties
Integration of the administrative communities in the consumption records
Creation of the first standard annual energy reports for 23 reference buildings using the energy controlling software
A first adventure tour by bicycle called "Renewable energies"

2014:

The core issues: metering and system optimisation (supported by the project team, the energy managers visit the municipal properties and examine the systems more closely)
Planned analysis and adjustment of energy supply contracts
The second pilot region in the specialised workshops: "Presentation and evaluation of energy reports by the energy managers", "Municipal energy supply contracts and tariffs" (in cooperation with the representatives from Leipziger Muldenland Saxony), and "Energy Transition in Rural Areas" – further meetings to be held on various topics
A second adventure tour by bicycle called "Renewable energies"

A strong focus of the project is on public relations work, public awareness raising, and communication. This includes regular press contacts, preparation of project information sheets, design and creation of the website www.energy-westlausitz.de, delivery of energy newsletters, presentation of the project at various events, and implementation of the adventure tours by bicycle. A best practice guide will also be written under the project, which will collect best experiences from the project and serve as an example for other regions with the same objectives.

Project objectives and drivers

The Westlausitz region targets the following priority objectives:

- Save energy and thereby reduce energy costs in the municipalities
- Establish a permanent energy management system in municipalities
- Use renewable energies
- Establish regional value-added chains
- Contribute to climate protection
- Support networks in the region
- Establish a "green image"
- Optimise energy-related investment decisions
- Improve local conditions for companies
- Improve the skills of local employees

The drivers behind these activities: reduction of energy costs and CO_2 emissions in order to contribute to climate protection.

Links to local development strategy

The Integrated Rural Development Concept of the Westlausitz Region is the local development strategy for the Westlausitz e.V. LAG. It indicates that "Achieving an energy-autonomous region for Westlausitz" is one of the priority areas of action. As a basis for further actions in the region, an energy concept for the 13 municipalities[4] of the Westlausitz Region was developed in 2009. One measure from this concept is the Saxony pilot project "Development of energy self-sufficiency for the LEADER region 'Westlausitz'", which has undergone implementation by all municipalities in the region since 2012.

LEADER funding

Table 1 Sources of funding for the Westlausitz project

Funder	Amount
LEADER funding	24,7964.10 EUR
Municipalities	82,654.70 EUR
Total project costs	**330,618.80 EUR**

There are two sources of funding for the project: the LEADER funding and funding from 13 municipalities. The LEADER funding covers the project management, training, and assistance of the nine energy managers in the municipalities as well as organisation of meetings, trainings, workshops and events for local citizens. The municipalities identify the employees to assume the role of energy manager. Salaries for these employees are contributed by the project. Saxony's Energy Agency SAENA provides technical knowledge within the project. It is responsible for carrying out training and assistance of the nine energy managers in the municipalities. SAENA is funded by different sources than the project.

Project outputs

The Westlausitz project resulted in a number of outputs from the various activities conducted, for which there were numerous beneficiaries within the project area. Table 2 details the beneficiaries and outputs achieved throughout the project.

Table 2 Project outputs and beneficiaries

Activity	Number of Activities	Number of beneficiaries
Working meetings between the project team and the local energy managers	9 working meetings	10 people per meeting
Training program "Energy Manager Kommunal®": ▪ first software training for the energy managers	6 events	10 people per event

[4] The regions consist of 13 municipalities: Arnsdorf, Bischofswerda, Bretnig-Hauswalde, Elstra, Frankenthal, Großharthau, Großröhrsdorf, Lichtenberg, Ohorn, Pulsnitz, Rammenau, Steina and Wachau.

Activity	Number of Activities	Number of beneficiaries
Specialised workshops: ▪ "Energy-efficient street lighting" ▪ "Maintenance of heating systems and optimisation of maintenance contracts" ▪ "Presentation and evaluation of energy reports" by the energy managers ▪ "Municipal energy supply contracts and tariffs" ▪ "Energy Transition in Rural Areas"	4 events	47 people in total
Training on energy controlling software	3 trainings	10 people per training
On-site meetings in the municipalities	35 meetings	73 people in total
Citizen events	2 adventure tours by bicycle called "Renewable	30 – 50 people per tour
Presentation of the project at various events	7-10 events	400 people in total

Benefits resulting from the project

Table 3 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3 Benefits and impacts of the Westlausitz project

Theme	Benefits	Quantitative results	Project impact
Social	Increased community cooperation	Was already established before the project started	Low
	Capacity building (e.g., No. of people in the municipalities involved, No. of schools involved, No. of trainings)	3 schools, 80 participants per school	Medium
Economic	Number of jobs created (full time equivalent)	1.5 for the project management	Low

From the table above, it is evident that social and economic benefits were gained from the project activities and could be quantified to some extent.

As an example of the mitigation benefits achieved by this project, three energy reports from 2013 were evaluated, which included information about the following reference buildings:

- Kindergarten "Kunterbunt" from the Bischofswerda municipality
- Municipal hall in Rammenau
- "Ernst-Rietschel" primary school in the municipality of Stadt Pulsnitz

Within the framework of this project, an inventory of demand data, including heat, energy and water use, for different reference buildings was taken in 2012. Monthly values were collected. The application of measures started in 2013 after the possible options/measures to reduce energy, heat and water use were introduced by the Energy Agency experts to the energy managers for the communities.

After application of the first measures in 2013, the energy reports showed a visible reduction of energy and water use in Rammenau and of heat use in the "Ernst-Rietschel" primary school in Stadt Pulsnitz. However, associated cost reductions are not visible yet. In the long term, the project foresees an approximate 15% reduction in the heat, energy and water use by the communities. The biggest potential is seen for the heat sector, in particular in primary schools as they are the biggest heat users. This reduction can only be achieved through optimisation of heating installations and by avoiding measures that require investments. Additional awareness raising activities and projects should run in parallel to the technical measures implemented in the schools, which has been estimated could contribute to a reduction of ca. 20% in heat use.

In addition to climate change mitigation, reductions in water consumption is another environmental benefit contributed by the project's activities. The main social benefits include: capacity building and improved environmental awareness by the local administrations and the public in the region. The capacity building benefit is mainly seen in the instruction of school pupils through carrying out small projects on energy saving issues; for example, to switch off the light when leaving a room or to turn off the heater for the night or the weekend. With regard to the main economic benefits, two benefits were indicated: 1) reduction of energy consumption and costs and 2) creation of jobs.

Actors

The Westlausitz e.V. LAG appointed the planning office 'Schubert' to act as regional management for the project. The LAG is primarily concerned with the implementation of the Integrated Rural Development Concept and coordinates amongst other things the following tasks: advice and support for funding applicants, assistance to and initiation of projects that promote rural development, organisation of the implementation of the flagship projects, and public relations. Table 4 outlines the three main actors and their roles in developing or implementing the project.

Table 4 Actors in the Westlausitz project and their roles

Actor	Role in the project
Thirteen local municipalities in the Westlausitz region	Establishment of local energy manager jobs in the local administrations – 9 energy manager positions were established in 13 municipalities
Saxony's Energy Agency SAENA	Provide technical knowledge, training, and assistance to the nine municipal energy managers
Planning office "Schubert"	Carry out project management and organisation of the training and assistance of the nine energy managers in the municipalities; organisation of meetings, trainings, workshops and citizen events

Success factors and barriers

The main factors that have led to the success of the project include:

- Improving the energy efficiency of municipal buildings
- Reduction of the energy costs in municipalities
- Awareness raising and increased environmental sensitivity of employees in local administrations
- Establishment of energy manager jobs in the local administrations
- Involvement of schools in energy projects
- Knowledge transfer

Barriers were also encountered when implementing the Westlausitz project. Table 5 below outlines the various problems and solutions devised to overcome them.

Table 5 Barriers to the Westlausitz project and solutions

Barrier	Solution
Limited time resources of the local energy managers	Optimisation of administrative processes, instruction by the town mayor
No or limited municipal funds for the measures that need investments	No solutions

There were several main lessons learnt in the process of developing and implementing the project. As a first step in developing similar projects, it is important to train the energy managers. It is important that employees who plan to be energy managers have the appropriate technical knowledge or experience. The limited time resources of the local energy managers should be taken into consideration – time overloading should be avoided. Furthermore, sufficient time should be given for the establishment of the local energy management. It is of particular importance that the issue is supported and promoted by the municipal mayor.

Project as an initiator of future activities in the region

There are no follow-up projects or activities planned that have resulted from the project. Nevertheless, the region will presumably continue to cooperate in the energy sector and will include this issue as one of the priority actions in the LEADER local development strategy. It is not clear yet what type of projects or activities will be proposed since the LDS will be written in the next few months (end of 2014). However, expansion of the production and use of renewable energy in the region is one of the priority climate actions that could be supported by LEADER in the future.

<u>Additional sources:</u>

Infoblatt Projekt "Aufbau eines kommunalen Energiemanagements", http://www.energie-westlausitz.de/tl_files/inhalte/downloads/Infoblatt-Aufbau-kommunales-Energiemanagement1.pdf;

Endevaluierung der Förderperiode 2007 – 2013 LEADER-Region Westlausitz, http://www.ilek-westlausitz.de/tl_files/inhalte/downloads/Bericht%20Endevaluierung_Region_Westlausitz.pdf

'Shadows and Sun' and 'Catching the Sun' – Improving the use of renewable energy

Project Background

The project was carried out by the Skofja Loka LAG in northwestern Slovenia. The LAG covers two valleys in a hilly to mountainous area with a high percentage of forests and significant biomass resources. The project aimed to increase the amount of renewable energy generated by local users.

The project activities included:

Phase 1

- Animation and awareness-raising activities in the local media regarding renewable energy (e.g., radio shows, short radio advertisements, surveys, and demonstration trips)
- Creation of an interactive website focusing on renewable energy and energy efficiency, which allowed users to pose questions
- Organisation of demonstration visits to renewable energy operations and establishment of interest groups

Phase 2

- Establishment of interest groups
- Installation of solar panels for private households

Basic information and contact

Project duration: 1.10.2008 – 31.12.2008, 1.1.2010 – 31.8.2010

Thematic area: Renewable Energy

Country: Slovenia

Project Coordinator: Ms. Kristina Miklavcic

Email Address: kristina.miklavcic@ra-sora.si

Phone: +386 4 50 60 225

Website: http://www.las-pogorje.si/Slo/main.asp

Project objectives and drivers

Objectives:
In the first phase of the project, the aim was to increase awareness, knowledge, and experience sharing on the topic of renewable energies. The project brought together energy advisors, forestry advisors, and potential investors in order to increase the production and availability of biomass resources for sale, as well as to increase the use of other renewable energies (in particular, solar power). Building on the outcomes of the first phase, the second phase focused on providing advisory support for the installation of solar water heating panels by private households and further promoting the opportunities presented by solar power in the region. In order to save costs, households installed the solar panels themselves, which built on pre-existing initiatives supporting independent constructions.

Drivers:

- The LAG was interested in doing a project related to renewable energy and energy efficiency, and it had a good existing relationship with the regional 'Energy advisory office', This entity includes two energy advisors who provide advisory support to regional stakeholders, focusing on energy efficiency and solar and biomass energy. It had been operating once a week for some time in the same building as the LAG office before this project was developed. The LAG also had established a good cooperative relationship with the local forestry office.

- In the primary awareness-raising phase, the response was very good and interest was identified. A discussion forum was organised and a few interest groups were formed, one of them being 'use of renewable energy' on which the second phase was then built.
- Biomass is largely available and has a lot of potential in the local area. Thus, the first phase was aimed at increasing awareness about this resource.
- For the second phase, subsidies were available through the national EcoFund for solar panel installations

Links to local development strategy

The project is linked with the regional development strategy and the LAG's local development strategy, which focus on sustainable use of natural resources as well as capacity building for the local population. In particular, it responds to the following LDS priorities:

- environmental protection – use of renewable energies
- information support and advisory support for the local population
- information and advisory support for carrying out investments

LEADER funding

Table 1 Sources of funding

	Funder	Amount
Phase 1	Skoja Loka LAG	11,183 EUR
	4 Local Municipalities	8,126 EUR
	Phase 1 Total costs	19,309 EUR
Phase 2	Skoja Loka LAG	11,752 EUR
	4 Local Municipalities (24 households invested, on average, 1,500 – 2,000 EUR per household)	1,515 EUR
	Phase 2 Total costs	13,267 EUR

Project outputs

The project had a number of outputs which directly benefited over 140 people from the region, in addition to providing indirect benefits to the wider population. Table 2 details the Beneficiaries and Outputs achieved throughout the project.

Table 2 Project outputs and beneficiaries

	Activity	Number of Activities	Number of beneficiaries
Phase 1	20-30 minute radio shows	7 repetitions	General population

	Activity	Number of Activities	Number of beneficiaries
	Online renewable energy forum (http://forum2.ra-sora.si/)	One website created	General population
	Informational advertisements	46 repetitions	General population
	Survey with local population	6 surveys	24 – 36 respondents per survey
	Demonstration visits	4 sites	42 participants
			Estimated no. of people reached by Phase 1 activities: 12,000
Phase 2	Article on solar panels	Published in 5 different magazines / newspapers (totalling 17,000 copies)	General population
	Online information platform; shows on local radio station	One website updated and maintained; 3 shows	General population
	Lecture – introductory	1	61
	Lecture – "how to" on panel installation	1	63
	Demonstration visits	2 sites	55
	Nr of households that installed panels	24	Residents of 24 households
	Nr of panels installed	5-6 per household	Residents of 24 households

Benefits resulting from the project

The renewable energy activities in the project resulted in a number of various benefits, including mitigation, adaptation, other environmental benefits, social, and expected economic benefits. Table 3 shows the various benefits achieved and the overall impact of these benefits from the project.

Table 3 Benefits and impacts of the project

	Benefits	Quantitative results	Project impact
Mitigation	Energy generated from renewable sources (kWh/yr)	2,000 – 3,000 kWh per year per household	Medium
	Avoided / Saved GHG emissions in tonnes CO_2 equivalents	870 kg CO_2 per year for lifespan of 20 years = 17.4 tonnes CO_2 emissions avoided per household	Medium

	Benefits	Quantitative results	Project impact
Social	Increased community cooperation		High
	Improved environmental awareness		High
	Capacity building	60 participants in renewable energy lecture	High
Economic	Cost-savings from energy use reduction	Between 90 – 300 EUR per year per household from reduced purchase of firewood or heating oil for fuel for water heating = 1,800 – 6,000 EUR per household over 20 year lifespan of solar panels	Low

Actors

A number of actors were involved in the project. Table 4 lists the actors and their role in developing or implementing the project.

Table 4 Actors and their roles

Actor	Role in the project
LAG Skofja Loka	▪ Project coordination, facilitated the purchase of supplies and construction materials for the panels ▪ Designed promotional material, organised the activities, provided animation for local media
Energy advisor Regional Forestry Office	Designed the content for the radio shows and the awareness-raising campaigns, prepared articles for publications.
Radio Sora	Organised radio programme (20 min. informational shows) and promotional activities
Building and Civil Engineering Institute ZRMK	Advising of private households in the process of installing the solar panels
Municipalities	Supported the project through co-financing

Success factors and barriers

Various factors were identified which contributed to the overall success of the project.

- Good cooperation relationships were established among local actors, which helped with implementation of the project. Within the project area, there is a culture of cooperation and a tradition of 'do-it-yourself'. The local population has a large amount of practical knowledge from work done on farms and in households, which contributes to the sense of self-initiative and tendency to try new things. Installing individual solar panels as a working group fit nicely with local tradition of group work as well. These working groups functioned for 2 – 3 months.

- The project fit well with the objectives of the LDS.
- Panels are easy to maintain.
- Installation by working groups was a lot cheaper than professional installation, which made adoption of the solar panels more affordable for the participants.
- The second phase of the project built on interests expressed in the first phase, so it was directly driven by participant interest and there was a lot of motivation to do the work.

No significant barriers were encountered when implementing the first phase of the project. In the second phase, there was hesitation on the part of the participants as to whether the individual self-installation method promoted under the project actually works or can be done since it was perceived to be too complicated. This questioning – led to organisation of the lecture where practical experiences from those who had already installed the solar panels were presented. This was aimed at convincing around 50-60 local attendees that the system works and that the technology is not too demanding. In addition, two demonstration visits were organised. After this additional information was provided and the local people witnessed completed installations, the interest was substantial.

A minor barrier encountered in the second phase was also that some of the materials needed for installation of the solar panels were not available locally, so some supplies had to be procured across the border in Austria.

Lessons learnt through implementation of the project are instructive for future projects and for the project activities / results to multiple on their own.

The key to the success of the second phase was the technical support provided by the expert from the Building and Civil Engineering Institute. Unfortunately, this expert has now retired and no replacement was hired. Without this technical support, the individual building groups cannot function.

EcoFund (http://www.ekosklad.si/) no longer provides subsidies for the solar panels. Previously, the subsidies were 150 EUR per panel. The average installation per household was 4 – 5 panels, so in total the subsidy was 600 – 750 EUR and the total cost per household ended up being 1500 – 2000 EUR on average. This is a significant amount of money for individuals to have to put up-front as an investment in renewable energy, so the subsidies were very helpful before in increasing access to these technologies.

Project as an initiator of future activities in the region

Following conclusion of the project, several people continued with self-installation of panels. Two additional groups of up to 10 households were formed.

The LAG would like to build on the good experience in this project and promote self-organising groups, with the aim of applying the method to other environmental issues. A key issues in the coming year or two to which these groups could contribute will be the installation of constructed wetlands for private households in order to meet water quality objectives and reduce diffuse water pollution in rural areas.

To further promote regional biomass use and activities, other funding sources will be used, supported in part by regional development programmes for 2014–2020. In general, the requirement for co-financing of LEADER projects is a barrier to future actions, however, since the municipalities have very limited funds at their disposal.

Mainstreaming climate change into rural development policy post 2013 – Annex 4

Promoting climate action through LEADER post 2013

This Annex 4 is part of the Technical Guidance produced in the project "Mainstreaming climate change into rural development policy post 2013".

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Table of Contents

Introduction

The LEADER instrument can play an important mobilising role in climate protection and in improving climate resilience in rural areas. Focusing on bottom-up, participatory development activities, the LEADER mechanism enables the development of joint initiatives and pilot projects which can facilitate capacity building as well as concrete investments in rural areas. The outcomes of the study (in particular Annex 3 and Annex 6) illustrate many good examples for how LEADER has already addressed climate concerns in the 2007 – 2013 period. Nonetheless, the geographic concentration of visible climate projects in a smaller number of Member States together with the discussions held at the project workshop indicate that climate action could be further integrated in LEADER, in terms of topics addressed as well as in terms of the geographic coverage of climate projects.

In addition to identifying existing and new topics or concepts for LEADER action, the study also addresses some of the key barriers that were identified for greater inclusion of climate action in LEADER. LEADER in addressed in three sections of the study:

- Annex 3 which presents best practice factsheets for 2007 – 2013 LEADER projects
- Annex 6 where the long list of projects that were identified is available with short descriptions of objectives, thematic area, and contacts (where available)
- In Annex 4 guidance is provided on how some of the barriers could be addressed and what types of new innovative topics could be pursued through LEADER

Specifically, Annex 4 contains three sections:

- How could Managing Authorities support LAGs to better address climate action in local development strategies and LEADER projects
- How could Managing Authorities demonstrate the economic and other benefits of climate action for rural areas
- What types of innovative climate topics can be addressed in the future by LEADER

How could Managing Authorities support LAGs to better address climate action in local development strategies and LEADER projects

In Chapter 4 of the main report, the key challenges to greater inclusion of climate action in LEADER projects were identified. One of these is the need to increase awareness of how climate change can be addressed by LEADER ('how to do climate action in LEADER') by providing enough guidance to LAGs while at the same time allowing sufficient autonomy and flexibility to local communities, facilitating innovation and context-specific responses which are the hallmark of the LEADER approach.

For LAGs to act on climate change, the relevance of climate change and potential for action through LEADER needs to be better demonstrated in regional / local contexts and interest of local communities increased to act on the issue. If climate change is not explicitly named as an objective of local development strategies, this presents a barrier for local actors to develop specific projects. One of the first steps in further promoting climate change through LEADER is to raise awareness of the value of climate action for local communities, while also improving the capacity of LAGs to address climate change through incorporating it as objective of local development strategies and through developing concrete project ideas. A balance needs to be struck between allowing sufficient flexibility and ensuring that climate objectives (as horizontal priorities under the EAFRD) are addressed in all relevant RD instruments.

Some examples of steps that Managing Authorities could take in promoting climate action through LEADER are outlined below.

Promote the inclusion of climate action in local development strategies

- Incorporate climate change mitigation and adaptation as a thematic area to be addressed by LEADER at national level;
- Include a quantitative target for climate mitigation and adaptation focused funding by earmarking a minimum percentage of national LEADER funds for climate action;
- Establish a reward system for LAGs which prioritise climate within their LDS (e.g., extra points in the selection process for LDSs);
- Introduce climate proofing criteria for local development strategies and for LEADER projects;
- Projects that are funded under the LEADER instrument should be climate-proofed in order to ensure that at the very least they do not have negative impacts on mitigation / adaptation objectives, and to maximize the possibility that they can contribute actively to these objectives. Climate proofing means that projects are checked to make sure that they address climate objectives sufficiently, and at the very least do not lead to maladaptation. This is especially important for investments in capital works.
- Monitor how LDSs and LEADER projects are addressing climate objectives; report on progress and suggest improvements (see the following section)

- Promote linking of local development strategies with other regional and national climate strategies
- According to the Regulation (EU) No 525/2013 on a Mechanism for monitoring and reporting greenhouse gas emissions Member States need to prepare low-carbon development strategies and report to the Commission by January 2015 on the status of their implementation. In many cases the national low-carbon development strategies will be downscaled to the local low carbon planning/plans/actions. How these are implemented will vary across Member States. LEADER can be used as one funding stream for low carbon action plans.
- Ensure that sufficient technical guidance and support is made available to LAGs on how to address climate action through LDS and LEADER projects.

Provide technical guidance to LAGs on how to address climate action through LEADER projects

Provide examples of how climate action can be integrated in LAS objectives

Climate action can contribute to multiple objectives, from social, economic to environmental. MAs can illustrate to LAGs links between climate action and other objectives. For example, it can contribute to:

- Innovation: by trialing innovative approaches and increasing awareness and knowledge base
- Economic development: by building resilience and thus avoiding damages from climate change, by increasing resource efficiency and
- Social cohesion and quality of life: by maintaining the availability of land-based resources on which rural communities depend, and addressing the needs of vulnerable social groups which would be most affected by climate change
- Environmental protection

To make these links concrete for LAGs, Managing Authorities could collect best practices on how climate action delivers socio-economic benefits, benefits for environmental protection, social equality and inclusion of vulnerable social groups and disseminate them to the LAGs. The National Rural Networks and European Rural Network could be particularly relevant for this exercise. In particular, highlight how climate action contributes to economic development (see the following section). In doing so, they can also draw on the best practice examples available in Annex 3.

Incorporate climate change topics in national training and experience sharing for LAGs

MAs can encourage sharing of experiences between individual LAGs around climate change through twinning projects, workshops, training events, as well as through the advisory services. A mentoring system can be established for LAGs integrating climate action into LEADER projects. LEADER projects that address climate change mitigation and/or adaptation in brochures, or online platforms.

How Managing Authorities can demonstrate the economic and other benefits of climate action for rural areas

Introduction

The LEADER instrument provides opportunities for rural communities not only through the traditional focus areas of CAP – agriculture and forestry sectors – but in particular through supporting activities focused more broadly on local economic development.

At the project workshop, a concern was voiced by practitioners that the LEADER instrument is not suitable for climate action as it focuses traditionally on economic development and cultural heritage. From this perspective climate action could be perceived to be in opposition to economic development rather than an opportunity through which rural areas can be strengthened, both in terms of economic as well as social development.

Climate change impacts can have significant costs which need to be considered in the context of sustainable development in rural areas. Delayed action further increases costs, and climate adaptation needs to be integrated as a horizontal part of activities across all sectors in rural areas. Climate action can avert or minimise costs of climate change impacts while also presenting opportunities for local/regional economic development. At the same times, rural areas are also important in terms of reducing greenhouse gas emissions.

What types of social and economic benefits can low carbon planning and development on the one hand, and adaptation action on the other hand deliver in rural areas?

As illustrated by the best practice examples of LEADER projects from the 2007 -2013 period (see Annex 3), climate action projects deliver a range of benefits. Projects which provide climate benefits also deliver social, economic benefits, other environmental, and cultural heritage benefits. The potential of climate action projects to bring these wider benefits to rural communities illustrates that climate action is a very relevant area for achieving LEADER objectives and fits well with the instrument.

Managing Authorities can demonstrate to LAGs and rural communities the types of social and economic benefits of LEADER climate projects

The Managing Authorities can draw on the available examples of existing projects to demonstrate to LAGs and rural practitioners, how climate action is linked to social and economic development. It is hoped that the best practice factsheets in Annex 3 will provide examples and inspiration for envisioning how climate action activities can contribute to economic and social goals in rural areas. Managing Authorities can use these examples to illustrate the links between low carbon planning, adaptation and social and economic benefits.

Based on the best practice project factsheets, below are indications of the social and economic benefits which may be obtained from projects with a climate action focus and which can be emphasised.

Social benefits:

- Capacity building activities, such as workshops on climate with the local community, integration of climate change into school curriculums, and carbon footprinting for organisations, result in *improved environmental awareness*.
- Project activities focusing on coordination of community adaptation initiatives, farm / landowner management for restoration of habitats / wetlands, reducing emissions from supply chains through local buying, establishing local processing facilities for more local food availability as well as value-added opportunities, creating sustainable business networks, and renewable energy cooperatives *result in increased cooperation in the community.*
- Projects which involve activities that create or improve recreational opportunities for communities through nature conservation, enhance the natural resources in the local area, and build resilience to climate change impacts (e.g., floods) result in *improved quality of life.*
- Establishment of demonstration or model sites within the scope of the project to show how to implement climate-focused activities, e.g., sustainable land management methods, improve the *knowledge base and capacity to deal with climate change impacts*

Economic benefits:

- Creating a cooperative or joint action initiative, e.g., setting up a green waste collection system for CO_2 recycling or renewable energy schemes for communities, creates and potentially diversifies jobs, contributes to using a valuable waste material as a resource for local communities. Another way that jobs can be created within climate action projects is from the project management perspective – a coordinator role within the project to push forward activities and communicate with stakeholders.
- Projects which include carbon footprinting and investment in energy efficiency result in benefits in terms of the total investment in renewable energy production as well as the total investment in energy savings and efficiency.
- Building climate resilience for businesses, communities, individual stakeholders, etc. results in potentially large avoided damages from climate events.
- Targeted organisation of community energy provision as well as increased local planting of traditional cultivars for resilience to climate change and lower emissions from external food sourcing results in improved services / infrastructure and increased food self-sufficiency.
- Projects which involve activities that continue beyond the scope of the initial LEADER project, such as establishing a local business, community facility, processing or biomass energy plant, result in follow-up initiatives that help to further development and create value for the local area.
- Projects which include activities aimed at improving irrigation infrastructure or water resources for the local area can also result in economic benefits from more efficient use of inputs and higher yields of crops, for instance. However, projects focusing on improving natural resources may take a longer period of time to demonstrate the full extent of possible economic benefits, such as building soil humus for improved soil fertility and carbon sequestration potential.

Types of indicators that can be used to monitor and demonstrate benefits of climate LEADER projects

In addition to drawing on available information of economic and social benefits, establishing the monitoring and evaluation of existing and future LEADER projects in terms of climate benefits would increase climate visibility in LEADER. How different benefits that can result from LEADER projects can be measured by using different indicators is presented in Table 1 below.

Table 1: Examples of types of benefits and indicators

Benefit	Indicator
Social benefits	• Increased cooperation in community • Improved environmental awareness • Improved quality of life • Capacity building (No. of people, trainings held, etc.) • Improved health
Economic benefits	• Nr of jobs created • Nr of new business start-ups • Job diversification • Impacts of maintenance (employment, GVA) • Increase in income for employees • Rural population benefiting from improved services/ infrastructures • Total investment in renewable energy production (€) • Total investment in energy savings and efficiency (€) • Effects on wider economy (tourism, inward investments) (€) • Value of damage avoided due to climate change, flooding, other natural hazards (€)
Mitigation benefits	• Electricity generated from renewable sources (kWh/yr) • Heat generated from renewable source (MJ/yr) • Energy savings in heat (MJ/yr) • Energy savings in electricity (kWh/yr) • Volume of carbon stored/ sequestered in tones CO_2 equivalents • Increase in production of renewable energy in Kilo-Tonnes of Oil Equivalent (ktoe) • Avoided/ Saved GHG emissions in tonnes CO_2 equivalents
Adaptation benefits	• Nr of farms with farm resilience plans • Increased water retention at farm level • Improvement in water retention at catchment level • Improvements in water quality • Improvements in water quantity • % Reduction in flood risk • Reduced vulnerability • Increased resilience • Increased awareness of adaptation needs • Increased awareness of adaptation options
Other environm. benefits	• Increase in farmland biodiversity (Ha or species involved) • Improved soil fertility (Nr of Ha involved) • Reduction in loss of soils through erosion • Creation of new habitats (Nr of Ha involved) • Maintenance of habitats (Nr of Ha involved) • Reduced water consumption (in m^3) • Reduced availability of water for use (in m^3) • Increased connectivity of habitats

Benefit	Indicator
	• Improved air quality • Follow-up initiatives
Cultural heritage benefits	• Creation of recreation opportunities • Increase in traditional practices • Continuation of local traditions • Increased awareness of local traditions • Number of people benefiting from enhanced wildlife, landscape, visual amenity

In preparing project factsheets, LEADER project coordinators were asked to evaluate, whether by providing a quantitative indication of the benefit or a qualitative judgment as to the extent of the project impact (high, medium, or low).

For many benefits, estimates or quantitative results were provided and a judgment could be made as to the impact of the project's activities. Project coordinators found it difficult, however, to complete the quantitative indication for some categories, particularly the social benefits as well as adaptation and cultural heritage benefits. Often, expert judgment could be made as to the general impact of the project's activities (high, medium or low), but the benefits were harder to measure since they are less quantitative (e.g., capacity building resulting in X amount of knowledge gained which can only be represented as X people attending a workshop).

In addition, assessing mitigation benefits was often a challenging task. For instance, installing a renewable energy device resulted in X tonnes of CO_2 equivalent in avoided GHG emissions. However, in some cases this information was not provided due to the lack of monitoring and measuring of the benefits of the project's activities by the LEADER project. A potential reason for this lack of monitoring and measuring is lack of technical capacity or knowledge by local project managers, stakeholders, or project implementers as to how to effectively measure climate benefits. LEADER projects are often small-scale and those from the local area involved with developing, designing, and implementing the project may not have climate expertise, particularly measuring emissions reductions or future adaptation potential, despite wanting to integrate a climate element into the project.

By providing trainings and guidance, Managing Authorities could help to improve monitoring and measurement of climate benefits from LEADER projects and potentially increase the uptake of climate action projects upon better demonstration of their wide-ranging benefits.

What types of climate topics can be addressed by future LEADER

What is innovative for a particular region and LAG depends on the already existing resources, initiatives and conditions in the region. In some Member States and regions, climate action has already been well integrated in LEADER (for example, in UK, Germany, Austria, the Netherlands), in other regions it is a much less visible part of this approach or largely absent. There is potential to learn from those who already have made valuable experiences, and the best practice examples (see Annex 3 as well as Annex 6) provide a useful starting point.

A list of possible project topics cannot be prescriptive. The list here is meant to serve as an illustration, indicating the types of climate actions that would benefit from being designed and implemented via the LEADER approach. In general, it can be said that while mitigation topics have already been incorporated in LEADER (renewable energies, energy efficiency, capacity building for mitigation) and these should continue to be present in future activities, there is in particular a need and opportunity to use the LEADER instrument also much more intentionally and systematically for the planning and implementation of adaptation activities. It may also be easier for local communities to see how adaptation activities fit with the more traditional LEADER objectives of economic and social development. Ideally, there would also be synergies with mitigation.

Climate Mitigation Activities

The types of mitigation topics and activities that can be rolled-out further across LEADER areas are illustrated in Annex 3 and Annex 6, as well as in Chapter 4 of the main report.

In particular in areas where there is absence of experience with climate action, LEADER can provide a mobilising role through capacity building and awareness raising on opportunities climate mitigation in rural areas, and to build 'carbon consciousness' among the population as well as in rural businesses. This includes the development and use of carbon audits and the identification of solutions. In addition, local and regional energy planning (and low carbon mobility planning), as well as closing of resource cycles (e.g. making use of waste materials such as green waste) at community level are the types of activities which can greatly benefit from LEADER funding while at the same time having a very tangible impact for local development, social inclusion, and rural quality of life.

Moreover, in principle, many if not most of the innovative mitigation actions identified under Annex 1 can also be supported in combination with the LEADER approach. LEADER projects can, for example, be used to increase the capacity of farmers to include these actions on their farms by organising demonstration events, trainings, discussion groups, sharing of best practice examples to support these mitigation actions (in particular if the actions are very relevant for the local area and there is no other RD support available for them, and there is also absence of other collaborative (joint actions) that are funded by RDP). Some of the key actions which could be supported in this way include:

- Carbon audits for farms
- Shelterbelts and hedges (linked to recreational goals)

- Restoration of wetlands

Climate Adaptation Activities

LEADER can play an important catalysing role for improved climate resilience in rural areas. Thus far, LEADER projects have largely not covered adaptation. Only a few examples of projects were identified where adaptation was a core part of LEADER activities (for a notable exception, see the Cheviot Futures project). From an adaptation perspective, LEADER is a very valuable instrument that has been underutilised so far and deserves more attention.

Climate change impacts are locally / regionally diverse and vulnerability depends on local structures and conditions, and the adaptive capacity of local communities and economies. While adaptive planning at national and regional levels is underway in many Member States, at local and sub-regional level adaptation often remains an abstract notion as strategies are not translated to this local level. On the other hand, where there are weak national or regional responses in place, local and bottom-up initiatives around adaptation can provide a jumping start for increased awareness and best practice examples that can translate into action further up to regional / national level. Adaptation can provide a jump-start for mitigation activities as well where there is overlap and synergies between the two (See Annex 1 for examples).

Climate adaptation activities through LEADER can contribute to:

- Increase awareness of climate change predictions, vulnerabilities, and adaptation options
- Establish local strategies and action plans for adaptation
- Select adaptation options to implement, and follow through with implementation (incl. by demonstration, financing capital works, or other project activities)

Different types of activities can be supported such as:

- Establish a networking environment such as stakeholder platforms or working groups to identify climate change vulnerabilities at regional / local scale and to identify adaptation strategies / options. Maintain a broad scope of vulnerabilities and actions in order to maintain interest and stakeholder buy-in. This differs somewhat from the climate networks concept for agriculture which is outlined in Annex 5 in the sense that here the focus is on cross-sectoral and more narrowly territorial cooperation.
- Fund studies to identify vulnerabilities / potential damage costs, as well as cost-benefits of adaptation options which can feed into adaptation strategies. Identify in particular also the most vulnerable social groups and sectors. Examples of studies that can be funded by LEADER include:
  - Climate change predictions http://www.cheviotfutures.co.uk/phpdocuments/73.pdf
  - Climate proofing Cheviot Hills http://www.cheviotfutures.co.uk/phpdocuments/68.pdf
- Develop adaptation plans for local communities (incorporating different sectors) and incorporate synergistic options which also have an impact on mitigation. The Climate Adapt platform - http://climate-adapt.eea.europa.eu/ - provides

valuable resources that are relevant for preparation of action plans. Some concrete examples of action plans (at regional, or catchment scale) can be found here as well:

- http://www.epnrm.sa.gov.au/Portals/4/Climate%20Change/EP%20Climate%20Change%20Adaption%20Plan%20Feb%202014.pdf
- http://www.label-eu.eu/uploads/media/DE_LABEL_Climate_change_study_4.1.3.pdf (in German)

- Develop information points or information campaigns to share best practice and support simple measures to adapt to climate change impacts. For example, demonstration projects can include:
  - Establishment and management of shelterbelts and hedges to provide multiple adaptation benefits (Fiche A5)
  - Improved irrigation efficiency (Fiche A7)
  - The provision of alternative water sources for livestock (e.g. under conditions of reduced rainfall, increased droughts) - http://www.cheviotfutures.co.uk/phpdocuments/Alternative_Water_Supplies.pdf
  - Demonstration sites for natural water retention measures and reducing the impacts of flooding (such as bank stabilization, tree planting along riverbanks)
  - Develop approaches for animal health and animal welfare planning under climate change conditions – e.g. http://www.cheviotfutures.co.uk/phpdocuments/AHW.pdf
  - A helpful overview of different possible types of actions is available here: http://www.cheviotfutures.co.uk/phpdocuments/cheviotfutures_newsletter4_dec2013_web.pdf
- Implement discussion groups and develop farm resilience plans: Under LEADER this activity could be used to roll-out a methodology developed under a joint action activity in a specific geographic area (see Annex 5 on joint actions). http://www.cheviotfutures.co.uk/phpdocuments/Farm_Resilience_Planning.pdf http://publications.naturalengland.org.uk/publication/5656542258921472
- Identify needs for and support local early warning systems for extreme weather events; support local communities to prepare responses to extreme weather events
- Different land management actions / capital works related to biodiversity which increase the resilience of natural systems can be funded under LEADER and contribute to adaptation.

Mainstreaming climate change into rural development policy post 2013 – Annex 5

Potential examples for climate-focused joint actions under the Cooperation Measure

This Annex 5 is part of the Technical Guidance produced in the project "Mainstreaming climate change into rural development policy post 2013".

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Table of Contents

Introduction

This Annex includes an indicative list of potential topics for joint actions under the Cooperation Measure and a list of success factors and barriers for pursuing collective actions. The list of topics is illustrative, it provides possible examples of types of actions that can be addressed under the Cooperation measure. Five potential topics are elaborated in more detail, outlining:

- Rationale and objectives for the joint action
- Potential actors
- Types of activities that can be supported
- Expected impact on mitigation and/or adaptation
- Combinations with other RDP measures

The following examples are elaborated in more detail:

No.	**Action**	**Author**
1	EIP operational group: Testing of regionally appropriate 'payment by result' schemes for N-efficiency	TI
2	EIP operational group: Development and/or improvement of regionally appropriate climate audit tools	Solagro
3	EIP operational group: Testing of innovative contracts for voluntary schemes to develop expansion tanks to store water for dry periods or to provide natural retention in case of heavy rains	INEA
4	Climate action networks	SRUC
5	EIP operational group: Develop a methodology for farm resilience plans for particular farm types/sectors, focussing on risks that farmers are currently underprepared for	AKI

Potential climate-focused topics for joint actions under the Cooperation measure

1. Cooperatives for machinery use

   Establishment of cooperatives for the purchase and shared use of agricultural machinery for no-till, reduced tillage, precise N-application technologies. In addition to sharing of machinery, cooperatives can provide training sessions for appropriate use of technologies (including, for example, on how to minimize the use of herbicides with no-till). In France, for example cooperatives for sharing machinery are quite frequent, especially in Western France. About 40% of the French farms are involved in this type of cooperatives. They are organised in local federations and some of them are beginning to propose training session in addition to machinery that is shared. Trainings that can be organised can cover, for example, direct seeding, herbicide application, or sessions on eco-driving.

2. Development and implementation of wetland restoration concepts

3. Climate action networks: Encourage peer-to-peer learning through demonstration farms and organise study groups to identify farm-level emissions sources and vulnerabilities as well as mitigation / adaptation option

   See the detailed description below.

<u>Establishment and operation of operational groups of European Innovation Partnership (EIP) for agricultural productivity and sustainability focusing on climate and dealing with one of the following issues:</u>

4. Joint initiatives on how to produce and certify baking wheat without late "quality fertilisation" with nitrogen (for example, a cross-country co-operative approach including cereal traders, mills and bakeries)

5. Development and/or improvement of regionally appropriate climate audit tools: the objective is to identify on-farm emission sources and mitigation options (while considering implications for adaptation) farm type or a mix of farm types

   See the detailed description below.

6. Development of health screening, identification of key health issues, and development of health plans or schemes in order to improve herd health status.

   Some diseases require the collaboration of a range of stakeholders (farmers, scientists, Government, veterinary industry, downstream processors etc) and there is scope for cross-border collaboration. An example of a Scottish initiative which was funded through the RDP is Quality Meat Scotland which received funding via the RDP's Skills Development Scheme to support "a series of interactive meetings across Scotland to be run by SRUC Research, for training and support for cattle farmers who wish to review and improve their management of Johne's disease with the aim of decreasing the financial impact that this disease has on farming businesses. The meetings cover herd management strategies, decision tools, and environmental aspects of Johne's by using working examples of Scottish herds from a previous study (the Paraban project).” http://www.qmscotland.co.uk/events/paraban-reloaded-1

7. Developing of regionally appropriate design options for adaptation of buildings: Focussing on specific types of buildings such as barns, poultry housing, cattle housing, greenhouses, etc.
8. Predictive mapping and development of practical tools to support the adaptation of crops and forest species to climatic changes
9. Identification of regionally appropriate strategies to increase resilience of forest stands to climate change, while delivering biodiversity and water protection
10. Testing of innovative contracts for voluntary schemes (payments for the loss of income and willingness of farmers to allow the use of agricultural land) to develop expansion tanks to store water for dry periods or to provide natural retention in case of heavy rains

    See the detailed description below.

11. Testing of regionally appropriate ‘payment by result’ schemes for N-efficiency

    See the detailed description below.

12. Develop a methodology for farm resilience plans for particular farm types / sectors, focussing on risks that farmers are currently underprepared for

    See the detailed description below.

13. Develop alternative substrates for horticulture, instead of turf (collaborate with research)
14. Establishment of monitoring and early warning systems among the advisory programmes to deal with climate risks (e.g. following a fodder crisis for the livestock sector, Ireland introduced such a service)
15. Practice-oriented operational groups for precise slurry application and improving N use efficiency (with cross-country cooperation)
16. Practice-oriented groups to support the transfer of existing adapted crops into practice, and increase drought resistance and waterlogging tolerance in the development of new varieties
17. Techniques for harvesting and processing weltand biomass (UK has financed a pilot project on this topic, see http://www.crops4energy.co.uk/decc-wetlands-biomass-bioenergy-competition/), or options for harvesting biomass from set-aside (a Finnish project)
18. Improve resource efficiency and minimise waste – energy efficiency at farm level and along the supply chain, and examine options for minimising waste locally and regionally in farm systems, primary production and supply chains (value of circular economy – recycling, efficient use of by-products).[1]

[1] http://ec.europa.eu/agriculture/research-innovation/events/2014-06--brussels/workshop-report_en.pdf

Success factors and barriers for joint actions

Table 1: Success factors and barriers for joint actions

	Success factors	Barriers
Develop-ment and organisation	• Build on existing informal social and information networks rather than generate entirely new networks. • Farmer-farmer networking and communication. • Tailored to meet the needs of a particular area (avoid a "one size fits all" approach). • Based on solid research and sound cost-benefit analyses. • The knowledge and expertise of local farmers is recognised and they are involved in the joint action's development and delivery (avoid "outside experts telling us what to do"). • Formalisation of the group through achieving some type of legal status (e.g., formal collective contracts which allow some autonomy), enabling groups of farmers to determine the terms of collaboration (e.g., allocations of costs and activities amongst themselves). • Scale of cooperation is logical, using geographical and/or landscape borders so that it is close enough to land managers. • Small, manageable group size - easier to maintain and develop good personal connections between members.	• Diversity of local conditions and contexts of farming systems (e.g., size, profitability, diversity of operation). • Potential problems with penalties or joint action compliance if the system is not adapted to the collective management structure (area (farmer) or management (agri-environmental cooperative)). • Divergent administrative arrangements. • Language barriers between collaborating locations. • Isolation may prevent farmers from being able to effectively work together. • Difficulties assessing impacts through use and adaptation of existing tools; developing complementary tools; engaging with researchers. • Traditional divides and working to bring various groups together; training; working through a territorial approach; engaging with institutions (contracting).

	Success factors	Barriers
Admin-istrative	• Groups develop their own solutions and implementation rules, as well as handle their own administration (e.g., payment systems for distributing funds to members). • Groups self-regulate and monitor for high standards of work - lowers administrative costs. • Flexible, practical and relevant approach towards member involvement and joint activities ("avoid calendar farming"). • Tackle the 'free riders problem': a combination of collective and individual approaches in the same area is not allowed.	• Official processes for obtaining policy support for joint actions are distant, formal, not trusted – "'jobs for the boys', just money for more consultants, etc." • Crippling bureaucracy – often worse in the early years of a new system. • Unfavorable policy framework (e.g., without tax rebates, leases), which fails to use existing possibilities to the maximum and engage with policy-makers where needed. • Lack of upscaling to ensure wider benefits from good joint action examples, which would involve working with local authorities and public institutions.
Actors	• Many different actors lead and should be involved in cooperative actions (e.g., farmers, local citizens, local authorities). • Coordination by public agencies or other bodies - tends to be more effective at being proactive than bottom-up led initiatives. • Selecting and training group facilitators to assist in group capacity building, scheme development, and ideas and advice on securing funding. • Having professional staff or an administration unit dedicated to the project.	• Farmers generally prefer to work independently rather than in groups, possibly to maintain a competitive advantage. • Lack of communication, mistrust between local actors and/or of the funding and regulatory bodies. • Concerns about free-riders, or exploitation by other group members. • Local actors' aversion to risk. • Lack of experience with collective action (e.g., securing funding) and potential lack of confidence in individual skills. • Seen as another form of administrative burden, management effort, or risk. • Farmers are unlikely to identify the environmental benefits of cooperative action by themselves. They do not see it as their role, nor their area of expertise, to identify opportunities for collaborative environmental working.

	Success factors	Barriers
Costs and benefits of the project	• Financial incentives for collective action exceed the additional costs of collaboration and perhaps the costs of increased management and risk. • Education and training, as well as effective communication and information, provided for effective implementation. • Deliver real benefits and outcomes ("avoid delivering soft money or farmers dole"). • Potential benefits including: sharing and minimising costs; sharing knowledge; sharing and mobilising resources; increasing credibility of decisions; allowing flexible, locally relevant responses; and building capacity to cope with future changes • Support positive farming activities rather than focus on limiting negative ones ("put the pride back into farming in marginal areas") • Initiate and support activities that increase members' opportunities (e.g., marketing initiatives)	• Current incentives to encourage collective environmental action amongst farmers or provide public goods are weak. • Farmers are predominantly focused on business profitability. • Cooperative action initiation and implementation can be costly. • Benefits must exceed the transaction costs involved with developing new mechanisms. • Lack of match-funding for investments / poor business confidence. • Low budget for expenditure outside administrative borders or cross-border cooperation (e.g., 5%).

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EIP operational group: Testing of regionally appropriate 'payment by result' schemes for N-efficiency

Summary

- EIP operational group (OG) aims at the development and testing of regionally appropriate 'payment by result' schemes for N-efficiency
- Effectiveness of the N-efficiency operation should be increased by promoting a higher uptake and potentially improve cost effectiveness (due to better impact control)
- In order to succeed different actors from science, practice, administration and politics are involved in the OG
- Potential actors: farmers, advisors, members of programming and managing authorities, water authorities, researches/evaluators
- Within the OG activities such as workshops/seminars, expert consultations and required equipment and personnel can be supported
- Increased N-efficiency reduces NH_3, direct/indirect N_2O emissions and CO_2 emissions from fertiliser production (see technical fiche M3 Increased N-efficiency)
- Ancillary benefits include less eutrophication, acidification, and biodiversity loss due to N-losses (see technical fiche M3 Increased N-efficiency)

Rationale and description of the action

Increasing N-efficiency in agriculture is an important option to reduce N_2O and NH_3 emissions without restraining crop production. As emission pathways are diverse, increasing N-efficiency can be very complex. A number of different options exist that can be used to abate emissions and save fertiliser (see technical fiche M3 Increased N-efficiency). However, the "right" option always depends on the circumstances, which is why payment-by-action support might have limited impacts on N-efficiency.

A payment-by-result approach is much more flexible. Farmers are only rewarded, if N-surpluses are reduced according to their commitments irrespectively of the mitigation activities they used. This way abatement can be specifically adapted to the prevailing farm conditions. Compliance with the commitments is verified using N-balances at farm gate that have to be produced by the farmer himself. While dealing with the different mitigation options, the farmers obtain a detailed knowledge about N-efficiency and related topics (Osterburg and Schmidt, 2008). Operations aiming to reduce N surpluses exist in some states of Germany (Lower-Saxony (pilot project), Saxony-Anhalt, Thuringia and Brandenburg) since 2009/2010. In Lower Saxony, the approach was tested within the EU Life project WAgriCo in 2006-2007.

WAgriCo - Water Resources Management in Cooperation with Agriculture (http://www.wagrico.org)

One objective of the project was to select and develop measure with good ecologic and economic efficiency to achieve the goals of the Water Framework Directive (WFD). Measures with positive impacts of the mineral N content in autumn and N balances and good cost-efficiency were selected in the project. The implementation at 50 model farms in three pilot areas in Lower Saxony was accompanied with a participatory approach. Advisory services and trainings were provided to the participants. Discussion groups and workshops at local level, of the project members and of experts were conducted. An innovative aspect was a result oriented measure to reward for improved N-efficiency. However, during the project it was shown that this measure is not yet suitable for practical application due to difficulties with data collection and management (high data demand). Further activities were considered to be necessary to develop reliable impact indicators and control mechanisms for the result-oriented approach in Lower Saxony (NLWKN, 2011).

Although this approach bears a number of benefits, it has only been adopted tentatively. Reasons are an increased monitoring effort, thus higher costs and a potential low acceptance by beneficiaries. Due to the flexibility of the approach, beneficiaries need to take much higher efforts while also having higher risks of either applying insufficient amounts of fertiliser or exceeding the N threshold and losing their premium.

Result-oriented measures have potential to be further developed for livestock farms and the whole farm level. Therefore, further requirements for farm management should be specified that are to some extend integrated in good agricultural practices, such as documentation of farm and plot balances, data at farm level about purchases and sales, additional indicators, e.g. soil samples of the plots, farmyard manure and feed samples as well as samples of urea in milk (Flessa et al., 2012).

The EIP operational group (OG) aims to develop and test a regionally adapted and transparent payment-by-result scheme for N-efficiency. It will try to improve existing approaches and develop solutions as to how to overcome barriers, in order to increase uptake of the result-oriented N-efficiency approach. Another aspect is how to select the appropriate performance indicators and thresholds, as well as the control and verifiability of results. All participants contribute to the development of a prototype payment-by-result scheme for N-efficiency, which will be tested on pilot farms. The development of the scheme involves the definition of an overall framework. This will be supplemented by concepts focussing on successful incentivisation (payment design) and effective monitoring.

As it is developed and tested in co-operation with different partners from practice, science, administration and politics, fast implementation of the approach needs to be facilitated. An exchange of experiences between OG’s from different regions and Member States could improve the dissemination of innovative approaches for increasing N efficiency.

Potential Actors involved

In order to be able to consider the multiple interests of the affected actors, the OG should consist of members from science, practice, administration and politics:

- Farmers (from different areas) – represent their interests as beneficiaries; add their experiences; test the approach; provide feedback and information on regional environmental conditions and their strategies to improve N efficiency
- Advisors – provide experiences and information; bridge between farmers, authorities and researchers
- Managing/Programming authorities – provide information on programming issues and related topics
- Researchers/Evaluators – gather relevant (scientific) information; monitor the testing; evaluate test results

Types of activities that can be supported

- Workshops and seminars (exchange of experiences, planning of the project, development of concepts)
- Development of the approach
- Consultation of external experts
- Acquisition of necessary equipment / personnel for the testing and monitoring

Expected impact on mitigation and adaptation / ancillary benefits

An increased uptake would increase N-efficiency and thus reduce GHG emissions (esp. direct and indirect N_2O emissions and CO_2 emissions from reduced fertiliser production). Farmers can save money as they need less fertiliser. Reduced N-losses would mitigate environmental problems such as eutrophication, acidification and loss of biodiversity. Due to the result-oriented approach, the impact assessment will be improved and the cost-effectiveness of the operation can be better evaluated.

Combinations with other RDP measures

- Knowledge transfer (Art. 14) (e.g. Training)
- Technical Fiche M16 Carbon audit (under Art. 15 advisory services farm management and farm relief services
- Art. 16 Quality schemes for agricultural products and foodstuffs
- Art. 28 Agri-environment-climate

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EIP operational group: Development and/or improvement of regionally appropriate climate audit tools

Summary

The objective is to identify the GHG emissions from the agricultural and forestry sectors of a territory while involving the stakeholders in the diagnosis in order to design suitable mitigation options, as well as adaptation options that take into account the specificities of local agriculture.

Beyond the climate audit tool, it is above all a process that fosters a dynamic around climate change issues for agriculture and forestry, on the scale of a territory. Given the different type of actors that have to cooperate, the type of joint actions suggested is the establishment of clusters / networks or EIP operational group.

Rationale and description of the action

Particularly in rural areas, agriculture and forestry sectors can represent the main sources of GHG emissions compared to other sectors. In this case, it could be quite relevant to gather all the stakeholders from agriculture and forestry sectors in order to raise awareness of these issues and decide on a common action plan.

The main issues of the action is to quantify the total GHG emissions from agriculture and forestry and its current situation for carbon sequestration while putting forward the agricultural and forest goods produced in the studied area.

In the situation where a successful shared action plan is agreed, local mitigation and adaptation options could be implemented. A diversity of type of actions could be retained, in which some of them would probably induce co-benefits including environment (see the 25 Technical Fiches detailing ancillary effects for mitigation and adaptation measures).

To be successful, this operational group needs to be representative by mobilizing all the expected type of stakeholders, especially those from agriculture sector for which climate change is not always foreseen as a priority (Bolo et al, 2011). Then, the availability of an appropriate climate audit tool suitable for a territorial approach could be a barrier. Sometimes, national initiative already exists (Colomb et al, 2012). Thus, ClimAgri[2] software developed in France had been used in more than 20 different places. Anyway, it is always possible to use the EX-Ante Carbon-Balance Tool[3] from FAO (Bernoux et al, 2011) that could be improved by researchers of the territory for regionally specific conditions. However, the establishment of this appropriate climate audit tool is not the main issue and needs to be contained. Finally, a crucial point is to define an appropriate territory to be studied in terms of size (related to the data to be collected and the type and number of stakeholders for an efficient consultation) that also integrates any existing initiatives dealing with climate changes in agriculture and forestry.

[2] http://www2.ademe.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=24979

[3] http://www.fao.org/tc/exact/ex-act-home/en/

Potential Actors involved

Climate change is a complex topic, that's why it is important to establish steering committee that will gather complementary skills. Thus, the list of potential type of actors involved is quite exhaustive:

- Local/regional authorities for agriculture and environment that will coordinate and manage the steering committee;
- Agriculture stakeholders: chamber of agriculture, farmers union, agricultural schools and university, agricultural institutes (crops, cattle, fruits, etc.), producers groups;
- Forest stakeholders: public and private organizations that manage and exploit forest;
- Economic stakeholders: Cooperatives, Agri-food industries, feedstuffs industries…;
- Research stakeholders in charge of agriculture, forestry and climate. Their role will be to explain the climate change issues (mitigation and adaptation) for agriculture and forestry and to make sure that the climate audit tool takes into account the regional specificities;
- Associations dealing with environment, air quality, renewable energies… To integrate the action plan in a global view of the environmental issues of agriculture and forestry.

The involvement of different agricultural and forest stakeholders in the steering committee is essential for their expertise, especially in the data collection, the validation of the results from the assessment and the construction of the scenarios.

Types of activities that can be supported

This operational group could support different type of activities:

- Scientific expertise to integrate regional specifications;
- Technical expertise to assess the GHG emissions sources from the agricultural and forestry sectors in the studied area;
- Dissemination of the results (brochure, workshop, meeting, conference);

Different steps that would need to be taken to be successful:

- Mobilisation of a steering committee and awareness of the stakeholders;
- Climate audit tool is improved for regional specifications;
- Data collection involving the agricultural and forestry stakeholders;
- Assessment and simulations using the climate audit tool;
- Valorisation of the results and implementation of an action plan.

Expected impact on mitigation and adaptation / ancillary benefits

The suggested organisation allows work on both on mitigation and adaptation. Any type of GHG emissions sources could be addressed (on-farm, off-farms emissions, carbon sequestration), depending on the steering committee action plan. The advantage of the climate audit tool is to provide a quantitative assessment of the GHG reductions. For adaptation options, qualitative information could be addressed in a resilience plan. Finally, the involvement of an environmental organisation is useful to ensure that mitigation and adaptation options don't have negative effects.

Combinations with other RDP measures

This kind of joint action could be combined with:

- Art 14(1), Knowledge transfer and Information actions
- Art 28(1), Agri-environment-climate
- The carbon audit fiche mentions the possibility to use already existing carbon tools. A joint action extending beyond farm boundaries and working at a territorial scale would foster a cooperation of different actors around climate issues and facilitate the actual implementation of actions at farm level.

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EIP operational group: Innovative contracts for voluntary schemes to develop expansion tanks to store water for dry periods or to provide natural retention in case of heavy rains

Summary

- Physical water storage is one component of a range of adaptation strategies. Inadequate storage leaves farmers vulnerable to variations of climate and drought stress.
- Increasing the potential catchment water retention capacity which in many cases has been affected by human activities is an important component of the protection and development of water resources
- Land management measures to promote natural water storage need the involvement of farmers along with local organisations and authorities.
- Each type of water storage/retention has its own niche in terms of technical feasibility, socioeconomic sustainability, impact on health and environment and institutional requirements. Each needs to be considered carefully within the context of its geographic, cultural and political location.
- Promoting collective approaches requires a careful design of the institutional framework and an in-depth analysis of (mainly private) costs and (mainly social) benefits well suited to the characteristics of local areas.
- The EIP operational group should be aimed to develop and test the involvement of local actors through innovative contract forms
- Methodologies that integrates GIS with a continuous runoff accounting should be developed and assessed
- The likely success is much greater if farmers are involved from the early planning stages onwards and the benefits of the project should be apparent to the farmers as early as possible.

Rationale and description of the action

Increasing attention is being focused on water supply techniques, as climate change increases rainfall variability and average temperatures, affecting both the supply and demand side of the irrigation equation. In some areas, annual precipitation will decline, decreasing river flows and groundwater recharge. In other places, total precipitation may increase but it will fall over shorter periods with greater intensity so that the risks of floods are more and more apparent. Increasing the resilience and adaptability of water supply systems is becoming a desirable feature. Farmers will generally need to adapt their activities to less soil moisture and higher evaporation. This means larger volumes and more frequent use of supplemental water. Physical water storage is one component of a range of adaptation strategies. Inadequate storage leaves farmers vulnerable to variations of climate and drought stress (Keller et al. 2000, IWMI 2009).

On the other hand, agriculture intensification, homogenisation of crop habitats, construction of drainage systems as well as urban development and resulting changes in surface character cause intensification of water and matter cycle in river catchments contributing to occurrence of floods. The natural water retention capacity of the catchment has decreased while the runoff paths have been streamlined what cause rapid runoff of precipitation and snow melting waters to river (Mioduszewski 2014).

Increasing the potential catchment water retention capacity which in many cases has been affected by human activities is an important component of the protection and development of water resources (Graham 2012). Large volumes of surface water can run-off farmland during heavy rain and this can cause soil erosion, water pollution and flooding. Water retention measures can help prevent these problems by holding back surface water flows and allowing them to dissipate into the soil or to slowly flow into a watercourse (EC 2012, Natural England, 2011). These methods can significantly contribute to the protection of water quality and improve the structure of the water balance. Small retention may play a role in reducing the negative impacts of droughts. Water accumulated in the reservoir can be used for irrigation or for other purposes.

Disadvantages of rainwater harvesting technologies are mainly due to the limited supply and uncertainty of rainfall. Adoption of this technology requires a bottom up approach rather than the more usual top down approach employed in other water resources development projects. On the other hand the protection against flooding that semi-natural agro-ecosystems afford is quite important and could be only achieved with relatively large-scale operations. Land management measures to promote natural water storage need the involvement of farmers along with local organisations and authorities. Promoting collective approaches requires a careful design of the institutional framework and an in-depth analysis of (mainly private) costs and (mainly social) benefits well suited to the characteristics of local areas. The EIP operational group should be aimed to develop and test the involvement of local actors through innovative contract forms guarantying adequate incentives to farmers and effective results in terms of better water management.

Potential Actors involved

The Operation Group should involve different stakeholders that cover the diverse aspects of the project from science to practice and policy making.

- Farmers should be helped to understand the importance of adaptive measures beyond the needs of their farms in terms of ecosystem services
- Advisory services provide information and advice on a range of potential measures with regard to harvesting and storing water for efficient irrigation and flood management
- Researchers show the potential of new technology according to the characteristics of local areas
- Government agencies and regulators may provide an incentive for farmers to take action by re-negotiating water abstraction licenses and/or introducing charging/tradable permit schemes to promote efficient use of reduced water resources
- Evaluators have to analyses the farmers attitudes and the institution suitability to collective actions and to test at local level possible options for effective implementation of collective measures

Types of activities that can be supported

A preliminary analysis of the physical characteristics of the catchment area is essential to promote effective projects. The suitability of a site for a farm pond requires a careful assessment of spatially varying parameters such as runoff potential, slope, and land-cover. Given the increasing demand for water requirements in agriculture, a GIS analysis could be effective in agricultural areas. To identify possible sites for rainwater harvesting through farm ponds, a methodology that integrates GIS with a continuous runoff accounting should be developed and assessed (Camnasio, Becci 2011, Napoli et al. 2014).

In a wide programme of good land management practices, water retention measures - including temporary storage ponds, seepage barriers, in-ditch wetlands, swales and grassed waterways - should be jointly implemented with other measures such as alleviating soil compaction and creating buffer strips beside water bodies. Specialist advice should be used when designing and constructing measures.

In case of water harvesting a possible option could be the use of ground or land surface catchment areas for collecting rainwater. It requires specific analysis of runoff capacity of the land surface in order to identify suitable techniques including collection of runoff with drain pipes and storage of collected water. Investments may be needed to create runoff harvesting structures like farm ponds that can be used to augment water supplies.

The chances for success are much greater if farmers are involved from the early planning stages onwards. However, the risk levels and profit potential for investment of labour and other inputs must also be acceptable. The benefits of the project should be apparent to the farmers as early as possible, including the potential financial incentive if the social benefits of these ecosystem services is highly relevant.

The collective contracts have to deal with the yearly management of the project, often undervalued when cost and benefit are assessed. Maintenance is generally limited to the annual cleaning of the reservoir and regular inspection of the channels and down-pipes. Maintenance typically consists of the removal of dirt, leaves and other accumulated materials, that should take place annually before the start of the major rainfall season.

Farm-level measures are needed to allow rainwater harvesting and improve drainage to reduce waterlogging. Each type of storage has its own niche in terms of technical feasibility, socioeconomic sustainability, impact on health and environment and institutional requirements. Each needs to be considered carefully within the context of its geographic, cultural and political location. With so much uncertainty in climate change scenarios, the best option is to focus on flexibility in storage/retention systems, wherever possible combining a variety of types to take advantage of their unique characteristics.

Expected impact on mitigation and adaptation / ancillary benefits

- Small surface water reservoirs could help to augment water availability for crops during severe drought period
- The potential of water storage is responsive to rainfall and effective water harvesting has to be based on runoff capacity of land surface
- The creation of water retention/storage areas provides multiple uses from productive purposes to recreational uses, from nature conservation to flood prevention
- Groundwater recharge could be helped by water retention and storage
- High evaporation loss fraction has to be assessed in order to assure a sufficient availability of irrigation water
- Relatively high unit cost siting may occur when structural and infrastructural changes are needed

- Absence of over-year storage has to be taken into account if small-scale water reservoirs is the main objective of the project
- Improved habitat for disease vectors may be happened if new wetlands are not well managed, enlivening water and cleaning channels and reservoirs
- Increased risk of eutrophication and salinisation in case of inappropriate water use
- Infrastructure damage as a result of higher flood peaks may occur in absence of appropriate risk analysis related to the hydro-climatic events

Combinations with other RDP measures

- Investment aids (art. 17)
- Knowledge transfer (art. 14)
- Advisory services (art. 15)

Fiche M9: Restoration of wetlands - MITIGATION
Fiche A8: On farm rainwater harvesting and storage - ADAPTATION

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Climate action networks

Summary

- Evidence suggests that significant unrealised potential win–win mitigation exists, i.e. there is scope for uptake of actions that can reduce emissions while providing a financial saving.
- Reasons for the apparent under-adoption of win-win actions include farmer knowledge levels, attitudes and prevailing social norms.
- Practical implementation of win-win actions on demonstration farms, measurement of their impact on farm (physical and economic) performance and dissemination of the findings via networks is one way to overcome barriers to adoption.
- Climate actions networks require a range of stakeholders and skills in order to: (a) setup and co-ordinate the network, (b) implement actions on-farm, (c) support implementation of actions and analyse impacts, (d) disseminate findings.

Rationale and description of the action

There is a growing body of evidence that seeks to identify appropriate GHG mitigation actions for agriculture. These range from high level studies with broad (sometimes global) scope (e.g. Gerber *et al.* 2013, Hristov *et al.* 2013) to studies examining an individual mitigation action in a specific context.

Several national level studies have been undertaken of the cost-effectiveness of mitigation (e.g. Moran *et al.* 2008, Schulte *et al*. 2012, Pellerin *et al.* 2013). These studies identify significant mitigation potential that could be achieved at a negative cost. Among the reasons proposed by MacLeod et al. (2010) to explain this apparent under-adoption of cost-saving mitigation measures, were that farmers do not always seek to maximise profits as their behaviour is influenced by a range of factors, such as their knowledge, habit and attitudes and prevailing social norms. One way to encourage uptake is therefore to implement mitigation actions on a subset of farms, which can then be used to demonstrate how the actions work in practice to a wider network of farmers. Examples of this approach are provided below.

Scotland: Farming for a Better Climate (FFBC)
(http://www.sruc.ac.uk/info/120175/farming_for_a_better_climate)

The emphasis in FFBC is on practical ways of improving farm efficiency as a way of reducing costs and GHG emissions. Key elements include:

- Identification of key action areas ((a) Energy and fuel use, (b) Renewable energy, (c) Locking carbon into soils and vegetation, (d) Optimising the application of fertilisers and manures, (e) Optimising livestock management and the storage of manure and slurry).
- Explanation of the five action areas, with links to practical examples and further information.
- Climate Change Focus Farms: a small number of volunteer farms (4 from 2010-2013, 5 from 2014) identify and implement practical actions across the five key action areas on-farm. The effects of these actions on farm performance

(including profits and GHG emissions) are measured and the findings disseminated via farmer discussion groups, newsletters and case studies.

Northern Ireland: The Greenhouse Gas Implementation Partnership (GHGIP) (http://www.dardni.gov.uk/index/farming/climate-change-farming.htm)

As with the FFBC, the emphasis is on simultaneously improving efficiency and reducing GHG emissions; the title page of the Phase One Report states the aim of the Partnership as: "promoting and encouraging the adoption of technical efficiency to improve farm business performance and reduce greenhouse gas emissions" (DARDNI 2014). Key elements include:

- Establishing a partnership and holding regular meetings
- Improve awareness by disseminating finding via a range communication channels
- Beginning implementation on farm
- Use scientific research results and transferring knowledge to farmers via training and case studies.

France/Germany/Italy/Spain: The AgriClimateChange project (http://www.agriclimatechange.eu/)

AgriClimateChange differs from FFBC and GHGIP in that it is a supranational project, and it seeks to influence policy and well as farmer behaviour. Less emphasis is placed on quantifying the effects of mitigation actions on farm economic performance. Key features include:

- Development of the AgriClimateChange Tool (ACCT) to quantify GHG emissions.
- Design and implementation of specific Action Plans for a network of 120 farms located in the four countries, and measurement of the effect on GHG using ACCT.
- Comprehensive proposals for integrating mitigation actions into EU policy, based on the lessons learned in implementing the Action Plans.
- Capacity building of agricultural stakeholders.

Potential Actors involved

Task: Network setup and co-ordination
Credible and trusted organisation/individuals are required to set up the network and recruit volunteer farmers, technical experts and network members.

Task: Implementation of measures
Volunteers to act as demonstration farms.

Task: Supporting implementation of measures and analysing impacts
Technical expertise is required to:

- identify the mitigation actions to be implemented
- identify the types of demonstration farms required
- devise a farm action plan

- quantify the impacts of the action plan on the physical and economic performance

These tasks will require (a) understanding of biophysical processes and ability to quantify changes in production and emissions, and (b) understanding of agricultural economics and ability to quantify the effect of actions on economic performance.

Task: Dissemination of findings
In order for the findings to be widely disseminated, the network requires the engagement of range of stakeholders, such as: individual farmers, industry organisations, farm advisors and agricultural policy staff.

Types of activities that can be supported

The networks could be national or regional and could focus on whole farm emissions or on a subset, such as energy or nutrient management.

The emphasis should be on actions that are likely to have negative costs, but have limited uptake due to the existence of non-financial barriers (e.g. stakeholders' awareness/attitudes).

Specific activities include:

- Implementation of mitigation actions on commercial farms
- Measurement of the (financial and physical) impacts of the actions
- Dissemination of the finding via a variety of communication channels, such as: farm visits, seminars, training events, website, reports and other media.

Expected impact on mitigation and adaptation / ancillary benefits

The mitigation, adaptation and ancillary benefits that arise will depend on the specific focus of the networks. These are explained in more depth in the fiches. An additional benefit that may arise from the establishment of networks is an increase in social capital – it has been argued that participation in networks can increase levels of trust and co-operation amongst farmers (OECD 2013, p69).

Combinations with other RDP measures

This example of joint action links with the joint action *Development and/or improvement of regionally appropriate climate audit tools and approaches* as the reliable measurement of the change in GHG is key to the success of this measure.

The measure can also be combined with the measures for agri-environment-climate (Art. 28(1)), knowledge transfer (Art. 14(1)), farm advisory services (Art. 15(1)) and LEADER projects (Art. 42-44).

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EIP operational group: Develop a methodology for farm resilience plans for farm types/sectors, focussing on risks that farmers are currently underprepared for

Summary

- EIP Operational Group (OG) aims at the development and testing of methodology for farm resilience plans for particular farm types/sectors, focussing on risks that farmers are currently underprepared for
- The planning approach can help better understanding of the potential impacts and possible action in order to avoid or minimize negative impacts and/or benefit from potential opportunities. Planning can be considered as a coordinated way that is embedded in the land managers and farmers' normal planning and development practice.
- Success of the OG is increased by close cooperation of stakeholders in order to utilize all available information and reflect their needs
- Potential actors: farmers, advisors, members of programming and managing authorities, climate change authorities, researches/evaluators
- Within the OG activities such as workshops/seminars, expert consultations and required equipment and personnel can be supported
- Resilience plans help to tailor farm investments to better incorporate adaptation needs and exploit mitigation opportunities tailored to farm resources and circumstances
- Ancillary benefits include improved GHG balance at farm gate, enhanced biodiversity and landscape amenity, and increased resource efficiency

Rationale and description of the action

Farming and the natural environment are affected by the impacts of climate change. Common risks include increasing flood risk due to disruption of rainfall patterns, heat stress in livestock and increasing risk of wind-borne erosion of drier soils all of them have impact to the farming systems (Kendal and Cairns, 2013). It is an important first step for land managers to understand and translate the broad impacts of climate change into implications for their own holdings. This enables them to plan for climate change and adapt appropriately. A tested planning approach could serve as a flexible and efficient framework to integrate climate change into the general development and decision making process at farm level.

Even in a given region where the potential impacts of climate change are the same each farm has its own unique circumstance. In order to close this gap it is still possible to tailor resilience planning along the different farm types. The planning process not only helps to obtain knowledge about the relevant impacts of climate change but by shedding the light of causalities.

Effectiveness of the resilience planning depends on the type and complexity of the climate change impacts and on finding the options to deal with them, under consideration of the private and public costs and benefits of these options.

Depending on the region specific variability and uncertainty of the impact of the interventions/actions the payment-by-result or the payment-by-action approach could be applied. Less variability means that a certain action taken by a land manager lead to definite impact (reducing certain risk or achieve a given rate of mitigation) which also translate that less effort is needed for monitoring and evaluation and put less risk on the beneficiaries of false application. Using region specific pilot study by the OG should reveal the specific suitable options.

Natural England – Climate change farm resilience planning (http://publications.naturalengland.org.uk)

Farm Resilience Plans are a concept initially developed by Natural England as a way of raising awareness among the farming population of climate change threats and opportunities for their faming and land management systems. The aim of this pilot project is to consider whether a planning approach can be developed that uses the best available evidence, integrates the natural environment and agricultural systems, recommends adaptive actions and is a practical training tool for farm managers planning the future management of their holdings.

The project ran between October 2012 and February 2013. It involved completing Farm Resilience Plans (FRP's) on ten farms in the North West Region within the Morecambe Bay Limestone's and Eden Valley National Character Areas. The ten farms that participated included a range of type and size of holding and are representative of the type and size of farms in these areas. The FRP approach consists of a visit to a farm by a suitably qualified consultant to discuss, on a one to one basis, climate change predictions, potential climate change impacts on the natural environment and farming systems and the possible mitigation measures that can be taken on the farm to reduce negative impacts of climate change and to realise positive impacts. The pilot has demonstrated that it is possible to incorporate an assessment of the natural environment with an assessment of farming systems and that doing these both in tandem ensures that climate change adaptations suggested seek to safeguard both the interests of the natural environment and the farming business. (Kendal and Cairns, 2013).

The EIP operational group (OG) aims to develop and test regionally adapted and transparent planning scheme for preparing and implementing farm resilience plans. The content of the resilience plan could include changes of current practices, new investments, incorporating new information sources in the decision making, knowledge transfer needs through advisory services or training. It will try to improve existing approaches and develop solutions as to how to overcome barriers, in order to increase its efficiency. Another aspect is how to select the appropriate performance indicators and thresholds, as well as the control and verifiability of results. The incentives could be based whether an action was done or not or a given performance was achieved. In the simplest way this could mean that a resilience plan is prepared. The second level could be if the actions appear in the plan are actually performed. Finally the third and most strict monitoring would be if not only the action but its impact or assumed impact is monitored on a farm-to-farm basis.

All participants contribute to the development of a farm type specific prototype scheme, which will be tested on pilot farms. The development of the scheme involves the definition of an overall framework. This will be supplemented by concepts focussing on successful incentivisation (payment design) and effective monitoring.

The development of the measure requires close cooperation of the involved stakeholders, which could be implemented in short time in case efficient coordination in place. An exchange of experiences between OG's from different regions and Member States could improve the dissemination of innovative approaches for resilience planning.

Potential Actors involved

In order to be able to consider the multiple interests of the affected actors, the OG should consist of members from science, practice, administration and politics:

- Farmers (from different farm type/sector) – represent their interests as beneficiaries; add their experiences; test the approach; provide feedback and information on regional environmental related challenges and their strategies to improve their approach to act to climate change related changes
- Advisors – provide experiences and information on communication; bridge between farmers, authorities and researchers
- Managing/Programming authorities – provide information on programming issues and related topics
- Researchers/Evaluators – gather relevant (scientific) information; monitor and evaluate the effectiveness

Types of activities that can be supported

- Workshops and seminars (exchange of experiences, planning of the project, development of concepts)
- Development of the approach and the methodology for farm resilience plans
- Consultation with external experts
- Acquisition of necessary equipment/personnel for the monitoring and evaluation

Expected impact on mitigation and adaptation / ancillary benefits

The resilience planning can help to gradually incorporate climate change impacts that are relevant to the specific farm types. As a result a balance of actions and their timing is revealed. Ancillary benefits include improved GHG balance at farm gate, enhanced biodiversity and landscape amenity, and increased resource efficiency. In case the result-oriented (=payment-by-result) is used, the impact assessment will be improved and the cost-effectiveness of the operation(s) can be better evaluated. This is because the payment-by-result approach itself assumes that the impact is incorporated in the implementation. For instance in case the increased occurrence of drought is in place, a possible response could be shifting tillage practices that are water retaining. Assuming some basic measurements are performed on the relevant sites the number of drought days could serve as possible performance or impact indicator.

Combinations with other RDP measures

This kind of joint action could be combined with:

- Art 14(1), Knowledge transfer and Information actions
- Art 28(1), Agri-environment-climate

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Mainstreaming climate change into rural development policy post 2013 – Annex 6

List of climate focused 2007-2013 LEADER Projects

This Annex 6 is part of the Technical Guidance produced in the project "Mainstreaming climate change into rural development policy post 2013".

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The main report of the project may be located under the following citation:

Frelih-Larsen, A., MacLeod, M., Osterburg, B., Eory, A.V., Dooley, E., Kätsch, S., Naumann, S., Rees, B., Tarsitano, D., Topp, K., Wolff, A., Metayer, N., Molnar, A., Povellato, A., Bochu, J.L., Lasorella, M.V., Longhitano, D. (2014). "Mainstreaming climate change into rural development policy post 2013." Final report. Ecologic Institute, Berlin.

Table of Contents

Introduction

This Annex contains the long list of LEADER climate action projects identified under Task 2 of the project. The method used to identify LEADER projects which had climate mitigation and/or adaptation elements throughout the EU is explained in Chapter 4 of the main report. A list of traditional RDP projects which also have a climate change mitigation or adaptation focus is included at the end of this Annex.

Long list of LEADER projects with a climate mitigation and/or adaptation focus

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Afforestation	Territorial supply plan of the "pays Barrois"	France	Support projects that carry out operations to reduce emissions of greenhouse gas emissions and adapt to climate change territory. It consists in establishing a late diagnosis of the available resource, determine its technical and economic conditions of mobilization, inventory consumption, current and projected short and medium term.	Started in May 2009	Syndicat mixte du Pays Barrois 12 rue Lapique 55012 BAR LE DUC Cedex Tél : 03 29 70 99 70 Internet : www.paysbarois.com
Agroforestry	L'arbre en Champ' - Agro-forestry Audit on the Farm and Mobilisation of Innovative Models	Joint Project: France, Belgium	The project's partnership intends to contribute to the wider development of the agro-forestry sector. More specifically, the 5 partner LAGs aim to (1) increase the competitiveness of rural areas by improving agricultural productivity, by diversifying agricultural production (e.g. fruits, flowers, oils) and forestry; (2) improve rural areas and the quality of life, by integrating the tree in the landscape, thus favouring the biodiversity of species and the value of soil; (3) promote the creation or development of new value chains of local agricultural and forestry products. The TNC project comprises of six major components: (1) exchange of knowledge and skills; (2) provision of legal and contractual expertise; (3) development of questionnaires and conduct of surveys (rural agro-forestry audit); (4) agro-forestry feasibility guide; (5) local showcases to demonstrate agro-forestry on site; and (6) a multimedia repository for documentation purposes (website). Implementation of each of these activities does not necessarily involve the participation of all partners.	31/12/2011 until 31/12/2013	Project website: http://www.agroof.net/agroof_projets/agroof_transgal.html Contact name: Jean François Pecheur E-mail: galcondruses@reseau-pwdr.be Telephone: +32 85 27 46 10 Languages for contact: English, French, Dutch
Agroforestry / Sustainable Agriculture	Zala Termálvölgye Association: Local Traditional Orchard Programme	Hungary	Local fruit tree program; Sustainable agriculture "best practice" pilot farm		Name: Tibor Szabó Email: szabo@zalatermalvolgye.hu Phone: +36(83)361-305 Website: www.zalatermalvolgye.hu

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Capacity Building on Climate Change	Developing a Network of 'Natural' Gardens in Wallonia	Belgium	The aim of this cooperation project was to develop a network of 'natural' gardens and by creating and enveloping these spaces, to raise awareness of natural habitats, enabling people to learn about and assist in preserving local biodiversity, avoiding the use of pesticides and encouraging planting of indigenous local plant species. The main activities of the project included (i) Development and promotion of the 'natural' gardens concept and methodology; (ii) Planning and creation of nine 'natural' gardens - one in each participating commune, including pedagogic spaces for animation, events, conferences and visits; (iii) Development of the network of gardens to provide a range of opportunities for events and activities that engage and promote interaction between the participating local rural communities.	01/01/2010 until 01/01/2013	Project website: http://www.reseau-pwdr.be/reseaupwdr/reseau-gal/fr/index_fr.cfm Contact name: Stéphane Delogne E-mail: cuestas@skynet.be Telephone: +32 63 45 74 77 (GAL Haute Sûre Forêt d'Anlier) & + 32 63/45 71 27 (GAL Cuestas) Languages for contact: French
Capacity Building on Climate Change	Aljarafe-Doñana con energía para el cambio	Spain	This is a school awareness raising project on climate change and renewable energy involving 700 children from 7 schools in the region (from Carrión de los Céspedes, Huévar Buonarroti, Olivares, Batteries and Sanlúcar la Mayor). It approaches global warming from the classroom through theoretical and practical sessions and activities, such as model UN climate change conference negotiations.		LAG GDR Aljarafe-Doñana, contact: Florencio Valero, Telephone: 955753820, Email: gerencia@adad.es Website: http://www.adad.es/en/home/564-medio-ambiente-y-famp-reconocen-un-proyecto-de-adad-como-buena-practica-andaluza-de-educacion-ambiental.html
Capacity Building on Climate Change	Carbon Buster Clusters Project	United Kingdom	School-based programme aimed at inspiring and empowering young people through climate change education to pupils and teaching staff in primary and secondary schools in Dumfries & Galloway. The project encourages a low carbon ethos by concentrating on forming a connection between people's everyday activities and their impacts on the environment. It is primarily delivered through teacher training and pupil workshops. A dedicated Schools Project Officer delivers workshops to school clusters. Teachers are trained on	July 2012-August 2013	Contact person: Emma Platt Contact telephone number: 01387 702348 Contact email address: e.platt@carboncentre.org Website: www.carboncentre.org

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			climate change and sustainable development education and are provided with resources, including a guide to the Schools Global Footprint Calculator (SGFC), through the project to incorporate the subject into the school's curriculum.		
Capacity Building on Climate Change	Carbon Neutral Exmoor	United Kingdom	This is a three year project which aims to kick start the ambitious Exmoor National Park Carbon Neutral Programme, and to build capacity in the community to enable it to derive value from local assets (e.g. wood, wind, water, cultural heritage), and to help it to develop its own response to the challenges posed by climate change. The project involves: • providing ongoing assistance to communities in Exmoor to support them in developing community-led low carbon initiatives; • engaging the farming community in relation to low carbon farming practices and brokering relationships between farmers and communities to facilitate the development of low carbon initiatives • raising awareness of and brokering in existing supports that assist communities in moving towards a low carbon future e.g. EST Green Communities programme and South West Agricultural Resources Management programme; • sharing knowledge widely both within and outside Exmoor.	Date completed: 31/08/2013	Katy Graham Telephone: 01237 426423 Email: kgraham@northdevonplus.co.uk
Capacity Building on Climate Change	Cheviot Futures - United in a Changing Rural Landscape	United Kingdom	The project aimed to identify key problems relating to climate change that individual farms face and develop farm resilience plans accordingly. The plans should aim to identify any actions that should be taken to aid the farm in coping with climate change. They should also include emergency planning for possible events, e.g., floods, to minimise damage and costs. A wider aim was to encourage others in the region to invest in climate change adaptation once the benefits of new techniques were proven. The project employed a Facilitator to work	01/02/2009 until 01/02/2012	Name: Tom Burston Email: tom.burston@nuleader.eu Phone: +44 1669 622063 Language: English

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			directly with farmers and landowners in order to aid them in using practices to adapt to the effects of climate change. Actions undertaken included: raising awareness of the predicted threats and opportunities of climate change; adopting practical approaches to land management; sharing best practice to support and, where appropriate, diversify rural businesses; developing and trialling new sustainable solutions to the impacts of climate change.		
Capacity Building on Climate Change	Climate Change on Montane Lichens	United Kingdom	To establish a series of monitoring transects with which to examine the near-term effect of climate change (ca 10-25 yr). The project will apply established methodologies to identify change in habitat quality (vegetation structure) and a measure of threat to montane lichen species which are characteristic of the Cairngorm vegetation. The data will be used to better understand the processes controlling lichen-rich montane vegetation, providing information feeding into adaptive land-management. The project funding was used to employ a former MSc student to carry out the fieldwork and write up the findings. The fieldwork comprised establishing a series of altitudinal transects and measuring vegetation composition and structure at points along each transect. The project lead, Dr Christopher Ellis, analysed the data and wrote a scientific paper on the findings. The monitoring will be repeated 10 years later in 2018.	6 months (from 29 August 2008 to 27 February 2009).	Cairngorm LEADER Local Action Group Telephone: 01479 870 543 Email: info@cairngorm-leader.org
Capacity Building on Climate Change	Climate Change Westray	United Kingdom	This project will work with local farmers on the North Isle of Westray to gather detailed information on the greenhouse gases from Agriculture in order to develop a more robust methodology to measure the contribution of this sector to national emissions. This will in turn allow the island to formulate a plan to reduce the impact the agricultural economy has on the environment as well as protect local jobs. The project will be conducted in phases which will run sequentially, punctuated by open meeting. The core team includes 5-7 farmers who		Name: Sam Harcus Telephone: 01857 677 888 Website: www.care4energy.co.uk

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			between them represent the major farm types on Westray. These farmers will use a web-based calculator called CPLAN (www.cplan.org.uk) to measure greenhouse gas emissions. Their findings will be presented at a local meeting and using well tested participatory appraisal techniques the audience will suggest amendments to the methodology. The next stage of the project will analyse both the 'accounts' and 'farmers' budget from a monitoring and certification perspective by the core team. Finally, recommendations will be reported to the Scottish Government.		
Capacity Building on Climate Change	Climate friendly Legion Hall	United Kingdom	It is hoped the refurbished Legion Hall will attract more users, and be able to offer an increase range of activities. Energy consumption will be reduced, together with the carbon footprint. The project to refurbish the Legion Hall will not only improve the facilities, but create a climate friendly Hall and reduce the energy costs for the community. The insulation of the Legion Hall is phase 1 of a two phase scheme – phase 2 being the installation of photovoltaic slates. The East Cornwall Local Action Group has awarded £13,598, nearly 90% of the total costs, to St Gennys Parish Council to refurbish the Legion Hall in St Gennys, North Cornwall.	01/06/2010 until 31/10/2010	East Cornwall Local Action Group Manager – Linda Emmett Email: linda.emmett@cornwalldevelopmentcompany.co.uk Telephone: 01208 265719 or 0752 8983334
Capacity Building on Climate Change	ClimECC (Eco Expert Cluster)	Luxembourg	The project aims to roll-out sustainable development approaches to tackling climate impacts and also boost the competitiveness of the cluster members. ClimECC's strategy involves encouraging both demand for, and supply of, ecological technologies in rural Luxembourg. The project employs a part-time cluster manager. It has a budget for promoting the cluster at events. Project activities include company coaching, improving company and customer contact and relations, and building business networks. In addition, the project helps companies from the LAG area identify their environmental training needs in order to provide a broader and better range of eco-friendly services in the LAG area.	April 2010 - March 2012	Name: LAG Manager Fons Jacques Email: rw@leader.lu Languages: English, French, German

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Capacity Building on Climate Change	Creating CSmart Organisations	United Kingdom	Helps 24 rural organisations across Dumfries & Galloway measure, monitor and take action to reduce their carbon emissions. Guidance and assistance will be provided over a period of 6 months. Guidance of the organisation through key stages, appointing a 'Carbon Champion' and conducting carbon management training of key staff, baseline carbon footprint assessment, carbon opportunities workshop, developing carbon management policy and action plan and implementing it, monitoring progress.	April 2009- April 2011	Contact Person: Gráinne Kennedy Telephone: +441387 702 041 Email: info@carboncentre.org Website: www.carboncentre.org
Capacity Building on Climate Change	Eco-Citoyen et Identité Européenne (Eco-Citizen and European Identity)	Joint Project: Romania, France	The overall objectives were to help the youngsters to become aware of their European identity and to make them realize what it means to be an eco-citizen. More specifically, the project aimed to: i) enable young people to apprehend the different realities of two countries, by getting to know and understanding each other; ii) provide them with opportunity for joint sports activities and discoveries of their natural and cultural environment; iii) make the young people aware of environmental protection issues, and in particular of their individual and collective responsibility to practice proper waste management; and iv) help the youth to realize the European dimension of eco-citizenship. Altogether, thirty youngsters participated in the project, of which 16 went on a journey from France to the micro-region of Huedin in Romania. A couple of weeks later, their visit was returned by 14 young Romanians. The French discovered the Romanian region's history and culture and experienced rural life in the area, in which their counterparts live. The visit to France, which was of a similar nature, also included joint field trips in order to advocate the respect for nature and environment.	08/07/2008 until 30/07/2008	Contact name: Florentin Georgescu E-mail: leader_pays@pays-vichy-auvergne.fr Telephone: +33 4 70 96 57 32 Languages for contact: English, French, Romanian
Capacity Building on Climate Change	Establishing a Community and Business Resource Centre in a	United Kingdom	The main objectives are to: develop a community and resource centre which will deliver social enterprise projects at local level, build the capacity of the voluntary and business sectors locally, develop a carbon footprint reduction programme and deliver training. The project	01/09/2009 until 30/11/2011	Name: Fiona Cameron Email: fiona.cameron4@highland.gov.uk Phone: +44 7827 281469,

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	Remote Area		aimed to establish a "one-stop-shop" to support the business community and voluntary sector in south east Caithness. The centre promotes environmental sustainability. The main activities included: establishment of the community and business resource centre in Seaview House in the Lybster village; employment of a Community Powerdown Officer (funded as part of the powerdown initiative - http://www.communitypowerdown.org.uk/ - that brings together communities aiming to tackle their carbon emissions by delivering carbon reduction projects locally) and a Resource Centre Manager. Some infrastructure works also took place for improving the Seaview House.		+44 1408 635215 Language: English
Capacity Building on Climate Change	Experience renewable energy in the Sun City of St. Veit – permanent exhibition	Austria	The exhibition "Adventure Energy" in the Sun City of St. Veit 'Fuchs' palace presents the renewable energy project in a stimulating and informative way through unusual artistic design. Using high-level multimedia, the exhibition brings renewable energy forms closer to the visitors. Environmental and energy data from the Sun City of St. Veit are set in a global context and made understandable to a general audience.		
Capacity Building on Climate Change	Fieldfare Local Action Group: Winchester Action for Climate Change	United Kingdom	WinACC work closely with other organisations to promote, support and provide information/training about climate change. The Fieldfare Local Action Group is looking to develop these opportunities with rural community groups and businesses and the training of "champions" will mean that local people can access advice and support when completing LEADER applications in future. They will be delivering two events for rural community leaders to promote the importance of low carbon economy and sustainability when developing community projects.	Dated completed: 30/4/11	Name: Ken Brown Telephone: 01962 848 588 Email: KBrown@Winchester.gov.uk Website: www.Fieldfareleader.org.uk
Capacity Building on Climate Change	Gable End Theatre Zero Carbon	United Kingdom	The Gable End Theatre Co Ltd aims to reduce energy consumption and become carbon neutral. To achieve this they need to re-vamp current insulation and install		Name: Lindsay Hall Email:

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	Footprint		an Air-Source Heat Pump to provide cost effective heat when needed. A consequence of all this work will be a considerable upheaval to the general running of the theatre. In order to maximise the opportunity thus afforded, they will, at the same time, re-organise their dressing room facilities, thereby meeting developing child protection legislation as well as carrying out an internal redecoration of the facility. Since the theatre first opened to the public in January 2002, there has been an ongoing problem of how to adequately heat the building. Although the applicant installed a wind generator last year, which effectively nullifies their energy consumption at current levels, they still require background heat all the time, not only to make the venue more easily brought up to reasonable levels for performances, but to protect the integrity of their sound and lighting equipment. Additionally, better insulation is required in the theatre.		lindsayhall@btinternet.com
Capacity Building on Climate Change	Glaslyn e-trail project	UK-Wales (funded by Powys LAG)	Awareness raising how well-managed upland areas and appropriate farming methods can help create lesser known benefits - like reduced flood risks, carbon storage, and wildlife protection. Using digital technology to provide new audio tours of the Glaslyn Nature Reserve, aims to attract, entertain and inform visitors. The audio tours and smartphone applications contain a mix of guided directions and stories told by local people from the project area. The project promotes the nature reserve and the local region's cultural history.	2008-2013 (under Pumlumon project)	Pumlumon Project Manager: Estelle Bailey Email: estelle@montwt.co.uk Telephone: 01938 555654
Capacity Building on Climate Change	Knowledge transfer on climate change mitigation, energy, environment	Austria	Applied knowledge transfer about climate and environmental protection was established in the form of an adult education programme meeting in the local church and in the schools. It aims to build a coordinated series of seminars, lectures, and information sessions on an adapted website and through concrete implementation in cooperation with selected education partners. Teaching staff can network with the Burgenland Educational Server in order to access	2011 until 2014	Projektträger panSol: Dr. Günter Wind Address: Marktstraße 3, 7000 Eisenstadt Telefon: 05-9010-3780 E-Mail: g.wind@pansol.at

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			prepared information. Economic and religious institutions and the middle schools are the project partners. Activities: • Targeted preparation and communication of current and independent knowledge in the field of climate and environmental protection through blended learning (lectures, workshops, seminars, educational server), taking into account the social relevance and economic feasibility in northern Burgenland (coordination with the educational server managers re: content development was already considered in the preparation phase) • Regular information evening sessions on special issues in the area of climate and environment • Integration of teaching content on the website and in the school system, as well as in the national education structure, including VHS, WIFI, LFI, and by integration in the Burgenland Educational Server • Coordination and promotion of events with other educational institutions and accompanying public relation activities		
Capacity Building on Climate Change	Learning about the environment through kindergarten	Slovenia	This kindergarten believes that a positive attitude towards nature and a healthy way of living should be developed early in childhood - with parents and wider family playing an important role too. So the aim of this project was to inform children and their families about ecological ideas and activities in an innovative and interesting way. Using interactive means, the intention was to produce items for fun and effective learning. Activities and items planned included development of a children's book with a catchy story, reading and storytelling by children, puppet making and a puppet show, and illustrating cotton eco-bags for all.	01/05/2009 until 31/03/2011	Project website: http://www.vrtec-slobistrica.com Contact name: Ivana Leskovar E-mail: ivana.leskovar@guest.arnes.si Telephone: +386 2 80 51 422 Languages for contact: English, Slovene
Capacity Building on Climate Change	North York Moors, Coast and Hills Sustainable	United Kingdom	The project worked with communities in the area to understand their carbon footprint, act on climate change, reduce fuel poverty and improve the natural environment over the two year period. A project officer		Names: Joannah Collins and Rosie Hughes (Yorkshire Energy Partnership) Telephone: 01439 772700

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	Communities		worked closely with communities to provide expert advice and guide them through the process of identifying actions and delivering solutions. Actions have included home energy audits and use of a thermal imaging camera, insulating 100 homes, and skill development training. Communities were helped to insulate community buildings by providing expert advice and access to funding.		Email: j.collins@northyorklmoors.org.uk Website: http://www.yorkshireenergypartnership.org.uk/index.php?route=page/view&page_id=59 Project output: http://yorkshireenergypartnership.org.uk/ebook/
Capacity Building on Climate Change	Region M.U.T. mobil – awareness raising for public transport and soft mobility	Austria	The issue of mobility, in particular public transport, pedestrians and bicycles traffic, is one of the main topics covered in this project, and is carried out by a number of measures to sensitise the population in the region. Awareness raising on the topic of the multiple benefits (including climate mitigation) of using public transport or bicycle has been done through public relations and marketing activities. Among other activities, a car-free day will be a focus in September.		
Capacity Building on Climate Change	Settle Hydro – Community & Visitor Learning & Educational Benefit	United Kingdom	Settle Hydro is Yorkshire's first community owned hydro electric scheme, it is an Industrial and Provident Society for the benefit of the community for the specific purpose of owning the Settle Weir Hydro Electric Scheme. It will generate revenue by selling 'green' hydro-electricity, any surplus will be used to benefit the local community through its twin aims of regenerating the local economy and promoting the environmental sustainability of the Settle district. The projects main objective is to install an Archemedian Screw, all funding is in place for this and they are now seeking LEADER funding towards the maximisation of the visitor and educational potential of the project. It will raise the profile of Settle and its 'Green credentials' and provide an invaluable educational resource. The project will build a drystone wall around the site, install webcams under and out of	2007-2009	Name: R. Berry Telephone: 01524251002 Email: rima.berry@ydmt.org

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			water, install a fish counter, handrails, bike racks, information boards, equipment to monitor head and power output, make information accessible on the website, renovate the waterwheel and resurface the car park. An opening event will be held along with Innovation events and the relevant literature produced.		
Capacity Building on Climate Change	Spotkanie z Natura 2010 - Meeting with Nature	Joint Project: Poland, Germany	The overall objective was to raise awareness and establish ecological understanding among young people from Poland and Germany. More specifically, the project aimed to enable responsible use of natural resources, by organizing innovative educational and sports activities for: (1) raising awareness about current environmental issues caused by improper use of natural resources, and; (2) transferring knowledge about concrete steps to protect the environment. The project partnership organized a recreational holiday-type event for thirty Polish and fourteen German youngsters. Means of education and play were applied to raise their awareness about the benefits of nature and its preservation. The secondary-level school students walked along the forestry education path 'Winiary', took part in recreational activities at an agri-tourism farm and participated in a 'rallye' competition, involving walking and cycling around the Jeziorsko lake.	01/09/2010 until 31/01/2011	Project website: http://www.krainanocyidni.pl/index.php?option=com_content&view=article&id=204:spotkanie-z-natur-2010 Contact name: Wiktor Baranowski E-mail: lgd-przymierzejeziorsko@wp.pl Telephone: + 48 43829 4879 Languages for contact: Polish
Capacity Building on Climate Change	Training needs analyses and programmes for farmers – communicating climate in farming	UK	Jointly with the other Cumbrian LAG, the Fells and Dales LAG has commissioned training needs analyses and training programmes are beginning to emerge for farmers communicating about farming and running farm visits, on climate change issues, water management and food security plus the management of specific habitats and local produce initiatives		RDPE Transition Team Telephone: 01900 706000 Email: info@fellsanddales.org.uk
Capacity Building on Climate Change	UoC - Beyond 2013 for Rural Land Management	United Kingdom	This project is to provide high quality knowledge transfer with respect to the emerging post 2013 Agenda faced by land managers. This will be in line with three main themes; first, the triangle of climate change, food security and peak oil; second the rising agenda of ecosystem services which has become a globally driven	2011-2013	Alison Love Telephone: 01768 869533 Email: alisonlove@fellsanddales.org.uk

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			issue through the UN Millennium Ecosystem Assessment project, to which the UK Government is bound to respond and third, specific agendas related to changes in farming in Cumbria, such as the change in the LFA boundary and the realignment of EU support. Whilst it is important to ensure awareness raising amongst land managers, this project aims to address these issues for the wider community so that all of us in Cumbria recognise the new challenges facing our everyday lives. To this end we will have raised these issues with a range of non-farming social groups, schools, Chambers of Commerce, larger SMEs and regional supermarkets.		
Capacity Building on Climate Change	Urhfont Community Eco-Mapping	United Kingdom	Urchfont Parish Council's Community Eco-mapping project uses a new set of tools to work with 10 households, from a range of properties and as many social groups as possible, to give a wider appreciation amongst local residents of climate change and the importance of reducing carbon emissions. This will result in increased awareness of the activities that can help reduce the costs and reduce waste and energy consumption.	Date completed: 31/08/2011	John Dowsett Telephone: 01380 732814 Email: jdowsett@communityfirst.org.uk
Capacity Building on Climate Change	VINUMBURANUM: Return of viniculture in Michaelbeuern	Austria	The aims of the project are to revive viticulture in the region, transfer knowledge about viticulture to interested school pupils and adults, and expand the regional range of products. The first harvest is expected in 2011. In the spring of 2008, planting of the first vines (800 vines) was started on about one-third of the area. By 2010, another 3,200 vines were planted. In addition to the actual cultivation of wine, the transfer of knowledge has played a central role in the project. The secondary school of the Stifts Michaelbeuern participated and has regular presentations in the biology classes and activities in the afternoon childcare scheme. Furthermore, the association VINUMBURANUM takes part in regional events and actively promotes public relation activities.	since 2009	Verein VINUMBURANUM Name: Helmut Timin Address: Josef-Mohr-Straße 4a, 5110 Oberndorf bei Salzburg Telefone: 06272/41217 E-Mail: office@flachgau-nord.at

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Capacity Building on Climate Change	Wharfedale Beekeepers Association, Bee Breeding Improvement & Education	United Kingdom	This project is to create an area high in bee forage suitable to rear bees, train beekeepers and give individually structured presentations to interested parties, including schools and colleges. It will create an apiary capable of breeding bees in the required quantity, this will reduce the need to import stock from out of the area. A bee breeding programme will supply new and existing members with good quality healthy local stock. It will run events in bee breeding, health and queen rearing and give demonstrations to various groups. It will advise and demonstrate to local authorities and property developers of bee beneficial plants that can be used in the grounds of new developments, parks, recreational areas and highway verges. LEADER funding will be used to purchase bee friendly hedges and plants, hives and hive equipment, queen mating bees and laptop etc for presentations, demonstrations etc.	Began March 2010	Name: R. Berry Telephone: 01524251002 Email: rima.berry@ydmt.org
Capacity Building on Climate Change	Yorkshire Dales Sustainable Communities	United Kingdom	There is a need for the project to improve awareness of climate change and how people themselves can make changes to their lifestyles, properties and businesses whilst working together as a community. The Dales area is believed by the applicant to be particularly suitable as an area for improvement and working with the residents on a community level the most effective way of informing and making sustainable changes. The project requires LEADER funding to provide advice and support to help people to work together to act on climate change. A project coordinator will be appointed to work alongside six communities for up to two years to assist them to understand their carbon footprint and how to deliver ways to reduce it. They will learn about energy efficiency and working together to build their confidence as a group on climate change. They will be made aware of insulation, micro-renewables and changes in their own use of energy resources. The coordinator will also help the communities to develop, find funding and deliver schemes suitable to them using local services	Funded on 14/10/2009	Name: R. Berry Telephone: 01524251002 Email: rima.berry@ydmt.org

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			and materials where possible. It is expected to reduce emissions for households, transport and businesses including farms. Each community will also choose a community building to adapt and improve as an example successful environmental practice whilst being innovative in sourcing new types of insulation material and producing energy.		
Energy Efficiency	Analysing local cold heat energy supply for the housing estate "Auf'm Hahnacker"	Germany	Investigating technical and economical feasibility of using warm waste water (30°C) of an industrial laundry for local "cold" heat supply of a housing estate. Objectives: • Check preconditions for implementation of cold heat supply • Provide a local, renewable energy system • Develop a regional supply chain Activities: Comparison of CO_2-emissions of several heat options (Heating oil, natural gas, geothermal heat, wood pellets and the cold heat supply)		LAG Hunsrück Name: Achim Kistner Telephone: +49(0)67697097 Email: kistner@rhein-hunsrueck.de Website: www.lag-hunsrueck.de
Energy Efficiency	Bioenergy villages in the Frankenwald	Germany	Objectives: • Reaching 100% energy self-sufficiency (only renewable energy) • Increasing the value added in the region • Contributing to climate change mitigation • Job creation • Strengthen regional solidarity • Determining and Using heat potentials from industry and craft • Establish 25 bioenergy villages • Reducing total energy consumption (use of energy efficient technology and energy saving) Activities: energy potential analysis and information campaigns. Focus of the project is on bioenergy intensive networking in order to facilitate communication between stakeholders		Energievision Frankenwald e.V. Telephone: 09261/ 6640840 Website: www.energie-frankenwald.de Email: info@energie-frankenwald.de
Energy Efficiency	Climate and Engery Region	Austria	Through community and cross-sector collaborations, networking with experts, and focusing on energy in the	since 2009	Leader region Vöckla-Ager Name: Bgm. Karl Staudinger

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	Vöckla-Ager		regional educational landscape, the region's attractiveness as a location for existing companies and start-ups in the field of energy technology is enhanced. Objectives: - prepare communities for joining the Climate Alliance, or for detailed concepts under E-Gem - become a leading region for renewable energy - reduce energy consumption in the region, particularly the use of fossil fuel energy - use regionally available renewable energy sources - contribute to climate protection by reducting CO2 emissions in the region - improve the profitability of farmers and foresters in the region - enhance the regional and local added value by being an attractive location for companies and energy industry - increase the information provided to and participation of all stakeholders in the region. Activities: • Creation of a regional implementation concept • Assignment of an energy manager to implement activities • Creation of a communication and information centre, which will be set up in the technology centre with fixed hours of operation • Acquisition, coordination and monitoring of the projects, resulting from the work on the implementation • Networking and awareness raising activities		Address: Steinhüblstraße 1, 4800 Attnang-Puchheim Telefone: 07674 20693 E-Mail: office@vrva.at Languages: English, Deutsch
Energy Efficiency	Community Energy Efficiency Programme	United Kingdom	The project aimed to reduce energy costs for community facilities on the Shetland Islands by reducing energy consumption and carbon emissions. Capital works: installation of more energy efficient lighting systems, provision of higher efficiency radiators and heating systems (incl. Heat pumps), provision of solar gain measures, building and pipe insulation, draught proofing, wall and loft insulation, provision of double glazing and storm proofing entrance and exist	Launched on 1 April 2011 and closed for applications Dec. 2012	Shetland Islands LAG Name: Sheila Tulloch Email: sheila.tulloch@shetland.gov.uk

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			routes, and thermal improvement measures.		
Energy Efficiency	Development of a local energy management for the LEADER region "Westlausitz"	Germany	Reaching energy self-sufficiency (on the balance sheet) in 2050 Objectives: • Development of an energy concept • Integration and counselling of regional stakeholders • Steering of these regional processes • Process evaluation Activities: conceptional preliminary studies, implementation of pilot projects, managing implementation, communication of results, awareness raising, public relations	2012-2015	Name: Daniela Retzmann Email: Daniela.Retzmann@pb-schubert.de Phone: +49 3528 4196 0 Language: German
Energy Efficiency	Energy autarkic region	Austria	In addition to climate protection, the implementation of this project increases the added value of the region by enhancing jobs and community incomes and providing many other benefits. As part of an energy survey, data on energy consumption in the publicly-owned buildings was collected and potential savings were identified. A tool for energy accounting and benchmarking for communities that reveals energy-saving measures was developed and applied. In parallel, four communities in the region implemented model-energy-saving projects in public buildings. As part of the project, the idea of an energy-independent Rosental region was communicated to the public.	September 2008 to June 2010	Carnica Region Rosental Name: Mag. (FH) Ingeborg Schönherr Address: Sponheimer Platz 1, 9170 Ferlach Telefone: 0043 (0)4227 5119 E-Mail: office@carnica-rosental.at Languages: Deutsch, English
Energy Efficiency	Energy autarky for Kötschach-Mauthen	Austria	In order to get the population involved and to implement the goal of becoming an "Energy self-sufficient community Kötschach-Mauthen", sub-projects on the topics "Energy experience Kötschach-Mauthen (module 1) and Learning gardens for schools (Module 2)" were implemented in addition to the project "Model system for a multifunctional energy center Kötschach-Mauthen to achieve energy self-sufficiency (Joanneum Research)". The project focused mainly on awareness raising among the population with integration of modern information, technology, public events and eco-tourism. The project	August 2008 to September 2010	Name: Sabrina Barthel Address: Rathaus 390, 9640 Kötschach-Mauthen Telefone: 04715/8513-36 E-Mail: info@energie-autark.at Language: Deutsch

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			sought to link the existing basic structure of renewable energy activities with new key opportunities, such as eco-tourism. Module 1 - Energy experience Kötschach-Mauthen (info point, environmental education, and eco-tourism), Module 2 - Learning Garden "renewable energy" (creation of an environmental education programme, events).		
Energy Efficiency	Energy concepts for the municipalities in Oberpullendorf (AT)	Austria	In the Burgenland communities, well-designed and supportive measures - forming the basis for climate protection, energy-savings, and added value within the energy sector – were worked out cooperatively in the form of a municipal energy concept. Activities: Phase 1: Team and working group formations in the community Phase 2: Demand-oriented analysis (presentation) of the actual situation, identification of the resources, evaluation, comparison, best practice models Phase 3: Development of objectives, concepts, forming strategic alliances, investment plans Phase 4: Merging, evaluation and presentation of the local concepts and integration into the country's energy concept.	2009 to 2012	Projektträger: TOB - Technologieoffensive Burgenland Name: DI Johann Binder (Geschäftsführer) Address: Marktstrasse 3, 7000 Eisenstadt Telefone: 05/9010/2220 E-Mail: johann.binder@eabgld.at Language: German
Energy Efficiency	Energy efficiency in agriculture in "the regional natural park of Haut Jura"	France	Development of solar dryer for fodder on a dairy farm The objective is the reduction of the costs related to the energy consumption of the farm. Further objectives were: • Training session for farmers and foresters about energy savings, fuel consumption from machinery. • Supporting farmers to reduce their energy consumption through studies and investment (thermal panels, efficient equipment for the milking parlour, solar dryer for fodder). • Share and capitalise experiences.	2003-2007	Name: Philippe Levy Animateur programme LEADER Structure / organisation: Parc naturel régional du Haut-Jura Languages: French, English Telephone: 00 33 (0)3 83 34 12 37 Email: p.levy@parc-haut-jura.fr
Energy Efficiency	Energy master plan for the	Austria	The market town of Thalgau sought to promote the sustainable development of its industrial areas. Existing	2010 until 2011	Marktgemeinde Thalgau Name: DI Klaus Roselstorfer

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	industrial park Thalgau		companies were motivated to take measures to reduce $C0_2$ emissions from their production processes. A company profile for new locations was created, which responded in particular to climate protection. Within the project, energy and material flows of existing companies and the opportunities for mutual use were investigated. Furthermore, it was determined which new companies should be placed in certain locations. The development of a sustainable site also involved demonstration of the possibilities to implement environmental measures. Likewise, possibilities to establish shared social services for the employees working in the companies was tested. In addition to commercial companies, agriculture and forestry was also included in the new concept. On the one hand, these sectors are suppliers of renewable resources for energy production, but on the other hand, they are producers of food that can utilise existing waste heat.		Address: Schallmooser Hauptstraße 85A, 5020 Salzburg Telefone: 0662/ 846 892-11 Email: k.roselstorfer@terracognita.at Website: http://www.regionfuschlsee.at/sites/default/files/downloads/ProjektbeschreibungEnergieGGThalgau.pdf Language: Deutsch
Energy Efficiency	Energy region Salzburg: Responsible and efficient energy consumption	Austria	Implementation of specific project on energy efficiency and renewable energy. Activities: Implementation of the energy mission statement of the region; counselling for municipalities, citizens and enterprises; projects on small scale hydropower, wind monitoring, photovoltaic installation with involvement of citizens are already in implementation.	2010 to 2013	Contact: Regionalverband Salzburger Seenland Name: Ing. Gerold Daxecker Address: Seeweg 1, 5164 Seeham Phone: 06217/20 240 Email: office@rvss.at Languages: German
Energy Efficiency	Promoting Energy Efficiency in Family Homes	France	The project aims to make families aware of their water and energy consumption, including showing them how to measure, control or reduce it. The project initially targeted families known to social workers, but the aim now is to encourage all the inhabitants of the village to share their ideas and experiences in controlling consumption, as well as promoting self-help home maintenance. Activities involve: a) establishing a plan in conjunction with the local authorities and agencies; b) training	01/03/2010 until 01/10/2010	Project website: http://www.compagnonsbatisseurs.org Contact name: Virginie Boireau Email: v.boireau@compagnonsbatisseurs.org Languages for contact: French

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			several 'ambassador' families in the use of good practice techniques; c) showing volunteer families how to use equipment to measure consumption, including simple techniques to reduce consumption, and to calculate potential financial savings; d) enlisting the ambassador and volunteer families for a two day public presentation of 'eco-gestures' to promote the project.		
Energy Efficiency	Roof restoration of the youth centre in Rastdorf	Germany	Preservation of the youth centre. Modernisation of the building. Insulation of the roof. The young people modernised and arranged the interior by themselves.		LAG Hümmling Name: Ralph Deitermann Email: deitermann@werlte.de Telephone: + 49 59 51 201 38 Website: http://www.werlte.de Language: German
Energy Efficiency	Substitution of Conventional Lighting System with Lighting through LEDs	Spain	Objective was to substitute standard light bulbs used for municipal lighting with latest technology LED lamps, fabricated in the Autonomous Community of Valencia. In this way, the project intends to improve the quality of life for the inhabitants of the municipality as well as achieve a demonstration effect that will promote a massive adoption of the LED technology throughout the Valencia regional territory.	01/12/2008 until 31/10/2010	Contact name: LAG "Ceder Aitana" E-mail: postcards@enrd.eu Telephone: +34 965 591 636 Languages for contact: Spanish
Energy Efficiency	Sustainable Energy on Small Islands (IRDA Energy project)	Joint Project: Ireland and Denmark	The main objective was to produce an energy strategy and implementation plan for each island in the project. This was achieved through the organisation of training and workshops for the islanders, as well a conference where experience was shared along with expert guidance. The training and workshops helped participants to develop a sustainable energy strategy and to plan and schedule the implementation stages. By moving to a climate-friendly energy infrastructure, the islands hope to benefit from a 'green' branding which could attract investment. Workshops using expert guidance were organised at local, national and transnational level to make it possible for islanders to	01/09/2010 until 29/06/2012	Project website: http://www.aktionsgruppe.dk/IRDA.aspx Contact name: Mr. Morten Priesholm E-mail: mp@aktionsgruppe.dk Telephone: +45 38 33 00 67 Languages for contact: English, Danish

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			achieve their individual objectives as well as to enable cooperative work between islands. The participant groups met in their own countries to exchange experience and all groups met up for joint activities 3 or 4 times in each of the two countries.		
Energy Efficiency	Sustainable production in viniculture	Austria	The local winemakers know their ecological footprint, and have a catalogue that shows how much energy can be saved in the short / medium / and long term using which measures. Activities: • Data collection by the winemakers for ecological assessment • Creation of a science-based LCA = Calculation of CO2 emissions • Preparation of proposals to reduce CO2 or to advise on sustainability increase in the overall system • Elaboration and practical verification of the sustainability criteria • Rough conceptualisation of a possible local CO2 trade initiative • Compilation of basic information / arguments for "climate-friendly" viticulture production • Final Report • Presentation of the results	2011 until 2012	Verein Vitikult rot-wein-kunst mittelburgenland Name: Ing. Stefan Lang Address: Hauptstraße 55, 7301 Deutschkreutz Telefone: 0664/1449707 E-Mail: info@vitikult.com Website: http://www.vitikult.com Language: Deutsch
Energy Efficiency	Wörgl: our energy	Austria	The aim of the project was to achieve energy self-sufficiency by 2025 (excluding traffic) through the transition to renewable energies. For this purpose, a variety of measures to increase energy efficiency ("energy saving") were used. Additionally, new power generation and distribution systems based on renewable energy sources were adopted. In the first phase of this initiative, raising the awareness of the population, as well as know-how development, collection and development of the necessary basic information and implementation of initial small examples were the planned activities. The following measures were implemented: Wörgler Energy Days, climate	2008 until 2013	Stadtwerke Wörgl GmbH Name: DI Peter Teuschel Address: Zauberwinkelweg 2a, 6300 Wörgl Telefone: +43 5332 72566 318 E-Mail: teuschel@stadtwerke.woergl.at

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			protection information evening, entrepreneurs' energy evening, school projects, energy Info-Screen, exchange of experience with other communities, training of municipal climate protection experts, statistics, etc.		
Energy Efficiency / Renewable Energy	Pacto de los Alcaldes	Spain	This is a Commission initiative for a triple commitment within our towns and cities: Reducing emissions by 20%, saving 20% of energy consumption and increase renewable energy to 20%. This project has two parts: - baseline emissions inventory (IER) - Plan of Action for Sustainable Energy. Currently we ended PAES IER and Alcazar de San Juan.		LAG GDR PROMANCHA Name: Luis Miguel Pérez Ruiz Email: promancha@hotmail.com
Energy Efficiency-Transport	Co-ordinated Car-pooling in Sweden - Samåkning Tolg	Sweden	The main objectives of the project were to: i) use available LEADER funds to develop a new mobile phone application for a car-pooling scheme in Tolg village; ii) to market the scheme to the local community, and; iii) to provide training for users. A survey was initially launched in Tolg to test the interest of local villagers in a carpool. A new mobile phone application was developed. Several meetings were organised to decide routes and stops, the payment system, how to deal with transporting children etc. The system was then piloted by about 10 people. A big launch party was organised to present the carpool, during which participants could sign up and get on-site support. On-going improvement of the system is based on user feed-back.	01/03/2010 until 01/09/2011	Project website: http://www.mobilsamakning.se/mobilsamakning_Home.aspx Contact name: Maja Söderberg E-mail: maja@mobilsamakning.se Telephone: +46 735 811 422 Languages for contact: English, Swedish
Energy Efficiency-Transport	Energy Region Weiz – Gleisdorf	Austra	In this Leader area different climate change related projects have been realised: • Mobility concept/strategy • Climate and Energy Model Region • Energy Bike Region • E-Mobility for enterprises		Contact: Iris Absenger-Helmli Email: Iris.absenger@energieregion.at
Energy Efficiency-Transport	E-Port Region Mürzzuschlag-study on e-mobility in the district of	Austria	The community of the district Mürzzuschlag, represented by the Regional Development Association, sought to boost the e-mobility of the region and in this way fulfil the requirement for larger energy independence. To analyse the potential for e-mobility, information was		

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	Mürzzuschlag		collected and concrete implementation steps were planned. Specifically, an analysis of the need for special carports was called E-ports was conducted, a novel design that was developed by the company Secar Technologies. As a further step, suitable sites have been identified for E-ports in the district. In connection with the tourism association, a test track for electric bikes was built. The conversion of public transport, particularly for regional institutions, has been prepared.		
Forest Fire Prevention	Protection of Forests Against Fire	France	The key objective was to protect the forests from fire risk through the creation of new fire trails and the restoration of the existing ones. The project had to overcome difficulties stemming from natural barriers, such as the sandy soil. The project was included in the framework of a larger project to protect the territory of the Landes de Gascogne (which includes the three departments of Gironde, Landes and Lot-et-Garonne) against forest fires. The main activities were the construction of new fire trails and the improvement of existing ones. The sandy soil on the existing roads made access for large vehicles particularly complicated and slow. These roads were sprayed with gravel and their surface was improved.	04.05.2009 until 21/10/2009	RDP Territory: Hexagone Project website: http://www.dfci-aquitaine.fr Contact name: Pierre Mace E-Mail: ardfci@ardfci.com Telephone: + 33 5 57 85 40 42 Languages for contact: English, French, Spanish
Forest Fire Prevention	Forest Fire Prevention in Borsučie	Slovakia	The overall project objective was, through the reconstruction of the former reservoir, to increase the protection of the forest against fires and implement preventive measures. The beneficiary State enterprise Forests of the Slovak Republic aimed specifically to collect a sufficient amount of water, thus creating the conditions for facilitating and accelerating the intervention of fire equipment in the event of forest fires. The reconstruction of the reservoir was the main project activity and included reconstruction of the tank wall, the bridge, and the water drain. To do this the original tank was drained, the silt removed and the tank's firewall	01/05/2009 until 29/10/2010	Project location and other information: Oravská Polhora village, district Námestovo, Žilina region Contact name: Ing. Aladár Trnovský E-Mail: aladar.trnovsky@lesy.sk Telephone: +421 907 879 237 Languages for contact: Slovak

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			built, its length at the crown is 52m. A reinforced concrete pump pit and a new tunnel of 2200mm diameter were also built. The Polhoranka river basin was restored with the addition of a boulder field to the bottom.		
Forest Fire Prevention	Preventing Forest Fires on the Sierra de Cantabria Mountain Range	Spain	The primary aim is to develop a network of infrastructures, which, while minimising negative environmental impacts, will ensure the protection of forest areas in the event of fires through the separation of combustible forest materials. Further objectives include: improving transit routes for all types of vehicle, to aid people monitoring and extinguishing fires; and modifications which will prevent crown fires forming and resist propagation. The main activities will focus on creating fire barriers, to be mostly placed along forest trails. The fire barriers will be maintained through a pilot scheme launched in 2011 by a farmer on the eastern part of the mountain. The maintenance is to be extended in future years to all other fire barriers and will involve the rest of the localities farmers in the initiative. All work is carried out with the support and protection of personnel from the Provincial Council of Álava Forest Service.	01/01/2008 until 31/12/2013	RDP Territory: País Vasco Contact name: Autoridad de gestión del Pais Vasco E-Mail: oro-ochoa@ej-gv.es Telephone: +34 945 01 96 46 Languages for contact: Spanish
Forest management	Organizzazione Forestale del Territorio (OFT - "Forestry Organisation of the Territory")	Italy	The main objective of the project is multifunctional forestry for land use and water management. The project OFT "Forestry Organisation of the Territory" provides a new and original organization and definition of the structure of the forestry activities (present and future). This project seeks to organise and implements the forestry measures in the area of intervention of the project, to improve the feasibility, safety and quality, as well as to create new areas for restoration and protection of wildlife. Activities: Implementation of environmental and hydraulic issues, with the participation of local communities, groups, private companies, institutions, associations and local authorities.	01/02/2005 until 01/02/2010	LAG: VeGAL Venezia Orientale Name: Simonetta Calasso Email: info@comunesanmichele.it Telephone: +39 0421 394202 Website: www.vegal.net

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Forest Management	Combating Chestnut Blight to Improve Forest Ecosystems	Greece	The overall aim of the project is to protect 2,260 ha of chestnut tree in different Greek regions. More specifically, the project aims to discover the intensity and extent of the disease in these regions. Then to introduce biological control aiming to combat the disease through the use of a Hypovirus type with double-stranded RNA, which, after attacking the fungus, turns it from a virulent into a hypovirulent. The project is expected to achieve its objectives through: i) the conduct of a study by the Forest Ecosystem Protection & Wildlife Laboratory of the National Agricultural Research Foundation to determine the intensity and extent of the infestation of Chesnut Blight in the five project regions; ii) the anointment of a biological paste on affected trees for a duration of 3 years; carried out by teams of contractors.	01.12.2011 until 31/12/2015	Region: Dytiki Makedonia Project website: http://www.agrotikianaptixi.gr Contact name: Athanasia Meremeti E-Mail: ameremeti@mou.gr Telephone: +302105275097 Languages for contact: English, Greek
Forest management / Local Diversity of Economy	Kilfinan Community Forest	United Kingdom	The project aims to create opportunities for a sustainable future for the local economy, through recreation, tourism, the environment and education; the main aim is to deliver a truly 'working forest' where the local community and beyond can come and enjoy the forest. The forest is currently ex Forestry Commission land with mostly mixed conifers with little bio diversity. creating new infrastructure over the next few years there is a need to manage the existing forest properly so that the forest can be restocked with native trees thus creating a more natural forest to aid nature and protect the local environment; need for investment relates to the staff input and equipment required to deliver the above aims and objectives as well as the creation of the necessary infrastructure to provide access to the forest to extract the timber	Duration: 01/11/2012 until 31/01/2014	LAG contact for Argyll & The Islands - Located in Tighnabruaich Name: Sheila McLean Email: Sheila.Mclean@argyll-bute.gov.uk Website: www.kilfinancommunityforest.com
Landscape and resource efficiency / Rural quality of life / avoided	Actuaciones Innovadoras de Reconversión y	Spain	The project seeks to address the abandonment of traditional remote farms which are still inhabited and lack of basic services (electricity, water, utilities, internet). Objectives: small pilot projects on water supply and		LAG Agujama Contact name: Enrique Asín Email: leader@agujama.org

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
abandonment	Recuperación del Hábitat Disperso		treatment , renewable energy and new technologies in order to improve services to the population, which can serve as examples to bring other private sector energy investment to farms in the region The pilot contemplated actions will focus on the following concepts : I. Renewable energy: Studies of the energy requirements of the farmhouses; Installation of renewable energy: solar panels, batteries, transformers, turbines, etc. II. Water supply and treatment: Installation of an ecological treatment plant; Facility Water Supply III. Internet and new technologies: Ad hoc solutions for access to new technologies; Installation of antennas and / or devices needed to access the internet, TDT, etc.; Mobile coverage		
Landscape and Resource use efficiency	"Awakening Koppány-valley" complex sustainability project	Hungary	Promotes sustainable alternative local income streams through renewable energy (biomass), vocational training, and local product development. ESF: awareness raising, community development, school programmes; adult training. EARDF: motivating, animating and organising farmers, study visits and cooperation, planning; native poultry variety breeding programme. LEONARDO innovation transfer programme: adapting and introducing a state of the art Austrian curricula on renewable energy technician training for the local vocational school. Activities: • new production alternatives for small farmers; • enhance climate resilience: stop soil erosion and biodiversity loss, increase water retention; • create local food products; • increase local income generation potential; • increase renewable energy production from biomass; • reform and strengthen local vocational training.		Name: LAG Koppány-Valley and Vox Vallis Development Association Contact: Géza Gelencsér Address: 7285 Törökkoppány, Kossuth L. u. 66 Tel.: +36 84/377-656 E-mail: munkaszervezet@koppanyvolgye.t-online.hu

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Landscape and resource use efficiency	Building Community Partnerships to Protect Local Landscapes & Biodiversity	Belgium	The objectives of the project include: Development of partnerships between local stakeholders to ensure the sustainable management & maintenance of river banks and watercourses; Raising awareness of environmental protection needs and to promote direct actions; Restoring and preserving river banks and the biodiversity in the region, particularly through control of invasive plant species (Himalayan Balsam & Giant Hogweed). Activities include: (i) Identification of occupants of prioritized plots (ii) meetings with affected farmers; (iii) signing agreements with farmers to build river crossing pathways for cattle (iv) installation of troughs (v) installation of new fencing to control grazing (vi) Restoration of the riparian forest; (vii) monitoring of construction works (viii) promotion of agri-environment measures; (ix) managing Himalayan Balsam & Giant Hogweed (x) forming local partnerships (xi) promotion campaign	04/01/2009 until 31/12/2012	Project website: http://users.skynet.be/cr.ourthe/ Contact name: Pierre Pirrote; Contrat Rivière Ourthe E-mail: cr.ourthe@skynet.be Telephone: +32 86 21 08 44 Languages for contact: French
Landscape and resource use efficiency	CULTLANDS - Conservation of European Cultural Landscapes	Joint Project: Spain, Poland, Hungary, Austria	The project aims to promote products that help the participating rural areas to conserve the characteristic features of their cultural landscape. The specific objective is to establish a scientific basis for the marketing of products from extensively cultivated cultural landscapes (e.g., cider/juices from Austria, ham from Spain, and apicultural products from Poland). This may include information about: environmental effects (biological diversity, appearance of the landscape, climate efficiency/carbon footprint); quality (effects on health, taste, food safety), production process (keeping of animals), the production chain (traceability) and marketability for the purpose of agri-tourism. Transnational activities involve the presentation of examples of 'best practice' during mutual excursions, joint conferences on site, teleconferences and possibly the establishment of a 'cultural landscape brand'. Featuring the parameters of a typical, verifiably healthy and regional product, such common brand shall	01/01/2011 until 31/12/2013	Project website: http://www.zeitkultur.at/projekte/zeitkultur-projekte/cultlands.de.html Contact name: Wolfgang Berger E-mail: info@zeitkultur.at Telephone: +43 3334 31478-0 Languages for contact: English, German, Polish, Spanish

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			demonstrate the importance of the preservation and the beneficial indirect returns of extensively cultivated cultural landscapes.		
Landscape and resource use efficiency	Establishment of an Organic Winery	Greece	The project aims to promote rural entrepreneurship, capitalise from locally produced agricultural products, increase the value added of agricultural produce, facilitate the access to markets for local organic wine and diversify economic activity. An existing building has been modified and adapted for the establishment of a modern winery and bottling of wine produced from organic viticulture. The investment includes the transformation of existing facilities to a certified winery, a certification system for food health and safety and the provision of equipment that incorporates latest technology and automation such as a peristaltic pump, a de-stemmer, crusher, an insulated tank for cold wine stabilisation and a vinificator.	13/12/2010 until 01/07/2013	Contact name: Andreas Kontozisis E-mail: kontozisis@hotmail.com Telephone: +30 6979 108118 Languages for contact: English, Greek
Landscape and resource use efficiency	Exploitation of Oil Press By-products	Spain	The objective was the exploitation and valorisation of 4 000 tonnes of 'alperujo' (olive pulp obtained after crushing olives for oil) and 1,000 pruned residues, generated during olive oil production and used for obtaining high quality compost, to be used in applications such as organic soil amendment. The company involved is dedicated to the production of olive oil that is extracted cold through mechanical processes.	01/11/2010 until 31/10/2011	Contact name: LAG TEDER E-mail: teder@montejurra.com Telephone: +34 948 556 537 Languages for contact: Spanish
Landscape and resource use efficiency	Field crop fertilization and crop rotation plan calculation program.	Latvia	Ogres farmers' associations purchase of the hardware equipment will lead to wise distribution of resources and at the same time minimize harmful environmental effects. Proper crop rotation compliance has the potential to reduce the leaching of nitrogen. Project helps to purchase hardware equipment and specialised software for "Ogres farmers association". As a result, appropriate crop fertilisation and crop rotation plans can be calculated.		
Landscape and resource use efficiency	Flanders Moss - Boardwalk	Joint Project: Finland,	This Leader project's objectives aimed to encourage more people to visit, understand and support the bog conservation activities at Flanders Moss. New visitor	1/1/2005 until 31/12/2007	Project website: http://www.snh.org.uk/PeatforPeople/homepage.asp;

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
		France, Ireland, United Kingdom	facilities would be introduced to help local residents and tourists enjoy the NNR's important wildlife and landscape features. This included constructing a new board walk to improve accessibility to the bog and develop promotional materials about the bog. The objective of the transnational component was information exchange, through visits to each country to study how each partner responds to the challenge of getting people engaged in peatlands. The Scottish shared their method of engaging local communities & addressing conflicts between peatland conservation & farming. In Finland physical challenges of bringing people onto such difficult terrain were presented. The Irish partner led on the use of art to capture people's interest & challenge their perceptions about peatlands as 'just boggy wastelands'. The French informed about the use peatlands for education, training & how to get people actively involved in hands-on conservation work.		www.nnr-scotland.org.uk/reserve.asp?NNRId=39 Contact name: Alan McDonnell E-mail: Alan.McDowell@snh.gov.uk Telephone: +44 1786 450362 Languages for contact: English
Landscape and resource use efficiency	Forest Licence' project delivers skills for small-scale forest owners	Luxembourg	The aim of the 'Forest Licence' project was to prepare and run training courses for passive forest owners in how to use and take care of their woodlands. The ultimate goal focused on helping rural areas to get greater benefits from under-used forest resources. The Leader funds co-financed eight different training courses that were new and specially tailored to meet the needs of the target group. Initial courses involved helping owners to recognise the traditional methods that had been used in the past to mark the boundaries of forest plots. From this starting point, owners were trained in topics ranging from environmentally sustainable silviculture skills for different forest species, to chainsaw health and safety.	01/01/2011 until 31/12/2011	Contact name: Anette Peiter, LAG Müllerthal E-mail: anette.peiter@echternach.lu Telephone: +352 26 72 16 31 Languages for contact: English, French, German
Landscape and resource use efficiency	LEADER Funds for Environmental Services	Germany	The initiative aims at boosting agri-food products produced in areas that provide special care to and enhance the environment (measure 411). Therefore, a wide range of development activities are eligible,	01/02/2007 until 30/11/2013	Project website: http://www.leader-nordschwarzwald.de/home/index_html

Thematic Area	**Name**	**Country**	**Brief Description**	**Project Timeline**	**Contact**
			including farm infrastructure and equipment, and even post-farm products marketing – in other words, supporting the management and marketing activities that deliver public environmental goods. Several LEADER regions are using projects to safeguard and enhance the environment through support activities, such as building new fences and water supply, marketing agri-food products, etc. The LAGs involved in the project actively participated in the preparatory work to decide the eligibility criteria as well as informing and training farmers, preparing the administrative documents, screening all applications, monitoring project implementation and providing feedback.		Contact name: Dajana Grzesik, LAG Nordschwarzwald E-mail: 13.grzesik@kreis-calw.de Telephone: + 49 7051 160 203 Languages for contact: English, German
Landscape and resource use efficiency	MUFLAN: ecologically optimised, multifunctiona l use of landscape and resources	Austria	The project aimed to increase effectiveness in the management of use-conflicts over the availability of environmental resources between many different interest groups. Activities: 1st level: The project provided an ecological inventory of the region, including regionally specific environmental problems (soil and land, mineral resources, water resources, biodiversity and nature protection, land use) 2nd level: The region received an instrument for predictive resource planning and to improve coordination of the user interests and conflict prevention. 3rd level: Communication both internally and externally.	2010 until 2012	Regionalverband Pongau / Regional Association Pongau LAG Lebens.Wert.Pongau Address: Bahngasse 12 (Bahnhof), 5500 Bischofshofen Telefone: 0043 (0)6462/33030 35 E-Mail: leader@pongau.org
Landscape and resource use efficiency	Portuguese forest environment project protects rare birds and creates business opportunities	Portugal	The project aims to increase biodiversity values in a Natura 2000 area with desertification susceptibility, by implementing a sustainable strategy that contributes to climate change adaptation and mitigation. Extensive farming and forestry managing systems are eco-functional and resilient, well adapted to local conditions and climate, coping successfully with natural risks like drought, fire and erosion. These specific land systems increase soil fertility, improve water infiltration and storage, contribute to carbon sequestration, and	02/05/2008 until 31/12/2013	Project location and other information: Castelo Branco, Idanha-a-Nova and Vila Velha de Ródão Project website: http://www.drapc.min-agricultura.pt/drapc/iti_tejo_internacional.htm Contact name: Estrutura Local de Apoio da

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			produce biomass, replacing feed products that incorporate fossil energy. In the case of the Tejo Internacional ITI, its aim is to use axis 2 &3 funds in combinations to (inter alia): conserve the basic ecological structure, and maintain non-irrigated cereal-fallow rotations, with direct drilling of cereals; re-naturalise forest areas, maintain groves of native trees and shrubs and conserve ecological corridors; protect regeneration processes; operate partnerships approaches to management / implementation of ITI objectives. Implementation of a sustainable strategy involving extensive farming and forestry management. The farm Herdade do Fervedouro illustrates the type of individual project supported by the Tejo Internacional ITI. The property has more than 200 ha of oak, and the management of 50 ha of this is being supported by annual forest-environment payments, to maintain groves of native trees and shrubs (including notable or relict specimens) and conserve the network of ecological corridors. The farm will also apply for non-productive investment support for deer fencing to protect natural regeneration.		Intervenção Territorial Integrada do Tejo Internacional E-mail: dadqmr@drapc.min-agricultura.pt Telephone: + 351 272 348 600 Languages for contact: English, Portuguese
Landscape and resource use efficiency	Preservation of the Haspengouw Landscape	Belgium	The main objective of the project was to put in place a set of initiatives to: Preserve the traditional landscape through the protection of the small landscape elements such as hedgerows and traditional orchards; Support cooperation amongst farmers and local authorities as well as social and farmers' organisations active in the area; Create new jobs, including for people with special needs, and new income support for farmers in the region. The main activities of this LEADER project were: • Drawing up plans to restore, preserve and develop the small landscape elements. • Purchasing a new hedgerow thresher, for the pruning of rural hedgerows • Purchasing a mobile juicer, providing a method to	01/01/2009 until 31/12/2011	Contact name: Regionaal Landschap Haspengouw en Voeren vzw E-mail: info@rlh.be Telephone: +32 011 31 38 98 Languages for contact: Dutch

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			prevent fruits rotting in the orchards, as they can only be stored for a short period of time and farmers cannot process them. During the harvest the mobile juicer visits many of the municipalities and farmers can have their fruits pressed.		
Landscape and resource use efficiency	Separate waste collection system`s development in rural areas of Gulbene`s district.	Latvia	The project aims to create separate waste collection system in Gulbenes district rural areas, providing residents the opportunity to live in a clean and orderly environment at the same time improving resource efficiency. Overall 60 waste containers for glass and plastic/paper will be setup in 30 rural villages. Shared waste sorting and collection service will be provided not only for the rural population, but also state and local authorities as well as local businesses, who return and recycle cardboard and plastic packaging containers.		
Landscape and resource use efficiency	The Management and Use of Robinia (false acacia)	Joint Project: Hungary, France	The Médoc's Robinia forests are spread over 36 communes, with more than 2,400 owners, and have not benefitted from any strategic management for many years. Local Robinia was previously used for stakes by the wine industry, as well as for buildings, but in recent years it has been widely replaced by imports. Forest owners needed to be encouraged to recognise the potential of this natural resource, which is an excellent timber for construction. The project consists of a joint programme of training and the exchange and transfer of knowledge. The training has been provided in Hungary, with forestry management of fragmented forests being provided in the Médoc. This has the support of the LAG Felso Homokhatsag, with visits to both areas. Each LAG will present the results of its work in an exhibition in their respective regions.	01/05/2010 until 01/12/2011	Contact name: Marie Amouroux E-mail: gpfmedoc@laposte.net Telephone: +33 5 57 75 03 33 Languages for contact: French
Landscape and resource use efficiency	Training and Information for Forest Owners to Develop Sustainable	France	Forests mainly produce timber for construction, but it is also possible to produce energy from wood industrially. The combined potential is huge, including the development of agricultural equipment and the creation of a heating network. The main needs are the following: a) to develop the supply and processing of timber; b) to	01/04/2010 until 01/01/2011	Project website: http://www.pays-adour-landes-oceanes.com/ Contact name: Pays Adour Landes océanes E-mail: lucie@pays-adour-

Thematic Area	**Name**	**Country**	**Brief Description**	**Project Timeline**	**Contact**
	Forestry		create demand by raising awareness amongst potential users: local authorities, planners, house builders. The creation of sustainable forests would improve the region's environmental and economic wealth by realising their economic potential. This requires a major effort to raise awareness among the interested parties and encourage them to help establish a regional development plan. An information pack has been produced and distributed to forestry owners. Six regional meetings have been held, at which geographic, administrative and other matters were discussed.		landes-oceanes.com Telephone: +33 558 574140 Languages for contact: English, French
Landscape and resource use efficiency	WiWaLaMoor - Water landscapes and wetland in Wildpoldsried	Germany	Objectives of the project: Prevent flooding due natural water retention; Creation of recreational area; Creation of habitats for wetland species. Activities: Creation of a wetland that consists of several pools; Construction of a structured pond system including infrastructure for recreational activities; Utilisation of fruits (Streuobst), planting of traditional fruit trees; Secondary sedimentation of cleaned sewage water in reed beds.	2005-2008	Name: Susi Vogl Email: susi.vogl@wildpoldsried.de Phone: +49 8304 9205 11 Language: German
Landscape and resource use efficiency / Sustainable land management / agriculture, avoided abandonment	Recuperación e Inventario de semillas de variedades locales y sus técnicas de cultivo de la provincia de Albacete. Aportaciones a la soberanía alimentaria local	Spain	The project will directly affect the following aspects: - Development of innovation through the exchange of experience in the relevant jurisdictions regarding the introduction of permanent mechanisms for sharing the ethnobotanical heritage. - Effective integration of the principles of environmental protection, animal welfare and food safety in agricultural and livestock activities. - Avoid land abandonment and maintenance of good agricultural and environmental conditions, reinforcing the sustainability of rural areas and the maintenance of the population and landscape And as a result of use of agricultural land for organic farming CO_2 fixation will increase and therefore reduce the impact on climate change Activities: • Training of workers in the management of traditional		LAG CEDER Manchuela, contact: Malaquias Jimenez, Phone: 639158319 Email: malaquias@lamanchuela.es Website: http://www.reddesemillasalbacete.org/#2

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			farming systems • Improved profitability of farms through niche markets of high organic quality and organic production		
Landscape and resource use efficiency / Sustainable land management	Connection Runde – Integrating peat restoration and protection with river restoration in Southeast Drenthe	Netherlands	The project aimed at linking and restoring the Runde river as a robust and resilient water body and as a driver for further development of natural and recreational areas. Parts of the river have been restored and dug out to allow the free flow of water from the Bargerveen (via the Runde and Ruiten Aa) to the Dollard. The project also created an ecological corridor along the Runde and Ruiten Aa, which connects the Bargerveen and the Ecologische Hhoofdstructuur (EHS – protected areas aimed to be connected within the Netherlands) areas Westerwolde and Dollard, permitting free migration and exchange of plants and animal. These activities have strengthened the recreational and tourist value of the area.	2008 – 2014 (ongoing)	Contact: Gerard Meijers Email: G.Meijers@drenthe.nl Phone: +31654341638 Website: http://www.hunzeenaas.nl/werk-in-uitvoering/runderuitenaa/Paginas/default.aspx
Nature Conservation	Preservation of rural paths and planting hedges	France	Save several rural paths damaged, plant hedges to help create continuity and improve the biotope.	November 2011 to March 2012	Contact : M. Michilsen, Vice-président de la Communauté de communes du Bernavillois (80) Languages: French Telephone: 03 22 32 31 18 E-mail: v.parmentier@bernavillois.fr
Nature Conservation	Biotope networks and Climate Change - a nature conservation concept	Germany	The aim of the project is to develop a concept in order to ensure sustainable cultivation of the cultural landscape under climate change. This concept is supposed to be transferable to agricultural landscapes Objectives: Planning of measures to improve the ecological balance of the area; Development of a polymorphic landscape; Build up of biotope network; Cooperation between nature conservation, agriculture, forestry and the rural population.		
Nature Conservation	Parks Protection II – Management,	Joint Project: United	The overall objective is to generate economic/tourism activity through joint training promoting the exchange of measures favourable to the conservation of the	01/11/2012 until 20/12/2013	Contact name: Angela Manitara E-mail: info@parnonas.gr

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	Protection and Economic Development of Protected Areas	Kingdom, Latvia, Greece	environment. Taking into account the significant protected areas each partner disposes of, the project's specific objectives are (1) to raise awareness among members of the local community about the state and value of the natural environment in the different territories covered by the partnering Local Action Groups, and (2) to encourage the joint discussion of the challenges identified and the opportunities seized to date, in order to influence business practices, public space management, and behavioural patterns of the local population. Partners agreed a joint programme of "international educational weeks", attended by trainees representing above target groups. Training in the UK focused on the approach taken to managing shoreline habitats whilst maintaining the sustainability of the visitor offer. The Latvian part introduced traditions, essence and purpose of environmental interpretation. Being typical for Mediterranean mountainous areas, the Greek lead partner's event considered the challenges of the National Park Parnonas.		Telephone: +30 27570 22807 Languages for contact: English, Greek
Nature Conservation	Ecological advancement of Durbes lake.	Latvia	Purchase of equipment to reduce the overgrowth of the lake, which will ensure nature conservation, improvement of the ecological conditions and biological diversity as well as development of fish population in the lake. The purchased equipment is used to move Durbe`s lake public access points, river estuary and outflow, resulting in improved ecological condition of the lake.		
Recycling	Garson Recycling / Re-Use Centre	United Kingdom	Orkney Zero Waste (OZW) has initial funding and planning permission to construct this project on an industrial site based very close to the Stromness Civic Amenity Site. Site for disposal of things for reuse. A "wish list" of things people are looking for will also be kept. Work closely with Orkney Islands Council (OIC) and other partners in order to develop a good working relationship so that they will redirect people to the site for disposal.		Name: Jenny Taylor Email: jenny@jtlarch.co.uk Website: http://www.orkneycommunities.co.uk/LEADER/index.asp?pageid=2969

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Recycling	Shetland Amenity Trust - Enviroglass Business Development	United Kingdom	Social enterprise recycles all waste glass collected by Shetland Islands Council through kerbside collection and bottle bank schemes. Objective was Trust plan to purchase new imploder technology specifically designed for recycling glass. Activities were Glass is processed into recycled glass products, including aggregate, abrasive blasting products and precast concrete paving slabs.	Approved November 2012	Shetland Islands LAG Name: Sheila Tulloch Email: sheila.tulloch@shetland.gov.uk
Renewable Energy	Rural Portugal for a sustainable future	Portugal	Main objectives were: demonstrate the technical and economic feasibility of using technologies related to renewable energy and energy efficiency; discover basic mechanisms for implementing energy efficient systems for each area; generate illustrative systems on usage of renewable energy sources; contribute to diversification of the rural economy through granting access to alternative income systems; check the suitability of the legal framework. Activities were preparation of a regional intervention plans by each partner and a reference manual on renewable energy and energy efficiency; implementation of at least one low-voltage wind power system, a photovoltaic system, a water system, one energy efficient system; monitoring, testing and reporting on performance of the installed systems; selection of energy saving systems to be installed in various contexts; delivering of a workshop and production of information and marketing materials.	01/03/2010 until 31/03/2012	Project location and other information: North, Centre and West of Portugal Project website: http://www.leaderoeste.pt/ Contact name: Jose Coutinho E-Mail: leaderoeste@netvisao.pt Telephone: +351 262 691 546 Languages for contact: English, Portuguese
Renewable Energy	Baling machinery and storage facility development for agri-residue use; Wood chips manufacturing	Hungary	Activities: 18 accomplished (4 rejected, 4 discarded) - bioenergy/biofuel/biogas; 6 projects accomplished (1 waste project rejected) - agricultural waste; 42 projects accomplished - solar energy; 130 completed projects; 15 rejected; 5 excluded; 4 resigned - energy efficiency.		Abaúj Leader Egyesület Contact: Bratuné Bucskó Mariann Address: 3860 Encs, Petőfi út 62. Tel.: +36 46/587 344
Renewable Energy	Biogas plant (dry process)	France	The aim was to build a tool available for all the stakeholders interested to valorise biowaste into energy		Syndicat Mixte du Pays Barrois

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			(waste from local communities, food industries and agriculture).		46 Boulevard Raymond Poincaré 55000 BAR LE DUC Telephone: 03.29.75.58.00 Email: pays.barrois@paysbarrois.com
Renewable Energy	Conception for Development and Documentation of Energy Demand and Consumption Data of community buildings	Germany	Objectives: • Development of suitable solutions for energy saving and the utilisation of renewable energy • Optimisation of energy supply (cost effective and environmentally friendly) • Determination of energy saving potentials • Adoption of renewable energies (for public buildings) Activities: Documentation of energy demand and consumption data; Analysis of weaknesses of potential solutions.		
Renewable Energy	Development of a wood energy supply chain in the "Pays vendomois"	France	Valorisation of renewable energies on the territory through biomass (wood energy).	October 2009 to December 2011	Name: Aurélie Buffault Structure / organisation (si différent de la MO): Communauté de Communes Beauce et Forêt – 5 Rue de la Salle – 41190 OUCQUES Language: French Telephone: 02.54.26 22 Email: a.buffault@beauceetforet.fr
Renewable Energy	Energy Region 2010 "Central blackforest"	Germany	Objectives: Joining local renewable energy plants with supra-regional policy and economic subjects; Developing a regional energy system; Transfer of concept to other regions; Increase usage of solar power; Develop maps that display suited roofs; Advice on renewable energies and saving energy; Job creation, support of region economy, incentives for private investors; Support for local authorities. Activities: 3 subprojects: 1) GIS-analysis in order to locate possible positions for		LAG Manager: Mark Prielipp Telephone: +49 (0) 7836-955 779 Email: info@leader-mittlerer-schwarzwald.de Languages: German, English, Dutch Website: www.leader-mittlerer-schwarzwald.de

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			photovoltaic installations 2) thermal imaging of public and private buildings in the region and related information sessions 3) modernisation of public and private buildings (e.g. insulation)		
Renewable Energy	Kyoto in Pajottenland	Belgium-Flanders	Develop local policies and initiatives for the development of local renewable energies in order to enhance the development and prosperity of the region in a sustainable way. Reduce municipal waste, which will be used for renewable energy production.		Website: http://www.kyotoinhetpajottenland.be/
Renewable Energy	Masterplan Ökoenergieland – master plan eco energy region	Austria	The Leader area of Southern Burgenland is an Austrian model region for renewable energy. The district of Güssing, part of the Leader area, is already energy autarkic. In this area the European Centre for Renewable Energy is located (http://www.eee-info.net/cms/EN/). In this LEADER period they have developed a “master plan eco energy region” as a basis for further activities in the field of renewable energy.		Contact: Ursula Maringer Email: maringer@suedburgenlandplus.at
Renewable Energy	Orkney Renewable Energy Forum Development Manager	United Kingdom	The Forum was established in 1999 and facilitates the development of the renewables industry in Orkney. Rapid expansion of onshore wind capacity and the prospects of more wave and tidal energy exist - already 350 jobs in the sector on Orkney. Forecasts predict will rise to around 1000 by 2020. Aim is to provide a Development Manager post to fulfil the partnership's objectives. Will ensure Orkney has professional leadership to represent the sector locally. Activities: Help ensure talented businesses focused on innovation and technology development, competitive and committed supply chain, in-bound flow of talent seeking to work in leading energy businesses, cutting edge technology adoption within both business and community, export of services and expertise based on transfer of knowledge and experience to other communities and projects around world, globally recognised and internationally connected businesses,		Contact: Matthew Finn Email: Matthew.finn@emec.org.uk Website: http://www.orkneycommunities.co.uk/LEADER/index.asp?pageid=4169&msg=Content%20Updated

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			and support for the infrastructure that creates the opportunity for new and innovative development, informed business and communities, work with local and national groups to promote a low carbon economy.		
Renewable Energy	Outer Hebrides Community Energy Fund	United Kingdom	This project aimed to support and operate a Community Energy Renewable Fund for the Outer Hebrides to support communities to assess the feasibility of their area to develop renewables as a revenue-generating project. This scheme was designed to make communities more resilient and self-sustaining through energy related improvements. Described as a "small-grants scheme". This proposed new Outer Hebrides Community Energy Fund (OHCEF) scheme looked to assist these community groups which are being disadvantaged by their inefficient buildings. This would make their facility more comfortable and attractive to new users, lower their energy bills and raise awareness locally of the importance of lowering carbon. The fund supported 26 different projects and this included installing energy efficiency projects such as insulation, undertaking renewable energy feasibility studies, energy audits, and educational projects such as learning visits.		ORGANISATION: Community Energy Scotland (CES) LAG contact: Kathlene Macdonald LEADER Innse Gall / Outer Hebrides LEADER Co-ordinator Tel: +44 (0)845 600 70 90 (Internal Ext: 211285) Email: kathlene.macdonald@cne-siar.gov.uk Website: www.outerhebridesleader.co.uk
Renewable Energy	Public information campaign "Energy efficient living"	Germany	Awareness raising regarding the energy efficiency of the housing sector, renewable energy for private energy consumption, lowering the regional carbon emissions, and supporting the regional economy Objectives: • Increase the proportion of modernised houses and energy saving measures • Increase the usage of renewable energy in private households • Improve the regional CO_2-balance • Support regional economy and applications for funds Activities: Creation of Information materials (brochures, news paper, internet etc.); Organisation		

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			of information events and advice; Presentation of best-practice examples.		
Renewable Energy	Purchase of innovative instrument - water kinetic energy measuring equipment - for the improvement of renewable energy services for local population.	Latvia	For the Association`s more qualitative operation to purchase a modem - water kinetic energy measuring apparatus with a wide range of applications. By exploiting the kinetic energy of the water measurement data analysis, provide citizens with the opportunity to use water free flow technologies for their own needs as well for the commercial power generation. So far electrical energy from the rivers was obtained with the old technologies - with the help of the dam hydroelectric power station, but the use of such technology creates an imminent damage to the ecosystem. Currently in Latvia more popular becomes new water free flow technologies, based on the submerged turbines that does not affect the surrounding ecosystem, but the complex measurement equipment for these technologies is not available. Because of this project, residents will be able to find out what type and capacity turbine can be inserted at specific locations.		
Renewable Energy	Renewable energy and energy efficiency in rural Italy	Italy	Initiative to increase the use of renewable energy and the adoption of more efficient energy system for rural houses through the aggregation of operators, training, technical assistance and information activities. Activities: • 7 feasibility studies • Balance was found between investment, energy consumption and return on investment • 6 biomass power plants were built for energy supplies of entire communities		RDP Territory: LAG Valli di Tures e Aurina-Val d'Ultimo, Alta Val di Non, Val Martello Contact name: Miriam Rieder Email: miriam.rieder@leader-tat.com Website: http://www.leader-tat.com/de.html
Renewable Energy	Study for a collective biogas plant in the "Virois" region	France	Study to demonstrate the technical and economical interest, localisation of the biogas plant in the territory, substrate supply, etc. Produce energy through anaerobic digestion, raise awareness of a collective approach of biogas to stakeholders of the territory.	Started in June 2010	Name: Valia QUERAN Structure / organisation: Pays du Bessin au Virois Language: French Telephone: 02 31 67 57 01 Email: leader@bessin-virois.fr

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Renewable Energy	Tennengau – Pongau Energy Region	Austria	Increase in the level of information on renewable energy for private persons and tradesmen (building and living with energy and the environment in mind) as well as the increase in energy competence and energy use in all areas of renewable energy sources and resources. Contained in the local working group (LWG) Lebens.Wert.Pongau strategy in the field of action of "Natur.Wert.Pongau".		
Renewable Energy	The Hungarian Virtual Micronetwork Balance Circle Cluster	Hungary	Aims to develop an entire range of renewables for the region.		Name: Dr. József Nagy Email: leaderbukkmak@nagyfkft.t-online.hu Phone: +36 46 576-280 Website: http://www.bukkleader.hu/
Renewable Energy	Updating the energy concept "Pellworm"	Germany	Objectives: Development of a concept in order to exploit the renewable energy potentials; Recommendations for actions for the community; Maximum exploitation of the renewable energy potentials; Maximise energy savings. Activities: • Identification of energy producers and energy consumers • Update of energy concept • Recommendations for action • Foundation of "Enery Network Uthlande"		
Renewable Energy	Texel Energie	Netherlands	An energy cooperative was established as a non-profit organisation, and any benefits resulting from its activities are invested in initiatives to increase small and local renewable energy production on Texel. The cooperative was set-up to provide green energy to the islanders, with the ultimate goal to supply the island with energy which is mainly created on the island. Currently, only a small part of the energy which is sold by Texel Energie is generated on Texel itself (mostly by solar panels purchased by private household or wood incineration). Texel Energy has a strong innovative character and aims to offer a space to experiment,	April 2008 - September 2009	Contact: Job Stierman Email: jobstierman@texelenergie.nl Phone: +31 (0)222 314 939 Website: http://www.texelenergie.nl/

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			research, and build knowledge. In 2007 prior to the beginning of this LEADER project, Texel Energie prepared a business plan including a feasibility study. Future energy production installations planned by the cooperative are: thermal storage batteries, harvesting wind energy by employing a kite, and a tidal power plant. Texel Energie also had plans to install windfarms on the island, but the province was unwilling to grant the necessary licenses.		
Renewable Energy - Agricultural Waste	CO_2 Recycling: producing of compost from organic waste	Austria	Retention of CO_2 in the soil and replacing chemical fertiliser by natural fertiliser (compost).		LAG Unterkärnten Name: Peter Plaimer Email: peter.plaimer@lag-uk.at
Renewable Energy - Agricultural Waste	Norra Möre – a Biogas Plant in Småland	Sweden	The specific objective of the project was to undertake a feasibility study to realise a biogas plant able to serve eighteen farms, whereas the overall objective was to use economy of scales created by the a large-scale facility. The main activity undertaken was a feasibility study, which brought about the effective realisation of the biogas plant. The feasibility study was undertaken and officially presented in January 2011 and by February 2011 the activities for the realisation of the plant started.	01/04/2010 until 01/04/2011	Name: Ingela Nilsson Nachtweij Email: ingela.nilsson.nachtweij@lrf.se Phone: +46 492 28833 Language: Swedish
Renewable Energy - Bioenergy	Development of miscanthus of biomass (Brittany region)	France			Association LEADER Hôtel de Ville- 22800 Quintin Telephone: 02 96 74 99 88 Email: accueil.leader@yahoo.fr
Renewable Energy - Bioenergy	Development of the line forest-wood-energy through the development of the forestry cooperatives	Italy	Realisation of forest biomass plants for energy production and implementation of collective platform for forest biomass processing and stocking. The purpose is to achieve evaluation elements to support and create on the territory an energy politics based on the endogenous capacity of supply of renewable energetic resources coming from the agriculture forestry sector.		RDP Territory - LAG Garfagnana Ambiente e Sviluppo

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Renewable Energy - Bioenergy	Improving production processes for generating bioenergy from coppice crops	Ireland	The brothers wanted to explore new options for strengthening their business. Higher productivity and improved product quality were considered possible from installing precision-built pre-drying equipment, which would extract moisture from the raw wood material before it was processed into dry wood chips. The company wanted to use renewable energy as source of heat for their drier. No equipment of this kind was available in Ireland and so a dedicated drying facility needed to be commissioned. Technical specifications for the drying facility centred on building large boiler units which could produce enough heat to dry 20,000 tonnes of wood chip. Design, construction and installation costs for this innovative piece of wood processing equipment were part-funded by the LAG which provided €150,000 of EAFRD towards the project's total cost of €319,325.	01/01/2008 until 01/01/2009	Project website: http://www.timberpro.ie Contact name: Fiona Larkin E-mail: Fiona.larkin@meathpartnership.ie Telephone: +353 46 9280790 Languages for contact: English
Renewable Energy - Forest Management	Elimination of Cattle Farm Wood Shavings	Spain	The objective was to develop a product to help reduce and eliminate cattle farm solid waste deriving from wood shavings and/or sawdust through a process of gasification, the combustion of the generated gas subsequently resulting in thermal energy production. This treatment is targeted at types of cattle farms which use "beds" made from forest residues, such as stables, cow sheds, poultry coups, animal laboratories. The main activity is the treatment of the waste by gasification followed by the burning of the gas to produce thermal energy. The company carrying out the process is an engineering venture which has operated in the field of renewable energy for more than fifteen years. It has cogeneration plants located throughout Spain, consisting of biomass facilities run on biogas.	06.01.2009	Project website: http://www.cederna.es Contact name: LAG Cederna Garalur E-mail: info@cederna.es Telephone: +34 948 206 697 Languages for contact: Spanish
Renewable Energy - Forest Management	Small-Scale Energy Production from Wood in La Réunion	France	The overall aim is to evaluate the conditions for the development of a new industry for producing energy from wood in four potential sites, identified in the PER, and located in the Upper region of the island. The operational objectives are the use of plots of land for the production of wood, and the setting up of two trial units	07/07/2010 until 03/12/2012	Project website: http://arer.org/ Contact name: Mrs Elodie Grouset E-mail: egrouset@arer.org Languages for contact:

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			for wood gasification. The project is also funded under measure 412 Environment / land management. The project is being carried out in 6 phases: 1) Initial studies (into wood resources, techno-economic feasibility); 2) supply of resources (investment in equipment, wood handling and land monitoring); 3) production of renewable energy (setup /construction of the plant); 4) heat development (techno-economic studies and global energy assessment); 5) recovery of by-products (uses for the ash and other waste); 6) development of small-scale industries (based on an analysis of local geography).		French
Renewable Energy - Miscellaneous	Jena-Saale-Holzland – A Bio-Energy Region	Germany	The objective was to promote local bio and renewable energy production alongside the existing network, increasing efficiency and reducing costs. The aim was to raise the local share of electricity and heating from around 15% to 30% by 2020, with an increase in the agricultural biomass share to 75%. Apart from the financial benefits, this would enable some local waste recycling plants to be closed. Activities of this Leader project include: i) Education and PR to strengthen the Players Network and educate the local population; ii) a bio-energy centre to combine activities and conceive new ideas; iii) professional-technical consultancy to optimise existing heating systems and increase crop diversity, and; iv) the creation of the Schloben 'show village' to demonstrate bio-energy concepts and the potential of straw as a renewable fuel.		Name: Ronny Killan & Thomas Winkelmann Email: r.kilian@bioenergie-region.de Telephone: +49 36693 23 09 -45 or -44 Website: http://www.bioenergie-region.de
Renewable Energy - Solar Energy	Assessment of the potential for solar energy	Austria	Survey of the solar potential for the entire district of Landeck. Activities:Determination of the exposure to sunlight and the solar energy potential was based on a surface model and a digital terrain model. The evaluated data was incorporated into the Tyrolean Spatial Information System TIRIS and is available free of charge to all public facilities and the interested public.	2010 until 2011	Regionalmanagement Landeck Name: DI Gerhard Witting Address: Bruggfeldstraße 5, 6500 Landeck Telefone: 05442-67804 E-Mail: witting@regiol.at

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Renewable Energy - Solar Energy	Setting up a Solar Power Station and Solar Thermal Collector	Hungary	The objective of the project was to present - besides other renewable systems already in use in these demonstration yards- the use of solar energy in one of the Community Energy Yards and to set up a 5.04 kWp solar power system to produce electricity and a 800-1,100 kWh solar thermal collector in order to produce hot water. The beneficiaries of the electricity and heat produced by these demonstration systems are the local communities and schools. The main activities undertaken were: a) the purchase of the solar power system to be set up in one of the exhibition yards (which are in continuous use so the project needed to be planned accordingly; b) the compulsory maintenance work of the equipment and c) ensuring distance supervision of the system. The produced energy is taken over by the local energy provider who deducts the amount of renewable energy fed into the grid from the school's energy consumption per year.	01/06/2010 until 30/08/2010	Project website: http://www.freeweb.hu/bukkmakleader/22_1_falu_1_MW.html Contact name: László Lukács E-mail: dedes@t-online.hu Telephone: +36 46 576 280 Languages for contact: English, Hungarian
Renewable Energy - Solar Energy	Solar Mobility in Kärnten	Austria	Awareness raising for electric mobility. Activities: • Conduct a kick-off event on the future topic "Sustainable transport - Electric Mobility" • Establish solar energy stations • Establish PV systems and micro wind turbines • Purchase electric vehicles • Workshops to develop local, municipal and business mobility concepts • Project management	2009 until 2011	Forum Regionalentwicklung Kärnten Name: Valentin Blaschitz Address: Gabelsbergerstraße 5/1, 9020 Klagenfurt Telefone: 0043 (0)664 5026257 E-Mail: voelkermarkt@rmk.co.at
Renewable Energy - Solar Energy	Twechar Solar PV	United Kingdom	Installed Solar PV Panels to the roof of the main sports hall in the Village		Craig Clelland, Community Capacity Builder, Twechar Healthy Living and Entreprise Centre, St John's Way, Main Street, Twechar, G65 9TA, Telephone 01236 827154
Renewable	Solar panels	Netherlan	The main objective of the project was to increase the	1 February	Contact: Henk Egberts

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Energy - Solar Energy	for farmers in Northeast Overijssel	ds	amount of renewable energy used on farms in the region and thereby reduce the energy costs for the farmers who participated in the project. A number of solar panels were installed during the course of the project. A further objective was to stimulate energy efficient electric cycling by creating posts where electric bicycles could be charged.	2013 – 1 April 2014	Email: GHBH.Egberts@overijssel.nl Phone: +31 (0)529 47 81 80 Website: www.stimuland.nl
Renewable Energy - Solar Energy	'Shadows and Sun' and 'Catching the Sun' – Improving the use of renewable energy	Slovenia	In the first phase of the project, the aim was to increase awareness, knowledge, and experience sharing on the topic of renewable energies. The project brought together energy advisors, forestry advisors, and potential investors in order to increase the production and availability of biomass resources for sale, as well as to increase the use of other renewable energies (in particular, solar power). Building on the outcomes of the first phase, the second phase focused on providing advisory support for the installation of solar water heating panels by private households and further promoting the opportunities presented by solar power in the region. In order to save costs, households installed the solar panels themselves, which built on pre-existing initiatives supporting independent constructions.	1.10.2008 – 31.12.2008 and 1.1.2010 – 31.8.2010	Contact: Kristina Miklavcic Email: kristina.miklavcic@ra-sora.si Telephone: +386 4 50 60 225 Website: http://www.las-pogorje.si/Slo/main.asp
Renewable Energy / Tourism / Adaptation	Fruit processing facility development using RES; RES control unit factory; Energy efficiency development at Erdőpartner Ltd.; 4,5 kW PV with network connection at	Hungary	Local adaptation examples: This particular area is the largest sour cherry growing area in the country and after processing, a significant amount of pits are left over, which are now combusted in a boiler to generate heat and electricity. There is a small "showcase", where different renewable energy systems could be visited side-by-side in local "real life" setup. A "nature trail" which demonstrates the ongoing changes of land use and natural resource use in general has been established. Climate change adaptation, as a "general consideration", is included in the strategy of the LAG and appears in more and more projects as an issue to be considered and acted on ("planning"). Water harvesting and water management in general is less of an issue, due to the proximity of the		Börzsöny-Duna-Ipoly Vidékfejlesztési Egyesület Name: Neubauerné Szatmári Zsuzsanna Address: 2628 Szob, Köztársaság u. 2. Telefone: +36 27/370-890 E-Mail: borzsony.duna@gmail.com

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	Ipoly Irisz Ltd.; 6 kW PV at Ipolytölgyes		Danube and dolomitic water sources. 8 projects were accomplished in Bioenergy/biofuel/biogas; 10 projects accomplished in solar energy; 7 projects accomplished in energy efficiency; 8 projects accomplished in tourism.		
Tourism / Diversification of Local Economy	Nature park in motion	Austria	• Strengthen ecologically sound tourism • Visitor management in environmentally sensitive areas • Quality management as a competitive advantage • Strengthen regional awareness • Contribute to active climate protection • Strengthen the region from the inside • Safeguard jobs and quality of life in the region • Activities: • develop a regional shuttle service • install a hiker bus service system • certify hiking paths, bicycle trails and mountain bike trails • develop bicycle rental services • develop services offering mobile alternatives - electric bicycles.	2010 until 2012	Tourismusverband Naturpark Zirbitzkogel-Grebenzen Name: Reinhard Ferner Address: Stadlob 500, 8812 Mariahof Telefone: 03584/2005 E-Mail: office@naturpark-grebenzen.at Website: http://www.naturpark-grebenzen.at/startseite.html Language: Deutsch
Tourism / Diversification of Local Economy	Eco-tourism and environmental education in Thessaloniki	Greece	The project aimed to introduce a coordinated package of environmental education and eco-tourism facilities. This approach fits well with the Thessaloniki LAG's objectives for making sustainable use of 'dormant' natural resources, boosting the area's attractiveness, and encouraging entrepreneurship. Costs covered by the project include: new information and viewing points along eco-tourism routes in fields and meadows; organising and running a publicity campaign to mark and promote the new route; producing a website and series of informative guides for children about the wildlife which can be seen in their local area.	01/01/2012 until 01/01/2013	Contact name: Vasileios Papavasileiou E-mail: papavasileiou@aneth.gr Telephone: +30 2310801057 Languages for contact: English, Greek
Tourism / Diversification of Local Economy	Re-creation of the Landscape	Joint Project: Poland, Belgium	The objective is to elaborate of a tourism/recreational concept, with the Flemish Westhoek area being the pilot region, and the other partner areas sharing the benefit from the transfer of the jointly developed knowledge and expertise. More specifically, the partnership intends to jointly establish a high quality tourism offer, by		Name: Pieter Santens Email: Pieter.Santens@west-vlaanderen.be Phone: +32 51 27 55 61 Languages: English, Dutch

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			capitalising on the ecologically valuable landscape of each region. This requires improved access to and the design, management and maintenance of existing and newly developed recreational infrastructure. Upon project completion, the partnership would like to realise an easy-access network for recreational use in regions with ecologically valuable landscapes. A number of expert working meetings will help to get to know each other, to introduce the different features and to share the achievements of the partner regions to date. Joint evaluation of the work is expected to produce tips and tricks for solving common challenges. A joint conference in Poland (May 2013) will involve West-Flemish experts in tourism and public-private sector cooperation. An exchange visit programme for relevant organisations, youngsters and political stakeholders is underway.		
Tourism / Diversification of Local Economy	Environment and Tourism (Development of Eight Fjords by Orust and Tjörn)	Sweden	The project aims to implement an integrated package of measures that will a) make the sea cleaner and help the wildlife in the coastal zone, and b) provide the basis for development of tourism and other businesses in the local area. A series of actions are being implemented with a variety of local actors and stakeholders to enhance the marine environment and boost local economic development by: i) reducing the levels of nutrient pollution; ii) increasing the availability of fish (including the return of cod); iii) extending the tourist season by increasing the supply of coastal and maritime-based nature experiences, iv) creating viable maritime businesses, and v) providing increased opportunities for outdoor recreation.	01/01/2009 until 31/12/2011	Project website: http://www.terraetmare.se/ Contact name: Ulrica Holmgren E-mail: ulrica.holmgren@terraetmare.se Telephone: +46 702 940 203; +46 303 732 513 Languages for contact: Swedish
Water	"Est sesia, lavori per la manutenzione straordinaria della rete irrigua a Sartirana,	Italy	The objective of the project is the improvement of water infrastructures, eliminating the water flow infiltration and resulting in significant benefits in terms of water savings, costs and characteristics of the current irrigation management. Investments were made for the improvement of the irrigation network		LAG Lomellina Manager: Luca Sormani Email: info@gal-lomellina.it Phone: +39 0384 805854 Website: www.gal-lomellina.it

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	Cavo Corsica”				
Water	Feasibility study to open alternative water resources in the region of Rosche (Aquaro)	Germany	Objective: Store water in reservoirs (from sugar factory and the sewage plant); Land disposal of sewage water in the forest (area: 50 ha), if it cannot be stored due to operational and/or hygienic reasons. Activities: • Feasibility study as basis for raising of the ground water table. • Determination of irrigation needs • Identification of possible locations for the water reservoir • Identification of suited forest sites for disposal of sewage waters • Determination of phyto-sanitary conditions for disposal of sewage water • Identify measures to decrease possible pollution loads preliminary design, design and approval planning for the water reservoir, transport lines and French drains.		
Water	Improving Groundwater Protection through the LEADER Approach	Germany	The main objective of the project was to help farmers adapt their production systems to meet the WFD requirements in order to improve the quality of water and strengthen the water quality management. The main activity is to gather information about the different hop growing strategies to develop new approaches to help farmers meet WFD objectives. The project was developed by the land management organisation, the regional water users association and the hop farmers association.	01/01/2009 until 31/12/2014	Contact name: Alois Siebler and Klaus Amann E-mail: asiebler@zvwv-hallertau.de Telephone: Alois Siebler +49 (0) 8752 8 68 59 12; Klaus Amann +49 (0) 9441 207 358 Languages for contact: English, German
Water	"Local Product" projects from Bulgaria	Bulgaria	22 projects of public and private interest were co-financed. The “local product” projects for very small farms were quite helpful for the local community. Some projects, such as developing drop irrigation systems, small green houses or bakeries, proved to the local people that Leader is a realistic and working instrument. During 2006-2007 the ASA Foundation in cooperation with the SDC supported the establishment of four inter-municipal LAGs covering the		

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			territories of 11 municipalities - Panagurishte, Lesichovo, Strelcha, Hisar, Kaloianovo, Suedinenie, Karlovo, Sopot, Brezovo, Rakovski, Bratia Daskalovi with a total population of about 220 000 citizens.		
Water	Automated Irrigation System for Mediterranean Horticulture (Solomou Nurseries Limited)	Cyprus	The Nursery undertook this investment project with the following objectives: 1) To upgrade the existing infrastructure with new buildings and modern technology in order to increase productivity, improve the quality of outputs and reduce costs; 2) To protect the environment with the application of new, environmentally friendly technology, and; 3) To improve working conditions. Plans were drawn up for a quality-driven programme of modernisation that started in 2005 and was finally completed in 2010. The main activities with EAFRD funding since 2007 focused on the installation of new systems and machinery. A new greenhouse and working space were built together with an extensive new 'smart' irrigation system, including specific components for i) automated desalinisation of underground water; ii) collection of rain water, and; iii) waste water collection and treatment.	01.01.2008 until 31/12/2010	Region: Kypros / Kibris RDP Territory: Cyprus Project website: http://www.solomounurseries.com.cy/ Contact name: Marios Solomou E-Mail: marios@solomounurseries.com.cy Telephone: +357 225 21408 or +357 225 25519 Languages for contact: English, Greek
Water	Supporting the development of a young farmer's business in Cyprus	Cyprus	Vasilis Kyprianou, a young farmer with a strong agronomic background, aimed to develop a mixed farm business with a diversified product range that would be distinguished for its high standards in all respects of food quality, animal welfare, working conditions and environmental impact. Start-up funding (€40,000) was provided through the RDP's dedicated measure for young farmers and this was accompanied by a significant sum of support (€500,000) from the RDP measure assisting investments in farm holdings. Funding covered the installation of modern technology and equipment for animal breeding, milking and production of milk products, as well as the construction of a high-tech greenhouse for the organic production of vegetables.	01/10/2010 until 30/03/2012	Contact name: Vasilis Kyprianou E-Mail: riverland@cytanet.com.cy Telephone: +357 99 59 25 98 Languages for contact: English, Greek

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Water	Preventative Maintenance of a Riverbed and its Hinterland to Reduce Environmental Risk	Italy	The Consorzio Forestale Valli Stura e Orba (a public-private partnership with over 100 members) applied for funds from measure 226 in order to carry out - after more than 30 years - a much needed series of intervention on the woodland bordering the Valberlino creek. This involved selecting the trees to be cut and improving the state of the riverbed and its nearby areas. The other main goal was to find a suitable destination for the waste wood. After three distinct preparatory actions - finding an agreement with private owners whose estates where affected by the intervention plan; requesting the necessary work permits; and identifying the best use of the waste wood that would be produced - concrete operations on the woodland began. The project effected nearly 1 km of riverbeds, on both sides. The range of treated woodland areas were managed to maintain and enhance their biodiversity potential.	01/03/2011 until 30/09/2012	RDP Territory: Liguria Project website: http://www.consorzioforestale.com Contact name: Paolo Derchi E-Mail: p.derchi@stafge.it Telephone: +39 0108392626 Languages for contact: Italian
Water	Modernising the irrigation system in the Flumen Canal of Huesca	Spain	The main objective was to modernise irrigation in the area by eliminating old irrigation infrastructure based on irrigation channels and constructing a new irrigation network using a sprinkling method. The distribution network ends in each plot allowing each farmer to modernise his/her holding. The new pressurised irrigation system is governed by remote irrigation automation and control. Key activities comprised on the one hand the physical elimination of old irrigation channels and on the other hand the construction of a 208,200 m^3 dam and a pumping station. The new construction includes two main irrigation pipes, one with natural pressure for 1,995 hectares and another one with forced pressure for 1,075 hectares, both with the necessary network of pipes ending in irrigated fields.	30/06/2008 until 28/04/2011	RDP Territory: Aragón Project website: http://www.sirasa.net/arbol/pagina.asp?idArbol=172&idNodo=387 Contact name: José Víctor Nogués Barraguer and Pedro Campo Bescós E-mail: crsodeto@hotmail.com Telephone: +34 974 345421 Languages for contact: Spanish
Water	Restoration of a Poplar Grove to Natural Riverbank Habitats-	Spain	The main aim of this project is to promote the conservation of biodiversity through restoring the riverbank forest area, specifically by encouraging its gradual reversion back to natural poplar forest habitats. More specific objectives include:	01.01.2009 until 31/12/2012	RDP Territory: País Vasco Contact name: Autoridad de gestión del Pais Vasco E-Mail: oro-ochoa@ej-gv.es Telephone: +34 945 01 96

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
	Labastida, Álava		• The protection of local shrubs and arboreal vegetation • Woodland maintenance: ringing and cutting trees for the creation of snags across the entire area; and the upkeep of trees with large trunks. Activities undertaken in this project are primarily focusing on forest management including the annual pruning of small copses and the manual plantations of riverbank tree species. Throughout these activities respect will be given to environmental protection and the project will refrain from engaging in inappropriate commercial forest exploitation or forestation with rapid-growth species. The critical mating period of nutria and European mink will also be considered throughout the project.		46 Languages for contact: Spanish
Water - Flood management	Conservation of Natural and Cultural Heritage (Salini Rehabilitation Project)	Malta	The project aims to achieve two objectives: 1) Preparation of a management plan and guidelines for the Salini area, and; 2) The conservation and upgrading of the rural area in a holistic manner to fully realise the site's considerable potential in terms of its natural and cultural assets. The project aims to restore, conserve and utilise the site in an integrated and sustainable manner for the good of the community. The proposed project will reverse the current trend of degradation of the site, and provide a distinctive rural attraction for locals and tourists. The proposal includes the restoration and rehabilitation of the scheduled saltpans and sheds, and the creation of an interpretation centre. The operations of this project shall consist of specific investments associated with the conservation, restoration and upgrading of the natural and man-made rural heritage.	01/08/2010 until 30/09/2013	Project location and other information: Is-Salini Salt Pans, limits of St.Paul's Bay, Malta Contact name: Carmel Mifsud Borg E-Mail: carmel.mifsud-borg@gov.mt Telephone: +356 229 97595 Languages for contact: English

Traditional RDP climate projects

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Afforestation	Lairhope Burn Riparian Woodland	United Kingdom	An estate owner in Upper Teviotdale plans to mitigate the effects of climate change in the Scottish Borders. 9.3 hectares of new native woodland will be created, alongside a further 6 hectares of productive broadleaved woodland which will lock up carbon and strengthen the local habitat network for the area's wildlife. As well as enhancing the landscape, the new trees will also be protected by grazing deer and livestock by a new fence. 9.3 hectares of new native woodland will be created, alongside a further 6 hectares of productive broadleaved woodland.		
Afforestation	Creating a productive mixed forest on abandoned agricultural land	Latvia	The objective is to create a productive mixed forest stand of 25 thousand silver birch (Betula pendula) and 94 thousand Norway spruce (Picea abies) trees, to increase economical value of land. This new timber resource will help reduce future commercial pressures on forests with high conservation value. When the project started in 2010 the first job was to cut the overgrow bushes that had colonised the land since it was last farmed, then plough the soil and plant the young trees. Since then the grass has been cut regularly (for some areas twice in the season) to prevent it growing over the young trees and weakening or killing them. RDP funds were spent on preparation of an afforestation plan, buying the 121 000 young trees, and the work on the site described here.		Name: Maris Sloka Email: Maris.Sloka@skogssallskapet.lv Phone: +371 29445751 Languages: English, German, Latvian, Swedish
Afforestation	Afforestation Using Local Wood Species in Wildeshakusen, Germany	Germany	The objective was to create and maintain a new forest on a private property. There was no economic imperative to the project, which involved afforested species consisting of forest oak, hornbeam and wild cherry. Large parts of the afforested sites border the woods and maintain demanding species such as privet, rowan tree, cornus, etc. Following an initial site		

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			appraisal, specific activities were planned and implemented including the roll-out of compensatory measures. Site treatments included an application of roundup in winter followed by tilling and planting of oaks. In the first year a herbicide treatment was conducted. All activities were aligned within the framework of officially approved procedures for new afforestation projects.		
Afforestation	Creating a new productive forest in Latvia from non-farm land	Latvia	The aim of the project is to make effective use of land that was not previously being managed or producing an income. The project is being implemented in a way that will maintain and enhance the local environment's biological diversity. It will also contribute to the rural landscape and have recreational and aesthetic value. Naturally grown forest stands on the site were improved by clearing out damaged, undesirable, low productivity trees and then planting additional birch and spruce. To create the new forest on non-farm land the soil was first prepared then birch and spruce seedlings were planted. The RDP funds were spent on preparing project documentation, purchasing the plants, land works, soil preparation, planting, looking after the young trees and protecting them from damage by wild animals.		Name: Jānis Dzalbs Email: Janis.dzalbs@mkpc.llkc.lv Phone: +371 26459513 Language: Latvian
Agroforestry	Innovation in Machinery for Farming and Forestry - the Agro Living Lab Approach	Finland	Development of a business plan is a key aim. Then there are three operational objectives: 1) improve usability and added value of agricultural and forestry machines for the end users; 2) promote international-level living lab activities on smart technologies in agriculture and forestry; and 3) animate agricultural and forestry machinery producers to co-operate with end users and to consider user needs at an early stage in product development. In practice, interested machinery companies contact the Agro Living Lab, which maintains a user network and negotiates the assignment with the company. The Lab coordinates and facilitates the assignment with the end-users and reports the results. Various output targets are		Name: Sanna Kankaanpaa Email: sanna.kankaanpaa@stoy.fi Phone: 00 358 400 743 422 Languages: English, Finnish

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			being set each year. This includes devising and applying models and methods, studies of user needs, assessments of usability of technologies, seminars and publicity.		
Agroforestry	Safeguarding Rural Jobs and Landscapes in Lesvos	Greece	The aims of the RDP payments focus primarily on compensating farmers for higher operational costs in order to help them to continue to run their businesses. Multiplier effects from the farm payments include reducing depopulation pressures in the target areas (thereby protecting the viability of fragile rural communities) and sustaining environmental services provided by farming (such as preserving traditional landscapes and conserving wildlife habitats). RDP payments of 110€/ha per year are provided for farmers. The payments require beneficiaries to continue to operate active farming operations during the support period. These payments thus ensure that Mr Giannis continues to graze his herd of some 200 sheep on 20 ha of hilly land near the village of Agra. Much of the land around Agra combines grazing pastures with oak trees in a traditional agroforestry landscape.	02/12/2013 until 12/12/2013	Name: Thanasis Kizos Email: akizos@aegean.gr Telephone: +30 2251036447 Languages: English, Greek
Capacity Building on Climate Change	Reducing the Environmental Impact of Cattle Farming	Spain	The main objective of the project was to design and disseminate eco-management systems, specifically for organic agricultural waste, with the aim of reducing the negative environmental effect of agricultural farms. The project also aimed to promote the development of innovative systems for managing purines deriving from livestock farms (pork, poultry and bovine), which are respectful of and compatible with the environment. The project began with the drafting of an inspection report. This was followed by a process to identify the best use of by-products which involved; sample characterisation, farm compost production with analysis of the different compost samples, the application of the compost to the land, and an energy evaluation of cattle waste through anaerobic co-digestion. Subsequently a website was created and a composting manual developed. Finally the	January-November 2009	Name: Javier Barreiro Email: fegama@fegama.org Phone: +34 981534605, +34 981534512 Language: Spanish

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			ideas and processes developed were disseminated.		
Capacity Building on Climate Change	Promoting Energy Efficiency on the Farm ('Eco-Driving in Agriculture')	Sweden	The overall aim of the project is to create the motivation and knowledge for most farmers using tractors and other diesel vehicles to drive in a more "climate smart" way. This has started with the development of a training package for trainers in the Swedish county of Jönköping. Activities began with the collection and documentation of available knowledge and experience on the theme of eco-driving in agriculture. This was then applied to development of a professional 'training-of-trainers' course in the "economical driving" of agricultural machinery. At least ten instructors (including two women) will be trained who will later lead farm level training courses throughout Sweden. The project concludes with some local pilot training activities for tractor drivers.	01/12/2008 until 31/12/2009	Name: Sören Dahl Email: soren.dahl@konsult.lrf.se Phone: +46 363 42379 Language: Swedish
Energy Efficiency	Energy and Climate Initiative for Wilstermarsch	Germany	The main objective of the projects were: i) reduction of carbon emissions and thereby promoting climate protection; ii) raising private investment that could stimulate regional business; iii) maintaining attractiveness of rural residential areas by modernising old buildings. The project consisted of three main actions: i) creating a project partnership between local actors from different sectors to be involved in the promotion of the project online and in regional magazines; ii) setting up a 'Central Energy Competence Centre' which serves informing about the project and offers guidance to local population; iii) subsidising the investments with a help of the Public Office of Wilstermarsch.	01/01/2009 until 31/12/2012	Name: Heiko Wiese Email: wiese@wilstermarsch.de Phone: +49 4823948216 Language: German
Energy Efficiency	Solar Roof Tiles for Energy Efficiency	Hungary	Responding to the raised priority given in the Health Check of the Common Agricultural Policy (CAP) to mitigating climate change, the main aim of the project was to expand production of photovoltaic roof tiles to match market demand, while simultaneously creating employment in the rural area of Harsany. Construction and equipping new factory premises to expand	February 2008-January 2011	Name: Mr Miklos Toth Email: ideassolar.hu@gmail.com Phone: +36 46 504 734 Languages: English, Hungarian

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			production capacities were the main activities. This involved preparation of a well-researched business and financing plan, application for planning permission, and proceeding with construction and equipment installation after approval of the project.		
Energy Efficiency	New Equipment for More Efficient Forestry Management	Slovenia	There are several aims of this investment in machinery and equipment, namely: To increase efficiency and productivity of operations To improve environmental protection of the forest floor, forest roads and trees To enhance occupational safety To stabilise and boost income. The application was made using two public calls for projects within the same measure. The first was the purchase of a fixed winch tractor, chainsaw and protective forestry equipment. And the second was the purchase of a three-point hitch winch tractor	01/09/2008 until 31/03/2010	Name: Ciril Brečko Email: ciril.brecko@volja.net Phone: +386 41 648 201 Language: Slovene
Nature Conservation	Cooperation between Farmers for Wildlife Conservation in Flanders	Belgium	The main aim of this agri-environment scheme is to provide better habitats for meadow birds. The biggest challenge identified in the area is the survival of the chicks. To achieve better results, a cluster of measures is necessary to reduce predation and other threats. Landscape adjustment includes converting fields (maize) to grasslands that are mowed after 15 June to increase breeding success. Grassland borders along watercourses are sown with a grass-herb mixture and also mowed after 15 June. Banning fertilizer on borders reduces nitrates in watercourses. The herbs attract insects that meadow bird chicks feed on. New ponds create gathering and foraging areas. Poplar and poplar bush are replaced by lower-growing native plants to create more open landscapes.	01/01/2010 until 31/12/2015	Name: Davy Noelmans Email: davy.noelmans@vlm.be Phone: +32 497 476 435 Languages: English, Dutch
Renewable Energy - Agricultural Waste	Bio-Ethanol Plant Construction	Estonia	The main aim of the project is to establish a bio-ethanol plant and produce this form of bio-fuel by making use of the ample farm raw material in the form of animal and crop waste, along with sugar beet grown on previously fallow land. This would diversify significantly the enterprise and income base of the farm, increase employment for local people, significantly reduce farm	01/02/2008 until 31/12/2010	Name: Ants Pak Email: info@kadarbiku.ee Telephone: +372 671 627 Website: http://www.kadarbiku.ee Language: Estonian

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			waste, and contribute towards lowering the use of fossil fuels. Taking the project from conceptual stage through construction to making the plant fully operational were the main activities. A Spanish company experienced in planning and construction of bio-ethanol plants was contracted to manage the work, complemented by local expertise and labour. Training was provided on distillation, fermentation, lab work and other operational aspects. Some equipment was able to be sourced in Estonia, with the remainder imported from Spain.		
Renewable Energy - Agricultural Waste	Setting up a Biogas Co-generation System	Italy	The main objective was to build the infrastructure to allow for the production of bio-energy from manure and crops. Other important objectives were to diversify farm activities and integrate the income, while simultaneously introducing environmentally-friendly farming practices, based on recycling livestock effluents and agricultural residues. The construction of the co-generation plant was the main activity. It produces thermal energy and electricity through anaerobic digestion of livestock effluents and agricultural crops. The remaining composted digestate is used to fertilise the soil. 70% of the feedstock used in the plant is produced on the farm, while the remaining 30% is provided by local farms. Plant visits are organised by the beneficiaries to share their experience with other entrepreneurs.	01.01.2009 until 31/07/2009	RDP Territory: Lazio - Contact name: Aldo Bruno
Renewable Energy - Agricultural Waste	On-farm Biogas Cogeneration Plant	Latvia	The main objective of the project was to construct a power co-generation plant capable of producing electricity and heat from the available materials on the Jaundzelves farm, such as plant waste and other organic material. The main activities undertaken during this project, which made the production of electricity by the cogeneration plant possible, were: i) the preparation of the site by levelling the ground; ii) the building of fermentation vessels; iii) the connection of the co-generation plant to the local power supply network.	01/06/2008 until 31/12/2011	Name: Māris Treimanis Email: treimanism@inbox.lv Language: Latvian

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Renewable Energy - Bioenergy	The Biomassehof Waldstein Forest Production	Austria	The scope of the project was to i) contribute to the diversification of the energy supply in the Styrian regions by consolidating regional biomass farms ii) promote the use of bio-energy and reduce the dependency from external energy sources; iii) enhance the local economy by creating new job opportunities, create new sources of income and niche market opportunities for the local community. The main activity consisted in the erection of a warehouse that was complemented with a drying system (cold air through perforated ducts) for the drying of logs and wooden chips. The product can be purchased directly from the Biomassehof facility or alternatively delivered directly to the customer. Further activities included the promotion and marketing of bio-mass use and its contribution to energy production in the region.	01/05/2007 until 3/06/2009	Name: Dr. Horst Jauschnegg Email: horst.jauschnegg@lk-stmk.at Telephone: +43 316 8050 1277 Website: http://www.biomassehof-stmk.at/ Languages: English, German
Renewable Energy - Bioenergy	Bioenergy Hitzendorf	Austria	The objectives of the project were to: - Diversify the energy supply in the Styrian region - Reduce dependence on imported fossil energy sources - Mobilise regional marketing of domestic biomass resources to promote the wide application of bioenergy - Increase the incomes and profitability of entrepreneurs, farmers and foresters in the region - Create new employment opportunities in the region A biomass heating system with a connected load of 350 kilowatts was built and supplied by a short supply line. In the central heating system, a biomass boiler with a rated thermal input of 350 kilowatts, which produces the required thermal energy to power the plant, has been installed. The biomass boiler is operational throughout the year.	01/11/2008 until 30/04/2009	Name: Dr. Horst Jauschnegg Email: horst.jauschnegg@lk-stmk.at Telephone: +43 316 8050 1277 Languages: English, German
Renewable Energy - Bioenergy	Building a Bio-Gas Station in Desov	Czech Republic	The project aimed to provide the beneficiary (ZD Dešov) with a new, alternative, stable, long-term and environmentally friendly source of income. RDP funds were used to co-finance the investments in equipment and infrastructure. The station was constructed on land within the existing farm business and this helped to	01/07/2008 until 30/06/2009	Name: ENRD CP Email: postcards@enrd.eu Language: Czech

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			reduce overall costs. Further savings were achieved by the company's use of its own labour to prepare the biogas plant's foundations. A specialist firm constructed the actual gas generation units which are now operational and converting farm waste into green electricity.		
Renewable Energy - Bioenergy	Dairy Farm Renewal and Construction of a Biogas Plant near Kapuvár	Hungary	The objective of the project was to make use of the production waste (cattle manure) of the cow-breeding agricultural complex for the production of energy. To achieve this objective an engineering project for the construction of a biogas plant for a cow-rearing agricultural complex near Kapuvár has been the main activity of the project. According to the biogas plant design, production-waste (cattle manure) of the cow-breeding complex is used to produce energy. Recycling of biological waste gives biogas and electricity.	01/08/2008 until 31/03/2010	Name: Lóránt Szajkó Email: info@kisalföldi.hu Telephone: +36 96 250 059 Language: Hungarian
Renewable Energy - Bioenergy	Implementatio n of a Biogas Plant in the Iasi Agrizoo Farm	Italy	The main purpose of this project was to turn animal waste into an opportunity for energy savings and income diversification. Also, trading dairy products has become more and more competitive and the farm needed to devise a strategy to reduce its costs and diversity its revenue. Converting manure into a new source of income constituted an important innovation for the farm. The main activities included the establishment of a 130 KW biogas plant. The plant consisted of an electronically controlled anaerobic digester system, producing biogas that feeds a heat/electric power generator. Heat is used by the farm to cover all of its domestic needs and excess electricity is sold to the local utility company.	15/11/2011 until 31/12/2013	Basilicata region Contact name: Rocco Iasi and Luigi Iasi Telephone: +39 0971773396
Renewable Energy - Bioenergy	Better energy, better environment - enhacing the use of biogas in South Tyrol	Italy	The main objectives of the project were to produce sustainable energy and reduce its costs, to reduce the environmental impact of dairy farming, and to create alternative sources of income for local farmers. The objective was operationalised as a plan for improving the working of the biogas plant, specifically the collection, transformation and distribution of the	01.01.2010 until 31/12/2010	RDP Territory: Bolzano Contact name: Helmuth Innerbichler E-Mail: Helmut.pinggera@leader-tat.com

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			liquid manure from dairy farms. To achieve this, the main activities undertaken were: 1) to renovate the pipelines, the pump stations, the gas filter, the generator and the sampling, and 2) to build new distribution pipelines.		
Renewable Energy - Bioenergy	Energy Production from Agricultural Biomass	Italy	The main project objectives have included: i) the production of green energy; ii) self-supply of energy for the farm and iii) farm diversification. The project helped construct a plant for the production of fuel oil from cultivated plant material (rapeseed, sunflower, soybean, Brassica Carinata (a typical crop), with environmental benefits (reduced use of fossil fuels and reduced CO_2 emissions) and for the farm (sale and consumption of heat and power).	01/12/2009 until 31/12/2010	RDP Territory: Emilia-Romagna Contact name: Remo Scaramagli E-Mail: scaramagli.remo@tele2.it
Renewable Energy - Bioenergy	Rural entrepreneurs hip: utilization of forestry wastes	Portugal	The overall aims of this project were to add value to local resources and create employment and qualified jobs in the region. The specific objective was to produce biomass pellets. The main activities undertaken in this project were: • Investment in the operational components of a factory unit • Electrical and civil works • The installation of a solar thermal system for water heating.	01/03/2010 until 31/05/2010	Name: Paulo Esteves Email: geral@melpellets.com Telephone: +351936133101, +351965743244 Website: http://www.melpellets.com Language: Portuguese
Renewable Energy - Bioenergy	Supporting New Renewable Energy Businesses in Kalmar Kronoberg and Blekinge Counties	Sweden	The objectives of the initiative were to: 1) Provide information and coordination to actions related to the production and use of renewable energy; 2) Positively influence municipalities to make investments in renewable energy and thereby create new business opportunities for farmers and rural entrepreneurs, delivering renewable energy; 3) Facilitate the creation of at least three new businesses. The project had three main fields of activity: energy efficiency, assistance to the development of new renewable energy initiatives, and energy planning in the municipalities. In each information and training seminars to a range of local stakeholders was provided. Other important activities	01/07/2007 until 30/09/2009	Name: Kicki Svensson Email: Kicki.svensson@lrf.se Telephone: +46 470 703651 Language: Swedish Website: http://lrf.se

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			included the building of partnerships between providers of biogas and buyers of energy.		
Renewable Energy - Bioenergy	The Clean Fuel Concept – Biogas Brålanda	Sweden	The objectives of the Clean Fuel Concept are to i) Contribute to meeting today's and tomorrow's needs for more environmentally friendly fuels by introducing an innovative method for extracting biogas from manure; ii) Benefit both the farmers directly involved in the network and the local community which also benefits from the production of a more environmentally friendly fuel. The main activities were: 1) Construction and installation of underground pipes for transportation of biogas from on-farm digesters. 2) Installation of a central processing plant capable of treating bio-gas to comply with vehicle fuel standards. The biogas is then distributed through a pipeline to filling stations or gas suppliers. Farmers part own the facility.	01/09/2007 until 31/10/2009	Name: Peter Eriksson Email: peter.eriksson@innovatum.se Telephone: +46520 289 322, +46730 75 56 00 Language: Swedish Website: http://hs-vast.hush.se/?p=12014
Renewable Energy - Bioenergy	Linking Farm-Based Biogas Production Into A Larger Network	Sweden	Three main objectives were identified for the project: a) to build infrastructure for biogas production from farm manure and crops in the Bralanda locality; b) establish a market for high-volume production of biogas of vehicle fuel quality to reduce the greenhouse impact from vehicles; c) develop the untapped potential of agriculture to raise the production of biogas for vehicle fuel and associated environmental benefits. The project connects small farm-based biogas plants into a larger system so that larger amounts of energy can be produced. Technology development to enhance and develop biogas production adapted to farm level was the first step. This was followed up with training of partner farmers, and development of maintenance support services and investments in a demonstration plant. The first investment within the concept was made in 2009 and the first biogas production started in April 2010.	09/05/2007 until 31/10/2010	Name: Peter Eriksson Email: peter.eriksson@innovatum.se Telephone: +46520 289 322, +46730 75 56 00 Language: Swedish Website: http://www.innovatum.se/pages/default.asp?SectionID=3499&ArticleID=5508&ArticleGroup_projekt
Renewable Energy -	Biogas Production on	Czech Republic	To construct a biogas station that will make use of the renewable energy resources of the farm (notably animal	12/03/2007 until	Name: ZD Krásná Hora nad Vltavou a.s.

Thematic Area	**Name**	**Country**	**Brief Description**	**Project Timeline**	**Contact**
Biofuel	a Large Mixed Farm		manure) for the production, consumption and sale of electricity and heat - thereby diversifying the income base of the farm, spreading income more evenly and creating and securing employment. The project has proceeded through the following steps: a) development of the biogas idea and detailed business planning for financing and execution; b) making use of an advisory service; c) preparation and submission of a funding application to the RDP administration; d) construction of the biogas unit, and; e) conclusion of the development and operationalising of the biogas station.	01/10/2008	Email: zd.krasna.hora@sedlcany.cz Telephone: + 420 318 862 310 Language: Czech Website: http://www.zdkh.cz
Renewable Energy - Biofuel	Biofuel Briquettes Production in Lithuania	Lithuania	The main objectives of this project are to develop new and maintain the existing jobs in the area through manufacturing biofuel briquettes (from straw, crop residues, and rape) and to increase the diversity and scope of the non-agricultural activities in the village. The use of straw briquettes helps to save money that are used for consumption of fuel. It is also beneficial for the farmers who can get an additional income from selling straw, crop waste and rape which is used for production of the fuel.	01/02/2010 until 30/09/2010	Name: Company - UAB „Biogranus“ Telephone: +370 61036079; +370 69825677 Languages: English, Lithuanian
Renewable Energy - Biofuel	State of the Art Tree Felling Equipment	United Kingdom	Key objectives of this project include: improving the performance and competitiveness of the businesses to respond to consumer demand; encouraging diversification of traditional business activities on farms towards renewable energy production. General objective of the project is to identify, exploit and serve both newly emerging and existing markets. The project involves the purchase and installation, by "Geraint Watkins Timber", of new, state of the art, tree-felling equipment, which is capable of felling and stripping branches from a tree in just minutes. This equipment, used in the sustainable upland coniferous forests of Wales, features a specially modified excavator with upgraded hydraulics and a computerised control system that operates the tree-felling unit.	17/03/2010 until 31/03/2013	Name: Charlotte Cosserat Email: charlotte.cosserat@wales.gsi.gov.uk Telephone: +44 300 062 2222 / +44 300 062 2218

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Renewable Energy - Forest Management	Creating Added Value through Residual Forest Biomass	Spain	This project is investigating the use of forest biomass for board manufacturing, forest mulch or substrates, and as energy in all types of industries. This could result in the promotion and maintenance of rural incomes, and develop a business network that could be very important for the economy of rural areas. The project provides a subsidy of 51 euro per tonne for extracting and adding value to forest biomass, which also helps prevent forest fires, supports forest management, and improves forest structure.	01/01/2009 until 31/12/2013	Name: Pilar Ara Email: ara_pil@gva.es Language: Spanish
Renewable Energy - Forest Management	Biomass Energy Production utilising Forestry Waste Material	Slovenia	The main aim of the investment was to produce, consume and if possible sell some excess energy by making use of residual material from harvested wood as biomass. After analysis of options and planning the investment, the main activities of the project involved the purchase and installation of the machinery required for the biomass system.	01/04/2008 until 20/08/2008	Name: Ludvik Smogavc Email: info@smogavc.com Telephone: 00 386 41 689 356 Languages: German, Slovene
Renewable Energy - Miscellaneous	Processing Plant for Adding Value to Citrus by-products	Spain	The overall objective of this project was the integrated processing of residuals generated from the citrus processing in the agri-food industry. Through this investment citrus residuals are collected and processed such as pulp and peel. As a result by-products are extracted that are utilised as raw material for animal feed, second-generation bioethanol, D-limonene, essential oils and purified water that is suitable for drinking and irrigation. The projects involves the construction, installation and running of a processing plant for the extraction of citrus by-products. Citrotecno will contact manufacturers of juices and horticulture producers who are interested in using this technology for obtaining high value citrus by-products. The processing plant was designed with a capacity of around 15 to 25 tons per hour, which is believed to be the most cost effective and able to have an adequate return on investment.	16/11/2009 until 30/06/2012	Name: Emilio Cañavate, Joan Magraner Email: joan.magraner@citrotecno.com Telephone: +34 96 121 29 08 Language: Spanish Website: http://citrotecno.com
Renewable Energy -	New Greenhouse	Sweden	The primary objective of the EAFRD co-financed investment was the construction of a new 25 x 100m	01/06/2008 until	Name: Björn Isacsson Email:

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
Miscellaneous	with Environmental Technology (Hällnäs Plant Nursery)		greenhouse together with a heating system fuelled by wood chips. Project activities involved all aspects of constructing the new greenhouse.	30/06/2009	bjorn.isacsson@telia.com Telephone: +46 705 931308 Language: Swedish Website: http://www.hallnas.nu
Renewable Energy - Miscellaneous	Renewable Heating Energy in Hedenäset	Sweden	To provide renewable and locally produced heating energy. The main project activities were: 1) Setting up a local company with nine members; 2) Heating plant / boiler installation. A large wood-chip boiler with a capacity of 2000 kilowatts. Annual generation of over four million kilowatt hours of electricity; 3) Laying of culverts and pipes were laid to all of the properties of the owners who wished to be connected to the heating plant. The district heating project was implemented in just two years.	01/08/2007 until 30/09/2008	Name: Ulf Zakariasson Email: ulf.zakariasson@hedenaset.nu Language: Swedish
Renewable Energy - Miscellaneous	Biogas Plant 600 with Fermented Substratum Storage Tank	Slovakia	The main goal of the project was diversification into non-agricultural activities by setting up complementary non-agricultural production - utilising renewable energy sources. The specific objective of the project was to produce heat and electric energy from biogas. Produced electric energy is consumed during the operation of the biogas plant and the surplus is to be delivered to the public network. The project activity was building a 'Biogas Plant 600'. Manufactured biogas to be used in the cogeneration unit for production of electric energy and heat. Works included: stockyard, machine room, gas-bag, anaerobic reactor, silage canal, transformer station, cogeneration unit, gas boiler, dryer and reservoir - fermented substratum storage tank. After the building works landscaping was done to ensure that plant fits the surrounding environment without any disturbance.	08/03/2009 until 01/02/2010	Name: Ing. Štefan Štifner, CSc. Email: stifner@pnet.sk Telephone: + 421 35 760 3347 Language: Slovak
Renewable Energy - Miscellaneous	Pembrokeshire Coastal Buses Powered by Vegetable Oil	United Kingdom	To offer an environmentally friendly bus service to citizens of and visitors to Pembrokshire's coast. Pembrokeshire's County Council purchased six brand new buses which were subsequently modified to run on vegetable oil collected from schools and catering	20/06/2008 until 28/02/2011	Name: Geraldine O'Donnell Email: geraldine.odonnell@pembrokeshire.gov.uk Telephone: +44 1437

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			establishments across the country. The oil is recycled locally by a business that converts it into environmentally friendly fuel able to power buses serving four of the routes of Pembrokeshire's popular Coast Path National Trail.		775790 Website: http://www.pembrokeshire.gov.uk
Renewable Energy - Solar Energy	On-farm Diversification into Solar Power	Slovenia	The main objectives of this project were for the farm to: Produce energy, in the forms of heat and electricity, from sustainable sources for on-farm use Increase the use of the renewable energy sources and reduce the CO2 emissions of the farm Increase the focus on environmentally friendly farming – specifically organic crop farming and animal husbandry. This project installed a 70 kW solar energy plant on the farm, which produces twelve times more electricity than the farm consumes. This included the installation of photovoltaic (PV) modules, which cover 462 m2 of the south-western roof part of the housing and commercial premises.	01/05/2008 until 31/12/2008	Name: Stanislav Košir Email: kosir.anja@siol.net Telephone: +38613645117 Language: Slovene
Water	Construction Works for the Artificial Enrichment of the Carstic System of Ypereia and Orfana	Greece	The project with EAFRD funds aims to: i) increase the aquifer levels so that there will be sufficient water supply for the irrigation needs; ii) decrease the electrical consumption for extracting the ground waters as the level of the aquifer rises; and iii) monitor the quantity and quality of the water resources. The key activities to achieve the project objective are: i) the construction of a small dam with fortified cement to withhold the Enippeas river flow; ii) the implementation of protective works for the water course and riversides; iii) a water transfer canal and enrichment tunnel with shafts on its floor; iv) measuring stations of the Enippeas river flow and drilling to monitor the aquifer; and v) the instalment of four automatic monitoring stations of the water resources.	01/11/2008 until 31/12/2012	Name: Odysseus Karasahinides Email: li210u044@minagric.gr Telephone: +30 210 8399849 Languages: English, Greek
Water	Private Groundwater Sources Metering	Malta	The objective is to account for the water use and eventually to limit extraction to reverse the saltwater intrusion. The idea behind metering of groundwater is to provide a clear indication of how much water is being abstracted and the metering of private wells aims to	03/10/2011 until 31/12/2013	Name: Stephen Galea St.John Email: stephen.galeasstjohn@wsc.com.mt

Thematic Area	Name	Country	Brief Description	Project Timeline	Contact
			provide this figure. The project activities concern the supply and installation of water meters on private groundwater boreholes to account for all private extraction aimed solely for agricultural use. The project will also provide pipelines for treated sewerage effluent for agricultural areas that meet current irrigation standards.		Telephone: +35622443390 Languages: English, Maltese

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