EU wide Farm-level Carbon Calculator
Lot 2: Testing the Carbon Calculator
Deliverables 2.1 and 3.2

FRAGARIA consortium

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Administrative summary

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List of abbreviations

CAP	Common Agricultural Policy
CC	Carbon Calculator
CEC	Commission of European Community
CEEC	Central and Eastern European Countries
CMEF	Common Monitoring and Evaluation Framework
DG	Directorate-General (e.g. DG-Agri, DG-JRC, DG-ENV, DG-ESTAT)
EAFRD	European Fund for Rural Development
EC	European Commission
EEA	European Environmental Agency
EU	European Union
FSS	Farm Structural Survey
GAEC	Good Agricultural and Environmental Condition
GHG	Greenhouse gases
HNV	High Nature Value farmland
IACS	Integrated Administration and Control System
IT	Information Technology
JRC	Joint Research Centre
LFA	Less Favoured Area
LSU	Livestock Unit
LPIS	Land Parcel Information System
LUCAS	Land use/cover area frame survey of Eurostat
NGO	Non-Governmental Organisation
NRF	National Regional Forum
OECD	Organization for Economic Cooperation and Development
RDP	Rural Development Programme
SAPS	Single Area Payment Scheme
SAPM	Survey on Agricultural Production Methods
SMR	Statutory and Mandatory Requirements
UAA	Utilised Agricultural Area

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Executive summary

Context, objectives and methodology
Agriculture is the second largest GHG emitting sector in Europe after the energy sector. Although in the past 20 years, a downward trend in N_2O and CH_4 emissions from agriculture has been recorded, it is not expected that this trend will continue at this rate.

In 2010, The European Parliament asked the European Commission to carry out a pilot project on the "certification of low carbon farming practices in the European Union" to promote reductions of global warming emissions from farming. This scheme was required to take into account all the main factors contributing to greenhouse gas emissions from farming. The task to carry out this pilot project was taken on by the Joint Research Centre in Ispra (IT), and has two specific objectives:

- to develop (and test) an EU-wide farm-level carbon calculator
- to asses policy options for promoting the use of carbon calculator and the application of low carbon farming practices in the EU.

JRC is supported by two research groups: Solagro (France) that developed a prototype of the Carbon Calculator (CC), and the Fragaria consortium that used the prototype to test the feasibility of the CC at farm level and assessed the possible policy options for promoting low carbon farming practices by using the CC. The results of the testing of the prototype of the CC are presented in this report. The policy options are discussed in a separate report.

In this report, the results of the testing of the prototype of the CC at farm level in a wide diversity of farm types across all major environmental zones in the EU are discussed.

The testing of the CC, which is presented in this report, will contribute to the overall objectives of the pilot project mentioned above in terms of an evaluation of:

1) the performance of the CC in the sense that it can be applied to different farm types, in different geographical regions and generate estimates of the total GHG emissions of the farms
2) the user friendliness of the CC (considering the farmers being the main users) as well as the attitude of farmers towards using such a tool
3) the carbon mitigation options that are generated by the CC for the different types of farms so that the feasibility of these and the farmers' willingness to take these up can be assessed.

In order to collect the information for testing the CC a survey was performed among farmers in different regions across the EU. The regions were selected according to a sampling plan that ensured that the testing of the CC was done with farmers that are well distributed over the main farm types and environmental zones occurring in the EU-27. As a result, farmers were interviewed in Sweden (Småland), Denmark (Eastern Islands), UK (Yorkshire, North East, South East and South West), the Netherlands (Overijssel, Gelderland, Utrecht), Slovenia (from different regions), Germany (Brandenburg), Spain (Extremadura and Castilla y Leon) and Poland (Zachodnio-Pomorskie, Wielkopolskie and Matapolskie).

In the selected regions all efforts were made to get a sample of "willing" farmers that covers different farming types and farmer characteristics. The dominant farming systems were covered per region. A wide diversity of farm types is included in the total sample of interviewed farms. It includes all of the main farm types in the animal sector, such as dairy, beef cattle, pigs, sheep and goats and mixed animal systems, and in the cropping sector specialised cereal farms, mixed cropping and permanent crops systems are included. The permanent cropping farms are included in the Spanish sample and include mixed arable-olive activities and olive-citrus mixes.

Although the questions asked to the farmers were the same, the way the farmers were approached and interviewed differed per country. These different ways of approaching farmers allowed increasing the response of the farmers and applying a survey method that would fit best with the culture of the local farming community.
The survey was carried out using a questionnaire consisting of two main parts that were presented to the farmers in two steps.

I. The first part aims at identifying the willingness and preparedness to use the CC, as well as the ability to use and supply data to the CC. These questions were presented to the farmers prior to the CC. The farmers were also asked to provide data to fill the CC.

II. The second part of the questionnaire was presented to the farmers after demonstration of the CC. These questions address capability to use the calculator without support (other than translation) at this stage and what benefit in terms of income or management farmers would derive, if any, from using the CC. Farmers were also asked if they could see any barriers to using the CC and what changes (if any) would make the use of the CC easier to use and increase their willingness to use it.

In total 170 farmers were approached in all 8 case study countries. 71 farmers responded. 43 farmers also answered all questions in part 2 of the questionnaire, and 48 farmers provided data sets for testing the CC.

Initial willingness to use the CC and perceived benefits

As to the willingness to use the CC and perceived benefits it is very difficult to distil clear conclusions as the answers given to the questions on this subject were answered very differently both within and between the case study regions. The views on perceived relevance of using the CC differ strongly.

The willingness to use the CC was detected as highest among Dutch, Spanish and German farmers, while it was by far the lowest in Slovenia. The minimum and maximum scores also indicate that the views on perceived relevance of using the CC and willingness to use the CC after the final version is available differ strongly. The response to the questions on willingness to use the CC and perceived benefits showed that in the two Spanish cases and the Dutch case the average perceived relevance of using the CC was the highest. In Spain this does not, however, lead to a high share of farmers also willing to use the CC once a final version is available. There are large differences in views detected within the farming population also per region. In Slovenia, there is very little perceived relevance among the farmers interviewed to use the CC due to high time investment compared to perceived benefits. The share of farmers interviewed that does not see any benefit is quite high. Itis estimated over all case study regions at 31%, but is particularly high in Slovenia, the Netherlands, Denmark and Sweden. Another 17% does not know the benefit. This occurs particularly often in the Spanish regions. In Germany and Poland the potential for marketing based on environmental performance of the production process of a product, is seen as an important potential benefit by some. In Poland, Spain, Denmark and Sweden the perceived income and environmental gains are also mentioned by several respondents. That no benefit is seen is not necessarily explained by the fact that the farmers are not open to taking additional mitigation measures. Rather, many of the farmers interviewed are already taking a variety of mitigation measures and do not see a reason why the use of the CC would lead to taking additional measures. This sentiment was particularly evident in the Netherlands and Germany, where it was noted that many of the interviewed farmers question the utility of the CC as the best instrument to reduce emissions and improve the carbon cycle. They indicate that the interaction between soil carbon and fertilizer is very complex and an assessment of the carbon cycle is very difficult. According to them, the starting point for sustainable soil management should be the maintenance of soil fertility and the use of financial incentives to promote related measures, such as reduced tillage, improved water retention capacity, soil structure and improvement of soil organic matter rather than stimulating the use of a carbon calculator.

In the United Kingdom farmers are very much used to working with computers, either with general office software or specialist industry software packages, such as farm planning or accountancy tools. Farmers did

not therefore feel that they would face any insurmountable problems in using the spreadsheet-based CC, either alone or with support from an advisor. The same situation also applies to farmers in the Netherlands, Germany, Sweden and Denmark while this is less often the case in Slovenia, Poland and Spain. In spite of this, the confidence level of the Spanish farmers of using the CC alone is higher than in the other countries. The time investment willingness is, however, low and probably not realistic given the complexity of the undertaking. In the United Kingdom, farmers are most familiar with working with computerised tools such as the CC, but because of the many technical problems encountered during the testing of the CC they were not necessarily more open to using this CC once the final version would become available.

Farmers were generally reluctant to provide the data necessary to the CC. By far, the most important reason given in all case regions is the required time investment, which was generally perceived as very large. In Slovenia, this was the key reason given by all farmers, along with the difficulty of providing the type of data requested at farm level. As an exception among member states, all UK farmers participated in the survey provided data to test the CC and data input was generally not regarded as complex. As a matter of fact, many farmers in the United Kingdom are already familiar with the use of farm-level carbon foot-printing, and indeed many already supply data for use in carbon calculators, either through certification scheme membership, or as a requirement of supplying to a supermarket buyer. When asked about the level of difficulty associated with providing data for the CC it was universally agreed that the data requirements were relatively easy to understand and respond to. It was even reported that some of this type of data was already being generated for a carbon calculator operated by a supermarket buyer.

Evaluation of CC calculation results

In the Netherlands and Poland, interviewed farmers found the results produced by the CC to be most helpful, while in the United Kingdom the farmers are generally disappointed about the added value of the outcomes of the CC for their current farm operations. This is likely to be strongly related to the prototype version they were confronted with in this testing phase. UK farmers were disappointed as it took so long before the CC results were presented to them, after all the time investment they had already done, and once the output was presented to them it turned out that only 7 of the 28 mitigation options were really implemented. This was also why there was generally not a very positive response to the mitigation options suggested by the CC to the farmers in all the regions for which evaluation responses were collected (all except for Spain and Slovenia). It was observed that the majority of the farmers are already familiar with most of the mitigation options suggested by the CC and many are already applying similar mitigation options. This is explained by the fact that at the time of testing, only the most common mitigation options were implemented in the CC. These are often not very challenging to include in the farm management and are often already part of legal obligations and/or Good Agricultural and Environmental Condition standards in the EU.

Cost is the most frequently mentioned reason for not continuing with existing mitigation measures and/or lack of willingness to implement new mitigation measures in Germany, Poland, the United Kingdom and the Netherlands. Technical problems are the second most cited reason. The latter, in particular often refer to problems encountered with no-till after several years of use, but also other to technical problems related to not having the necessary know-how to implement it well. In Sweden and Denmark it does not relate so much to the financial aspects, but more to lack of training and technical support.

Different conclusions could be drawn regarding to the actions/incentives needed to make farmers continue or newly implement mitigation measures. In the Danish, Swedish and United Kingdom regions there were not a large interest and/or clear response to this question. In the other regions the financial support either through compensation for higher costs or for investments was mentioned most often and practically by all farmers interviewed. The education, training and or demonstration were also mentioned several times.

Evaluation of performance of current CC

Overall it should be reiterated that significant technical problems were encountered in getting the current prototype version of the CC running. This was particularly true for farmers that were interviewed in the earlier phases of the project (e.g. Germany, Slovenia, Poland, England and Spain) rather than in the later phases (Netherlands, Sweden and Denmark). Response to evaluation questions should hence be considered in this light.

Farmers in England, as well as in Germany, the Netherlands, Denmark and Sweden are more used to maintaining detailed farm records which they need to report anyway in other systems (e.g. IACS) and to their accountants. They hence reported fewer problems with providing data than did farmers in Spain, Poland and Slovenia.

Data identified as "difficult" in large share of case regions were distribution of fuel between farm activities; information on natural infrastructure; details on (extensive) grazing practices; and data on other inputs. There was no indication of a difference in the ability of arable and livestock farmers to provide the data necessary for running the CC. As a general rule, data were easiest to obtain when it was available from farmer memory, i.e. the sort of data that farmers use in everyday decision making (although the accuracy of these types of answers can be questioned). Beyond this, it was necessary for the farmers to consult farm records. This increased the amount of time needed to provide data, but resulted in a higher level of data accuracy and reliability. The requirement to consult farm records for some data items did not appear to diminish the interest of farmers in using the CC, at least for those that were also willing to test the CC in this study. The most difficult data to collect were those items that were not familiar to the farmer, i.e. they neither used in normal farm accounting practices, or everyday record-keeping. An example of this type of data would be allocations of fuel usage to individual farm enterprises, where fuel usage is normally only accounted for at the farm level.

Overall data entry in the CC proved to be challenging. This was particularly identified by the partners from England and Spain who collected most of the farm data for testing the CC and who had invested most work with getting the CC to run using these data. The problems encountered were related to the completeness (level of development) of the user front-end that hampered the use of the CC during the testing phase. For example, there were issues related to to the formatting conventions employed by the CC not being clearly described and/or unfamiliar to the users (e.g. the use of the 'comma' symbol in place of the decimal points). Most problematic however, was a lack of accuracy and/or explanatory detail in support of data entry. It was unclear in many places what units should be used when data was entered, and there was sometimes a lack of clarity over which data were essential for the proper functioning of the CC and which were optional.

Regarding the emission results calculated by the CC, it was concluded that firstly it was difficult to fill-out the CC in such a way to make it produce results and if it produced results it turned out to be difficult to judge whether the CC produced correct results. This is because in many places emissions for products or the whole farm are produced even if certain input data are missing or have not been specified correctly. As a consequence the CC produces results, which at this stage need very carefully checking. Checking is also very difficult as minimum and maximum default values to make comparisons are not included yet in the CC and therefore external reference data need to be used to judge whether results are in a realistic range.

As to the mitigation options suggested by the CC it is concluded that the most commonly suggested options are introduction of agro-forestry and adjustment of N fertilizer balance, with both of these being suggested on all 14 United Kingdom farms for which any mitigation options were generated. This was also seen for the Spanish, Slovenian, German, Dutch and Polish CC testing results. Overall there was a broad level of dissatisfaction with the mitigation options generated by the CC, with these viewed as being very

limited in number and unimaginative in scope, i.e. they are all familiar actions, of limited scope and simple in design. Many of the mitigation options suggested by the CC were already implemented at the farms surveyed. As a consequence, there was a sense that some of the more interesting and potentially significant (in terms of carbon footprint and economic implications) mitigation options listed by the CC were not yet functioning in the version provided for the test phase.

Main recommendations for improvement of the CC

I. Data requirements and entry:

- More use of prompts/warning is necessary for identifying and correcting errors or missing data at data entry stage.
- Much of the data required by the calculator are already available in the Farm Accountancy Data Network (FADN), central registers (animals, land registers) and the CAP subsidy applications. The hydrological and soil data are available in national registers. Farmers find it unproductive and frustrating (in addition to the time issue itself), if data entry has to be duplicated or entered from scratch when it is already collected or available in other systems.
- Simplification is required which would involve the use of more default values where possible and also incorporate automatic calculation of certain values (e.g. automatic conversions to the required unit, integration with software for manure management, etc.).

II. For improving the functionalities

- It must be ensured that the calculator will generate mitigations for all of the listed options including additional ones on optimising/maximising soil biodiversity and plant root capacity/biomass; application of nitrogen-fixing bacteria (e.g. Azoarcus)
- Result pages need to be accompanied with explanations on how to interpret the results from a perspective that is interesting to a farmer
- Mitigation results should not be calculated if data sheets are not completely filled in, as incorrect results are presented. This is dangerous as it may influence farmers to change their management based on incorrect information.

III. For implementation of the CC and enhance its use

- To enhance and facilitate the use of the CC there is a need for good user-guides in multiple languages, a clear help function and an on-line help office that can be mailed or called.
- The definitions of the mitigation options suggested/recommended at the end should be clearly outlined and should be accompanied by good explanations. It is recommended to revisit the current handbook in order to make the description more practical, in that examples should be given of how day to day practices at the farm could be altered to avoid emissions and store carbon.
- As the farmers also need to adapt to climate change and contribute to climate policy, the CC should also provide support in targeting farmers towards the most efficient adaptation actions which are also supported in the new CAP post-2013. This implies that the CC should cover:
  land use change actions at farm that have large emission and mitigation impacts such as conversions to perennial biomass cropping, permanent grassland, forestry, renewable energy production at farm, incorporation of landscape elements, riparian buffer strips.
- The best option for CC implementation would be to provide i) software which is free of charge and ii) a tool which suggests measures helping to decrease costs, while also benefiting soil carbon and the GHG balance.

- Data entry to the CC would be too time-consuming for many farmers to be willing to use the CC independently. However, most of the data required by the CC is already available (via calculation/reporting tools; see below), thus the data requested should be linked to existing farm records and information systems. This will take away the burden of the enormous data entry needs and will enhance the use of the CC among farmers.
- A change of language from 'mitigation' to 'business / farm resilience planning' should be considered. The term 'mitigation' switches farmers off, they find it meaningless, whereas 'resilience planning' demonstrates suggests to farmers the notion of being 'prepared and acting positively' rather than being reactive.

1 Setting the scene of the study

1.1 Background and objectives

Agriculture plays an important role in climate change mitigation efforts. The direct emissions of greenhouse gases (GHG) from agriculture account for approximately 9 % of total EU-27 emissions. Agriculture is the most important source of two powerful gases, nitrous oxide (N_2O) and methane (CH_4) and contributes to a smaller share of CO_2 emissions from land use and from fossil energy. Agriculture thus constitutes the second largest emitting sector in Europe after the energy sector. Depending on the relative economic importance of agriculture, environmental and climate conditions, and the dominant type of farming, agriculture's share of emissions can be considerably higher in individual Member States. Over the past 20 years, a downward trend of N_2O and CH_4 emissions from agriculture has been recorded as a result of increases in productivity and a decline in cattle numbers, and an improvement of farm management practices, as well as developments and implementation in agricultural and environmental policies . Nevertheless, without additional efforts this downward trend is unlikely to continue and further GHG emission abatements are viable only if they result from mitigation actions that maintain the sustainable equilibrium between environmental, social and economic objectives, whilst also taking into account impacts on a global scale.

In 2010, The European Parliament asked the European Commission to carry out a pilot project on the "*certification of low carbon farming practices in the European Union*" to promote reductions of global warming emissions from farming. This scheme was required to take into account all the main factors contributing to greenhouse gas emissions from farming. The task to carry out this pilot project was taken on by the Joint Research Centre in ISPRA, and has two specific objectives:

- to develop (and test) an EU-wide farm-level carbon calculator
- to asses policy options for promoting the use of carbon calculator and the application of low carbon farming practices in the EU.

JRC is supported by two research groups: Solagro (France) that developed a prototype of the carbon calculator (CC), and the Fragaria consortium that tested the feasibility of this prototype CC at farm level. This also included assessing the possible policy options for promoting low carbon farming practices by using the CC. The results of the testing of the prototype of the CC are presented in this report. The policy options are discussed in a separate report[1].

In this report, the results of the testing of the prototype of the Carbon Calculator (CC) (see Box 1) at farm level in a wide diversity of farm types spread over all major environmental zones in the EU are discussed.

The testing of the CC, which is presented in this report, will contribute to the overall objectives of the pilot project taken up by the JRC in terms of an evaluation of:

1) the performance of the CC in the sense that it can be applied to different farm types, in different geographical regions and generate estimates of the total GHG emissions of the farms
2) the user friendliness of the CC (considering the farmers being the main users) as well as the attitude of farmers towards using such a tool
3) the carbon mitigation options that are generated by the CC for the different types of farms so that the feasibility of these and the farmer's willingness to take these up can be assessed

[1] Frelih-Larsen, A., P. Jones, E. Dooley, S. Naumann (2013). Policy options for promoting the use of an EU-wide carbon calculator. Deliverable 2.4.2 and 2.5. to the Institute of Environment and Sustainability (JRC/IES)., Ecologic Institute and University of Reading.

Goal 1) is tested by completing the CC with the data provided by the farmer. This can be done directly by filling out the CC together with a farmer (this was only done in the English case) or by asking farmers to first complete a data requirement document. The data from the document are then used to fill out the CC without the farmer being present. The results of the CC completion are then demonstrated to the farmer in a second meeting.

Goal 2) is tested by asking feed-back from the farmer after using or demonstrating the CC. The feed-back is derived through completing a questionnaire with the farmer containing questions on how he/she perceived the user-friendliness of the tool and questions on whether the tool would raise their awareness of mitigation options on the farm and whether the use of the tool could change their attitudes towards taking mitigation measures on their farms.

Goal 3) is tested by asking farmers to complete a new list of questions after they have provided all the information needed to fill out the CC and seen the output of the CC for their farms or after the CC tool has been demonstrated to them including an overview of the mitigation options that can be assessed with the tool if data for their farm would be supplied.

The testing phase of which the results are presented in this report was the second phase in this project. In the first phase a survey was already performed among farm advisors and other relevant stakeholders in order to evaluate the availability of data required to feed and operate the CC. The results of this first survey were presented already summarized in another report (LOT 1 report [2]). The outcomes from this first survey showed that CC tool was perceived as complex and it was thought to require significant input of data on very specific and detailed farm activities, materials use and equipment and machinery.

Most interviewed farm advisors and stakeholders in the first survey estimated that 60% or more of the data that are required to complete the CC would be available from farm records. A significant fraction of the remainder was thought to be supplied by farmers in the form of an estimate bringing up the total data available to 90%. The reliability of these estimates is estimated by these interviewed farm advisors at 3.4 on a scale of 1 – 5 (ranging from highly unreliable to highly reliable).

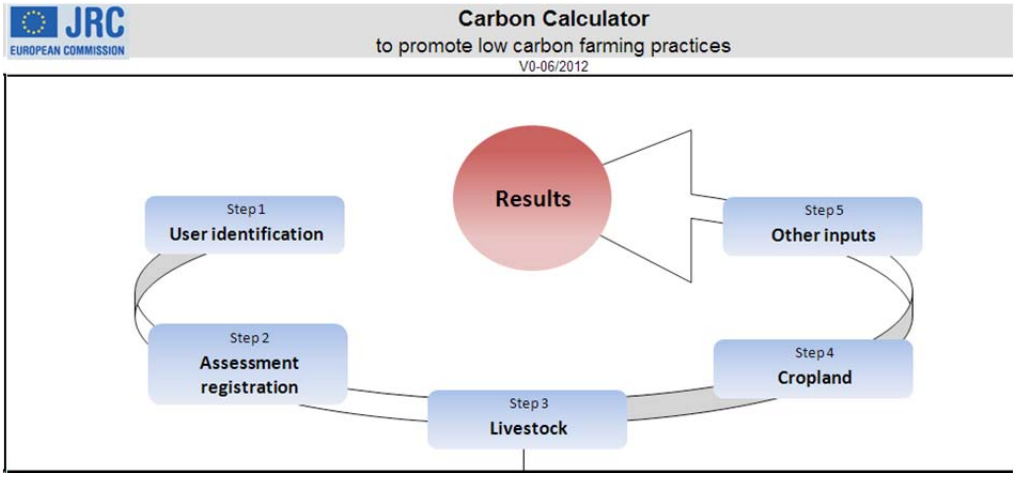
[2] Kuikman et al. (2013). EU wide Farm-level Carbon Calculator. Report on the data availability on farm level at farms across EU-27.

Box 1 The Carbon calculator tool

The carbon calculator (CC) is designed in such a way that it can calculate GHG emissions arising from all and separate farm practices and enables to testing the GHG impact of different mitigation actions that can be carried out at a farm. The assessment is carried out based on annual data, for example the annual amount of inputs used on the farm in relation to the quantity of agricultural production (meat, milk, crops etc.) in the same period. The tool is modular in design and the user is guided step by step through these modules (see Figure 1).

The data required for the CC are described in detail in Annex 4.

Figure 1 illustrates the structure of the carbon calculator.



The structure (steps and modules) of the Carbon Calculator

The prototype of the CC provided by Solagro to the Fragaria consortium for the testing was a typical prototype. This implied that the tool was still in development:

1) not all mitigation options of the extensive list of 27 mitigation options were already implemented (see Annex 3 for an overview of all mitigation options planned and the ones already implemented during the testing)

2) alerts to ensure correct input of data in terms of units used, and to use of correct decimal separators (comma or point) were not yet implemented.

An overview of the data that need to be included to run the CC is given in Annex 4.

The farm advisors estimated that data to be most difficult to complete relate to allocation of activities or volumes of specific farm products used especially in relation to renewable energy and to organic matter management. It was estimated that data on feed, fertilizers and animal numbers and changes in their numbers would be less difficult to derive from farmers. However it was also estimated that for the provisioning of these numbers farmers would much more rely on own estimates rather than on hard farm records. These data would be highly relevant to the calculation of the on farm GHG emissions. Changes in these activities are also the most influential in terms of mitigation effects and it is therefore most important that the data on these activities provided are of good quality.

Finally the LOT 1 survey results lead to the conclusion that the extensive data requirements (it was estimated by most interviewed advisors that using and filling the CC would take 6 hours or more) and the complexity of using the tool itself will yield in a low interest among farmers to use the tool at all. It must be highlighted that LOT1 survey was carried out presenting the list of data that needed to be collected to run the calculator and not showing the tool itself. In fact the use of the tool in a holding

allows skipping some questions that are not pertinent to the assessed farm, somehow simplifying the data input. Furthermore the experiences with filling the CC as reported here show that there are large differences in workload experienced when filling the CC between farmers from different regions.

Also, the computer use capacities and required skills may not be well developed in many farming communities across EU27 member states which will make the use and the willingness to use the tool at large scale even more unlikely, according to the interviewed advisors and stakeholders. However the use of the CC tool does not require specific computer skills. In practice however, the prototype testing did require some computer skills, but the final version of the tool is envisaged to be user friendly including for people with limited computer skills. The results of this project should be used to create this final version of the CC that is user-friendly.

1.2 Outline of the report

This report consists of 6 chapters including this first introductory chapter. Chapter 2 deals with the explanation of the data collection approach including a description of how farmers were identified, invited to participate in the survey and the response and non-response. Chapter 3, 4 and 5 present the results of the testing of the CC. In Chapter 3 a summary of farmers' response is given in relation to the willingness to use the CC and the perceived benefits farmers have of using such a CC for their farm. In Chapter 4 a summary is given of the outcome of the survey in relation to the awareness of mitigation measures and the willingness among farmers to also take up mitigation measures on their farms. Chapter 5 discusses the performance of the current carbon calculator. In the last chapter recommendations are presented for improvement of the CC in order to make it more attractive to be used by farmers and the type of mitigation measures possible that make the use of the CC more attractive. The latter is however addressed only briefly as this is extensively discussed in a separate report[3].

[3] Frelih-Larsen, A., P. Jones, E. Dooley, S. Naumann (2013). Policy options for promoting the use of an EU-wide carbon calculator. Deliverable 2.4.2 and 2.5. to the Institute of Environment and Sustainability (JRC/IES)., Ecologic Institute and University of Reading.

2 Approach to data collection in survey with farmers

2.1 Overall approach

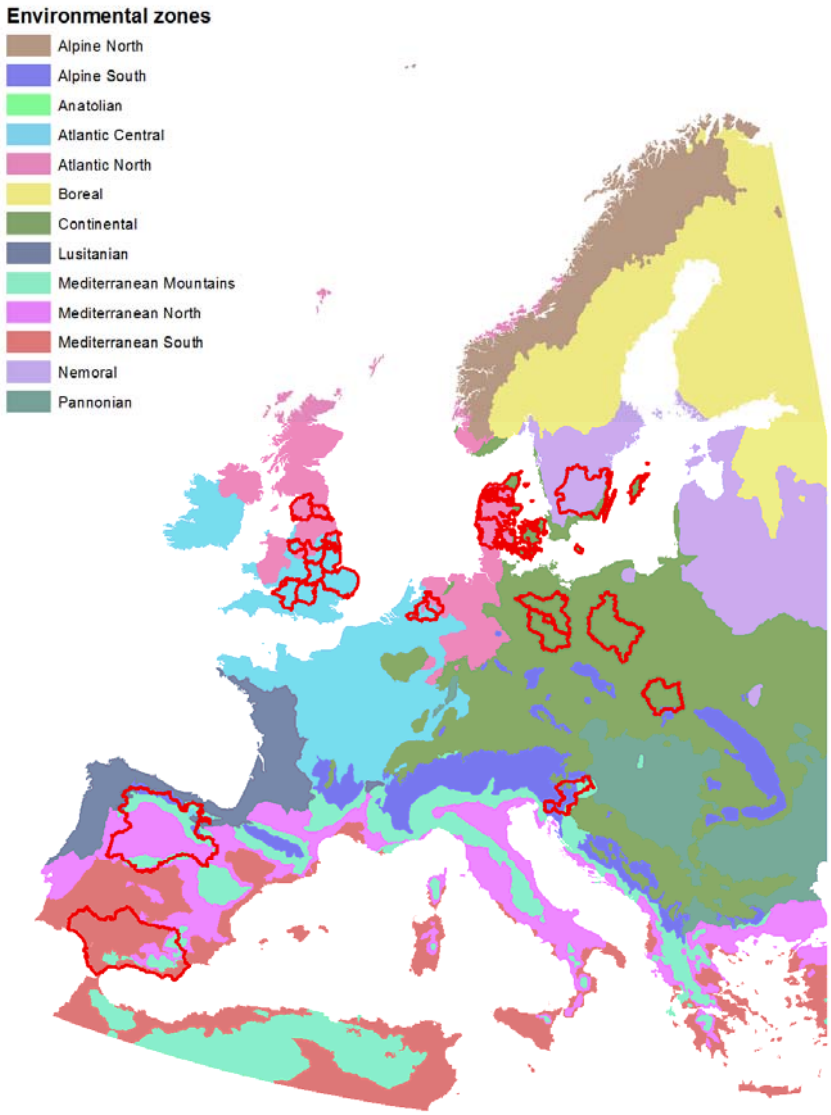
Farmers involved in the evaluation of the CC were selected according to the sampling plan elaborated in Deliverable 1.1 (Andersen et al., 2012). This plan ensures that the testing of the CC is done with farmers that are well distributed over the different farm types and environmental zones occurring in the EU-27. However, the first distribution over environmental zones for the availability survey ensured incorporation of the wide diversity in environmental endowment of farming, but it failed to incorporate the farming systems in central and Eastern European Countries of the EU-27. Therefore it was decided after the Lot1 study was finalised to add one additional case study which was Poland. Through the inclusion of this region it is ensured that the study has a better representation of farming systems of small size and/or very large size which are typical for farming in many CEEC countries. The Polish case was therefore added which covered both large and small scale farms. Moreover, during the testing phase due to the difficulty in finding farmers willing to provide data to run the carbon calculator, in England and the Netherlands it was necessary to add some farms located in regions not included in the Lot 1 study on data availability. The dominant farm types still remained the same in the additional regions. The distribution of the final sampling is specified in Table 2.1 and Map 1.

Table 2.1 Bio-geographic regions and farming types selected for the survey on data availability

Member State	Region	Bio-geo region (ENZ)	Dominant farm type*
Sweden	Småland	Boreal (Nemoral)	Dairy
Denmark	Eastern Islands	Continental	Cereal & Mixed
United Kingdom	North West, North East and Yorkshire	Atlantic (North)	Sheep & Mixed
United Kingdom	East England, South East and South West	Atlantic (Central)	Cereal, Dairy & Mixed
Netherlands	Overijssel	Atlantic (North)	Dairy
Netherlands	Overijssel, Gelderland & Utrecht	Atlantic (Central)	Dairy/Pig
Germany	Brandenburg	Continental	Cereal & Mixed
Slovenia	Slovenia	Continental (Alpine)	Dairy
Spain	Castilla y Leon	Mediterrenean (North)	Cereal & Mixed
Spain	Andalucia	Mediterrenean (South)	Permanent crops
Poland	Zachodnio-Pomorskie, Wielkopolskie and Matopolskie	Continental	Arable& Mixed

*These types of farms are dominant and these are covered at least in the survey population, but other farm types typical for the regions but less dominant are also included in the test.

Map 1 Location of the case regions



Approaching the farmers:
In order to collect the data farmers needed to be selected first. This was done differently per case study. The option was left open to do interviews with individual farmers or to have meetings with a group of farmers. All efforts were made to get a sample of "willing" farmers that cover different farming types and farmer characteristics. Differences in approach were allowed as cultures and traditions differ strongly between the countries/regions and all efforts had to be made to ensure the highest response.

The lists of questions and also an overview of the data requirements for filling the CC were all translated in the native languages of farmers to be visited. These were sent to the farmers before meeting with them as it would enable them to collect the necessary data from farm records (if they were willing to provide the data for the CC) and to prepare well for the interviews in advance of the interviews.

During the interviews it became clear, however, that only very few farmers were willing to provide all data to fill-out the CC for their own farms. Instead the farmers were presented with an example of a filled CC fitting to their farm type and an overview of mitigation options. Based on that example the evaluation questions (see Annex 2) were answered by the farmers.

For the farmers that did provide data for filling out the CC all data entries were checked by the interviewer and it was recorded, where possible, whether data are derived from farm records (R) or estimated (E). The interviewer was either a researcher or a farm advisor. For approaches in which the farmer and the interviewer were filling the CC together, e.g. the situation in England, there was a possibility to explain issues that were unclear during the filling process.

In the case studies in Germany, Slovenia, Sweden and the Netherlands meetings with 5-8 farmers attending were organised. Before the meetings the farmers were instructed through a phone conversation and/or a letter with further instructions and explanation, the (translated) questionnaire and a list of data requirements to fill the CC. During the meeting the CC was demonstrated and the questionnaire questions were answered, or the farmers were asked to fill out the questionnaires as soon as possible after the meeting. The reason this approach was chosen for these countries was that it is regular practice rather than visiting the farmers on an individual basis. Furthermore, this ensures a higher participation rate as farmers visit the meeting with the idea to also get useful information back. Furthermore individual farm visits would be more time consuming and would lead to higher non-response. At the meetings the farmers were also asked about their interest to provide data to fill the CC after the meeting. Only a very small selection of farmers agreed to do this. The CC calculation results were then returned to them and evaluation questions were answered again based on the outcome. Usually this was done in a telephone meeting and sometimes in a visit.

2.2 The questionnaire

The questionnaire consists of two main parts which were presented to the farmers in two steps.

I. The first part aims at identifying the (1a) willingness and preparedness to use the CC and (1b) ability to use and supply data to the CC. Questions to find this out were presented to the farmers before the CC was demonstrated to them. Together with presenting this questionnaire the farmers were also asked to provide data to fill the CC. The detailed questions in this part of the questionnaire are presented in Annex 1 of this report.
II. The second part of the questionnaire which is included in Annex 2 of this report was presented to the farmers after the CC was demonstrated to them. The questions included in this part of the questionnaire address 1c) capability to use the calculator without support (other than translation) at this stage and (1d) what benefit in terms of income and economy or management they would derive, if any, from using the CC and (1e) if they could see any barriers to using the CC and what changes to the CC would make the use of the CC easier and increase their willingness to use it.

2.3 Response and non-response and approach to data collection per case study

Although the questions asked to the farmer were the same, the way the farmers were approached and interviewed differed per country. These different ways of approaching farmers allowed to increase the response of the farmers and apply a survey method that would fit best with the culture of the local farming community. Detailed description of the way farmers were approached and the response and non-response is described underneath per case study.

In Table 2.2 a summary overview is given of the number of farmers that were initially invited to participate in the survey and that finally provided their responses to the first and second part of the questionnaires (Annex 1 and Annex 2) and whether they provided data for their farms to fill out and test the CC. Further details on this are also described per case in the following sub-sections.

Table 2.2 Overview of survey data collection among farmers, their response and non-response per case study

Country	Case study region	Number of farmers approached for Lot 2 questionnaire	Number of LOT2 part 1 questionnaires completed	Number of LOT2 part 2 questionnaires completed	Number of farm data sets completed to test the calculator
Germany	Brandenburg	35	9	9	2
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	14	10	7	2
Slovenia	Slovenia	17	12*	0	1
UK	England	43	0	7	19
Spain	Andalucia	15	10	0	10
Spain	Castilla y Leon	14	10	0	10
Netherlands	Overijssel, Gelderland & Utrecht	20	10	10	6
Sweden	Småland	5	5	5	0
Denmark	Eastern Islands	7	5	5	0
Total		**170**	**71**	**43**	**50**

*No individual results, the questionnaire was filled out with a group of 12 respondents

2.3.1 Germany

In order to identify potential farmers in Brandenburg, five farm advisors (which give advice to conventional and/or organic farms) were consulted. About 15 contacts were provided by these farm advisors. Further contacts were identified through previous research projects, recommendations from the farmers themselves, and a web search (e.g., organic farming associations).

In total, 35 farmers were contacted via e-mail and telephone; only 12 agreed to participate in the surveys and/or workshop which was held in Berlin on 25 October 2012.

The reasons given by farmers for not wanting to participate in this survey were lack of time or no interest in the topic; some other farmers were overwhelmed by surveys and thus not motivated to participate in another survey. The willingness of farmers to participate in the survey was much higher among the contacts given by the farm advisors or other farmers.

At the workshop the calculator was presented to and intensively discussed with the participants. In total, eight farmers registered, but only four farmers showed up (despite the fact that the farmers confirmed their participation via telephone shortly before the meeting). In order to achieve the maximum of 10 farmer surveys, the farmers not present at the workshop were interviewed via phone. Overall, 12 farmer surveys were completed. Of those 12, only 2 provided the data for filling in the carbon calculator. The CC was only presented to those farmers participating in the workshop. The farmers interviewed via phone received the list of data requirements and a description of the CC beforehand.

The main reason farmers did not want to provide the data for the carbon calculator was the lack of time to fill in the data requirement document (25 pages translated into German).

The consulted farmers represented those which are more advanced in sustainable soil management as well as other members of the farming community who are generally interested in the topic and already aware of climate change and its possible effects in Brandenburg. The farmers cited the more pronounced dry and rain periods as well as an increasing intensity of precipitation in recent years. They also revealed that

reducing GHG emissions is not of relevance in Brandenburg and that the implementation of suggested measures to improve the GHG balance are linked to increased costs and time investments. It was also mentioned that farms are oriented towards the market and respond to economic demands rather than focusing their efforts on soil fertility and maintaining the basis for successful soil management. This priority is compounded by the fact that product prices do not reflect increasing costs for the producers, which require the farmer to increase their production.

2.3.2 Poland

Ten farmers from the Voivodship of Zachodnio-pomorskie and Wielkopolskie took part in the surveys for the Carbon Calculator. The survey and data were conducted in form of individual interviews at the farms in one round.

Eight interviews were conducted in the Voivodship of Zachodnio-pomorskie. These interviews were conducted mid-September 2012, when the list for carbon calculator inputs had not yet been completed. Therefore, there was no possibility of sending the list of required data to the farmers in advance. Farmers were willing to answer the farmer questionnaire. When presented with the list of data for the carbon calculator however, five of the farmers expressed the unwillingness to spend time on providing information for the CC. They agreed to look at the data list and report if the requested information was a) readily available, b) only available through estimates or c) difficult to estimate or calculate. Based on this information they estimated their answers to the second part of the questionnaire. Three of the farmers interviewed in this region expressed interest in the carbon calculator and promised to send relevant data for the input, however they did not provide data, despite reminders. Most farmers refused to fill in the carbon calculator mainly due to time constraints and because they did not see how the calculator would create an added value for their farm.

In the Voivodship of Wielkopolskie two additional interviews were conducted in October (2012) with farmers that had been previously identified by farm advisors. The list of data was sent to the farm advisors in advance however it was not forwarded to the farmers. The farmers answered questionnaires and provided data for the CC during the interviews, which lasted approximately 4 hours. The farm advisors were present at the interviews and helped with collecting information and estimating data that was not readily available. The presence of the farm advisors and their interest in the project were crucial in convincing the farmers to provide the data necessary to fill the carbon calculator. The presence of farm advisors was crucial for the willingness of the farmers to provide data and was helpful in understanding and filling in the sometimes complex fields / definitions in the calculator. However, as the data provided was mostly based on estimates and was partly incomplete, the calculator did not deliver emission and mitigation results. Also, units provided by the farmers did not match the CC requirements, and the filling of several sections was unclear and proved difficult or confusing. Therefore, the answers to Annex 2 are based on estimates and personal experience of the farmers.

2.3.3 Slovenia

The workshop was organized as the first workshop in the testing of the calculator (10 October 2012) in Celje, Slovenia. It was organized together with a farm advisor from the Slovenian Advisory Services. At the beginning of the workshop 17 people were present, some of them left after the initial presentation. Twelve remained for the whole duration of the workshop. The remaining group consisted of seven farmers and five advisors who are also part-time farmers themselves. Initially, 12 farmers confirmed attendance (after they were invited and called twice by the advisor), on the day itself 7 of these farmers were present. The workshop lasted four and a half hours.

When farmers were invited to the workshop they received an invitation, introduction to the project, and the data requirement sheet. They were also asked to indicate if they would be willing to provide data for the CC in order to get calculation results back from the CC for their farm.

The farmers who attended were relatively interested farmers, the more 'progressive' farmers that have established good working relationships with advisers. Six of the 12 farmers that agreed to participate initially said that they were interested in doing a test run with the calculator. Once they saw the data list, however, only one farmer who was also an advisor (not specialist advisor, but basic advisor) with an organic farm, provided the data. The data was very sparse and limited and was improved upon during a phone call. This was the dataset that was used to present the calculator at the workshop.

Please note that this was also at the stage where the calculator was still crashing a lot and was not giving clear results, so it was not producing any information on mitigation options at that time. Since the calculator at that stage did not produce recommendations for specific options, it was not possible to get feedback during the workshop on these recommended (more targeted) options from farmers. Instead, in the workshop, a general discussion of the possible options emerged and the feedback on this is reported here. This also implied that the results for Slovenia for the LOT 2 questionnaire were collected through a group interview with the 12 farmers in a workshop. Therefore no individual answers per farmer were available and the group answer is presented in a qualitative way only.

In a later stage the CC was filled with farm data from one Slovenian farmer and the CC was run and produced mitigation results. Evaluation of these results is discussed in this report. An additional farmer has agreed to provide data. The results arrived too late however and are therefore not discussed in this report but delivered to the JRC separately.

2.3.4 England

Farmers were recruited for the survey from different regions of England, situated in the Atlantic North and Atlantic Central environmental zones. The North West England region has a wet and cool climate and has heavy soils over-lying rolling hills with some upland agriculture. In terms of farming systems, agriculture in the region is dominated by pastoral agriculture and consequently the sample consists of large-scale mixed livestock farms, or mixed livestock and arable farms with dairying, beef and sheep production. The regions in the East of England (Yorkshire, North East and South East) are the driest. The South East is the warmest region in the UK, with flat, low-lying landscapes and light sandy-loam soils supporting intensive, large-scale arable agriculture, especially specialist cereals. In the Northeast there are arable farms, mixed farms and in the hilly part mostly mixed livestock farms with cattle and sheep. In Yorkshire the hilly landscape dominates and upland mixed livestock systems (mostly sheep and cattle) dominate. Finally in the Southwest the climate is mildest and wettest and grasslands are the main land use with dairy systems dominating.

Farmer contact details were obtained from commercially-available lists and equal numbers of farmers in each case study region were randomly selected for contact (by telephone) for the purpose of recruitment

to the survey. A target of 20 recruited farmers (10 in each case study region) was set and this was achieved after contacting a total of 43 farmers. The success rate for recruitment was therefore about 50%. Differently from the other case regions, the UK farmers were immediately asked to fill the CC when participating in the survey. So from the start they agreed to provide testing data for the CC. This also implied that for the UK case the questions from the first part of the LOT2 questionnaire about willingness to use the CC were not asked as all farmers had already agreed with using the Carbon Calculator. At the first visit they therefore immediately started filling out the Carbon Calculator together with an interviewer. In the second visit the results of the calculations with the CC were returned and then the evaluation question (part 2 of the LOT 2 questionnaire) were presented and filled out by them.

Once a farmer had agreed to participate in the survey an interview date was arranged, surveys were carried out, by means of farm visits, and these took place in November and December 2012. Of the 20 farmers visited, 19 agreed to provide full data for the CC and this data was elicited and fully entered into the CC during the farm visit. Farmers were able to provide all data necessary for completion of the CC, either from farm records, or based on estimates, with assistance, via promptings or further explanation of requirements, from the interviewer. Data were entered into the CC by the interviewer. This data entry process also served to demonstrate the operation of the CC to the farmer.

Although data were fully entered into all CCs during the farm visit itself, mitigation option results were not at that point obtainable in any case due to technical and other problems with the CC. The interviewer was therefore required to take the results back to the office and correct the CC. Correcting the CC proved to be a laborious and difficult process and required the direct input of Solagro (the developer of the CC). Ultimately it proved possible to get mitigation options working in 14 of the 19 CCs, although this was only for the mitigation options that were implemented in the CC (i.e. 6 of the 27 options). The interviewer subsequently returned the CC results to the farmers asking for their views on the options indicated for their farms. Eventually 7 farmers subsequently gave a full response to all evaluation questions (Annex 2).

2.3.5 Spain

In Spain farmers were approached in two regions: Andalucia and Castilla y Leon. In the first region farmers were identified were specialised in olives (3 farmers), dairy and beef (5 farmers) and mixed (arable-olive activities and olive-citrus production. In the Castilla y Leon region the farmers identified had mixed crops (2 farmers), mixed livestock (1 farmer), cereals (6 farmers) and extensive beef (1 farmer) activities. Contacting the farmers was mostly done by consulting the farm advisors and other stakeholders interviewed in the LOT1 part of the study. The farmers they identified were already familiar with participating in similar survey studies and had above average experience with IT as compared to the average Spanish farmer.

Before the farmers were visited to answer the questions they received the questions and the list of data needed for the CC. After this in the first round, the selected farmers were visited by a farm advisor and they filled out the first part of the questionnaire (Annex 1). They also provided the data needed to fill out the CC. In the second visit CC calculations were meant to be presented, but with the data provided for the CC it was not possible to fill out the CC completely and produce emission and mitigation results within the time limits. The second part of the survey (Annex 2) could therefore not be performed. The testing of the CC was done within the limits of the project and the outcome of this is presented in this report. The evaluation of these results by the farmer itself could however not be derived. In Spain the technical problems encountered with CC let to non-response as farmers were no longer open to discuss results produced for their farms which were far too late to arrive and still incomplete.

The average duration of the interviews in the first round was around 1.5 hours, but in many cases follow-up phone calls were needed to collect all information to fill out the CC. Overall the farmers were able and willing to provide the data for their farms to the CC but problems occurred when filling out the CC because

data were still provided in units that were not matching with the CC requirements as these were not clearly reported in the CC prototype.

2.3.6 Netherlands

In the Netherlands initially farmers who participate in farm networks were identified and it was planned to invite these to a meeting where the Carbon Calculator would be presented. Dairy farmers in the networks "Koeien en Kansen" and "Gezond Zand" were invited and individual farmers for pigs and sheep were identified. All farmers identified were from the areas of intensive production in the provinces Drenthe, Overijssel, Gelderland and Brabant. A meeting with the "*Koeien en Kansen*" network was scheduled in September 2012 but was cancelled when the Carbon Calculator tool proved not to be working as expected as it did not produce mitigation options. Since the farmers in networks in the Netherlands use tools on a regular basis it was expected that they would not be pleased if precious time spend in gathering data would not lead to a result. Later, when the CC problems were (partly) solved it proved too complicated to schedule a new meeting with the "*Koeien en Kansen*" network. In the network "*Gezond Zand*", a meeting was also scheduled early December 2012. Unfortunately, this meeting was cancelled because of other obligations the farmers had encountered and further attempts to re-schedule a meeting failed.

To gather final data for the Netherlands two meetings with farmers not belonging to any network were organised. The farmers were selected from the list of farmers available at Alterra from former projects. The farmers contacted were often organic farms. The first meeting on April 10th (2013) was with a group of 3 farmers. The next meeting took place with a group of 4 dairy farmers (4 attended) in Overijssel that represented farms in different size ranges. On top of these, an additional 4 farmers were identified separately in the province of Utrecht and Gelderland who agreed to provide data to test the CC and/or fill out the questionnaires at home without participating in a meeting beforehand.

At both meetings the concept, principles and structure of the carbon calculator were presented in a powerpoint presentation with English screenshots. Farmers had been requested beforehand to complete a list of data required as input to the carbon calculator. At both meetings there was at least one demonstration possible of a CC completed with data received beforehand from one of the participating farmers. The completed carbon calculator could then be demonstrated as an example during the meeting. The list of all mitigation options was translated and discussed at the meetings with the farmers. During the meetings after the demonstrations the farmers were asked to complete the LOT 2 questionnaire on the use of the carbon calculator and its perceived benefits and a second questionnaire on the policy options. Both questionnaires were provided in Dutch. A total of 10 responses to the LOT2 questionnaire were returned. From 6 farmers data were also collected for testing the CC.

2.3.7 Denmark

The Danish farmers to be included in the analyses were identified in the database on fertiliser accounts. Farm size and livestock numbers were used to identify potential participants covering the most important farm types in the region. Eventually this resulted in a response of one large pig farm, one small cattle farm, one medium arable farm, one large organic dairy farm and one large dairy farm. All farmers were male and ranged from 30 to 60 years of age. In total 7 farmers were contacted to find the 5 farmers willing to participate. The farmers agreed firstly to participate in the interview on policy options and the LOT2 questionnaire on the evaluation of the carbon calculator. All farmers were visited and interviewed individually on their farm. At the end of these interviews the farmers were asked if they were interested in a second visit supplying all the data to enable testing the carbon calculator. However, none of the farmers were interested in this, mainly given the time required to supply the data (3 hours were indicated as needed). A few of the farmers also indicated that they were not really interested in changing farm practices and therefore did not want to contribute.

2.3.8 Sweden

The Swedish farmers in the analyses were approached by the help of an advisory office providing contact information. Using this approach all 5 contacted farmers agreed to participate in the interviews initially promising to help with the LOT2 questions on the use of the carbon calculator and the policy option questions. All farmers were visited and interviewed individually on their farms. Five different farm types were included: one large organic dairy farm, one medium dairy farm, one small cattle farm, one large dairy farm and one large arable farm. All farmers were male and from 30 – 65 years old. None of the interviewed farmers were interested in providing a full data set to run the carbon calculator. The main reason given was that they were too busy with farm operations at the moment and, for some, that they additionally lacked interest.

3 Willingness to use the carbon calculator and perceived benefits for the farm

3.1 Introduction

In the first round of interaction with the farmers, they were asked to provide answers to the questions in the first part of the questionnaire (Annex 1). These questions are focussed on assessing the general willingness to use a carbon calculator and the perceived benefits. It is important to know that these questions were presented to the farmer based on a general description of the CC. So they did not get a full demonstration of the CC yet when these questions were asked.

3.2 Relevance and willingness to use the carbon calculator

The first question asked was about the relevance considered by the farmers of using the CC for their farm business (see Table 3.1). On a scale of 1 to 10 the average score was estimated at 4.9. In the two Spanish cases and the Dutch the average perceived relevance was the highest. The minimum and maximum scores also indicate that the views on perceived relevance of using the CC differ strongly. However, there are large differences in views detected within the farming population also per region. In Slovenia, there is very little relevance detected among the farmers interviewed to use the CC at all. The reason for this is related to time investment-perceived benefit relation. The time investment is high, while most farmers do not see large or direct benefits of using the CC at this stage. This is different in the other regions where there are more benefits seen.

Table 3.1 Perceived relevance of using the CC for farm business expressed in average score and minimum and maximum scores (scale 1-10, 1 not relevant, 10 very relevant).

Country	Case study region	Average score	N= number of respondents	Minimum score	Maximum score
Germany	Brandenburg	4.7	9	2	8
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	4.0	10	1	9
Slovenia	Slovenia	1.5	12	Farmers would not be interested to use the calculator just for statistical purposes or for informational use, it is too demanding and time consuming for such usage. The motivation for the use also has to be financial. Very few farmers (a handful) would use the calculator just out of environmental interest.	
Spain	Andalucia	6.0	10	1	8
Spain	Castilla y Leon	5.3	10	1	8
Netherlands	Overijssel, Gelderland & Utrecht	5.6	10	3	8
Denmark	Eastern Islands	4.2	5	2	7
Sweden	Småland	4.6	5	2	8
Total*		4.9	54	1	9

*Weighted average (according to number of respondents (=N))

The next questions asked were about the willingness to use the CC in the future when the final version is available, the confidence in using the CC alone and perceived benefits of using it. In case there was no willingness to use it, the reason for this was asked. Results are presented in Tables from 3.2 to3.4.

The share of farmers willing to use the CC after the finalisation of the tool is highest in Germany and the Netherlands and lowest in Poland and Slovenia. In Poland and Sweden the interest is low and in Slovenia the lowest. In Slovenia farmers also rate the confidence in being able to fill out the CC alone as very low. Although, the Slovenian farmers interviewed showed interest in the topic and the calculator itself, they indicated that they would not use the calculator on their own, but would require assistance of the advisors. The topic itself is relatively new for the advisors themselves, so the first round of awareness raising would need to take place at the national and regional levels to train the advisers themselves.

In the UK, the questions of the first part of the survey were not answered by the farmers, but the interviewer observed that almost all UK farmers now use computers, either with general office software or specialist industry software packages, such as farm planning or accountancy tools. Farmers did not therefore feel that they would face any insurmountable problems in using the spreadsheet-based CC, either alone or with support from an adviser, particularly in view of the use by the CC of the user-friendly data entry form. This same situation also applies to farmers in the Netherlands, Germany, Sweden and Denmark while this is less often the case in Slovenia, Poland and Spain. In spite of this, the confidence level of the Spanish farmer of using the CC alone is higher than in the other countries, the time investment willing to make is however low and probably not realistic given the complexity of the issue.

Table 3.2 Willingness to use the CC once the final version is available

Country	Case study region	Yes, willing to use the CC (%/total N)*	Not willing to use the CC (%/total N)*	Average confidence level in using the CC alone (1=not confident-10 =very confident)**	Average time investment willing to make for using the CC (hours/year)	N= number of respondents
Germany	Brandenburg	90%	10%	6.1	5.3	9
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	40%	40%	5.4	20.7	10
Slovenia	Slovenia	Farmers would not be interested to use the calculator just for statistical purposes or for informational use, it is too demanding and time consuming for such usage. The motivation for the use also has to be financial. Very few farmers (a handful) would use the calculator just out of environmental interest.		1.5	3.5	12
Spain	Andalucia	80%	0%	6.0	2.9	10
Spain	Castilla y Leon	70%	20%	7.7	1.0	10
Netherlands	Overijssel, Gelderland & Utrecht	90%	0%	5.6	4.0	10
Denmark	Eastern Islands	60%	40%	6.5	3.0	5
Sweden	Småland	40%	40%	5.0	3.0	5
Total*		67%	21%	5.5	5.7	71

*If the 2 columns do not add up to 100%, the difference between the 2 column totals and 100% is the % of users that does not know whether they are willing or not willing to use the CC.
**Weighted average (according to number of respondents (=N) Slovenia excluded)

In the countries where there is a higher overall willingness to use the CC after it is finished this also goes together with an overall higher confidence level of using it by the farmer alone. The type of support the

interviewed farmers like to have also differs per case study region. In the German and Spanish cases about 50% of the interviewed farmers prefer to have direct access to an advisor while working with the CC who is at least directly approachable on-line or in person (visit). The other half requires at least a good help-function and/or manual in their own language. In the Slovenian case it was a clear wish that an advisor would need to help complete the data in the CC, at least for the first few years of use of the CC. In the Polish case the share of interviewed farmers that indicated to require help of an advisor during the use of the CC was also higher than in the German, Dutch and Spanish regions. In the Dutch situation there is only one farmer who would like to have help of a farm advisor, while the others only want to have a help function and/or good manual in their own language. In the Danish and the Swedish case 2 of the 5 respondents want help of a farm advisor and the other find a manual sufficient.

In Slovenia, the time investment to be made was the lowest as compared to the time willing to be invested in other case regions. We also see that the time investment willing to make when using the CC differs very strongly per country. Among the Polish farmers that are willing to use the CC the time investment accepted is more than 20 hours, while in all other regions it is considerably lower. On average it is estimated at 5.7 hours per year.

Table 3.3 Perceived main benefit of using the CC (1 answer per interviewed farmer) (%/total respondents (=N))

Country	Case study region	Better income	Improve environmental impact	Marketing, prove sustainability of product to consumer	Other	Not known/no answer	No benefit	N
Germany	Brandenburg	11.1%	22.2%	33.3%	0.0%	0.0%	33.3%	9
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	30.0%	30.0%	20.0%	0.0%	0.0%	20.0%	10
Slovenia	Slovenia	At this stage, the farmers would see very little benefit, the awareness of the resource efficiency and climate link is insufficient. However, this is seen as a valuable tool (if linked to agri-environment payments) to raise awareness of also economic benefits of resource efficient and environmental measures.						n.a.
Spain	Andalucia	10.0%	40.0%	0.0%	0.0%	60.0%	0.0%	10
Spain	Castilla y Leon	20.0%	20.0%	0.0%	0.0%	60.0%	0.0%	10
Netherlands	Overijssel, Gelderland & Utrecht	10.0%	10.0%	10.0%	20.0%	0.0%	50.0%	10
Denmark	Eastern Islands	20.0%	20.0%	0.0%	0.0%	0.0%	60.0%	5
Sweden	Småland	0.0%	20.0%	0.0%	20.0%	0.0%	60.0%	5
Total*		14.4%	23.2%	9.0%	5.3%	17.1%	30.9%	59

*Weighted average (according to number of respondents (=N), Slovenia excluded)

The share of farmers interviewed that does not see any benefit is quite high and is estimated over all case study regions at 31%, but is particularly high in Slovenia, the Netherlands, Denmark and Sweden. Another 17% does not know the benefit. This occurs particularly often in the Spanish regions, which can partly be explained by the observation of the interviewer in Spain who concluded that, in general, Spanish respondents did not have much training or information- or logically awareness- on climate change, carbon footprint and related impacts from agricultural activities. The most mentioned benefits referred to in Spain were a more efficient use of fuels (cost savings), and to a lesser extent pollution abatement (improve environmental impact). No relevant differences were found between the results for Andalusia and Castilla and León. In the German and Poland the argument of marketing, so proving the improved environmental performance of the production process of a product, is seen as an important benefit by some. In Poland, Spain, Denmark and Sweden the perceived income and environmental gains are also mentioned by several respondents. The reason that no benefit is seen is not necessarily explained by the fact the farmers are not

open to taking additional mitigation measures, but more the contrary. Many farmers interviewed are already taking many mitigation measures and do not see a reason why the use of the CC would lead to taking additional measures. This aspect was particularly seen in the Netherlands and Germany.

Slovenia has not been included in the calculation of the average score in Table 3.3. But from the average group response one can conclude that in this country there is a lower perceived benefit of using the CC then in most other regions. Although, if farmers would receive compensation for using the CC the Slovenian farmers expect it to be a useful tool that could raise environmental awareness among farmers.

In Poland additional observations were made during the interviews regarding perceived benefits. It was mentioned a couple of times that in Poland consumer awareness of organic products is relatively low, and even if awareness exists, people's purchasing power often does not allow for spending more on food. Therefore the market for organic products in Poland has remained limited and consumers are not willing to pay more for organic products. Also, consumers seem to be more interested in organic products, when it concerns their health directly rather than the environmental performance of its production process. A carbon calculator label that certifies low carbon agriculture is, in the eyes of Polish farmers, unlikely to change consumer behaviour. This concerns especially meat production, and according to some interviewed farmers leads to the fact that several farmers that grow their products organically and have certification, still have to sell their product as conventional products. The main problem consequently, is that most Polish farmers do not see how the carbon calculator would be useful to them in terms of increasing sales, or making the farm to operate better. This benefit was therefore not mentioned as often as in countries where the market for organic products is better developed e.g. in Germany.

During the interviews it was also noted for the German and also Dutch situation that many of the interviewed farmers question the utility of the CC as the best instrument to reduce emissions and improve the carbon cycle. They indicate that the interaction between soil carbon and fertilizer is very complex and an assessment of the carbon cycle is very difficult. According to them, the starting point for sustainable soil management should be the maintenance of soil fertility and the use of financial incentives to promote related measures, such as reduced tillage, improved water retention capacity, soil structure and improvement of soil organic matter rather than stimulating the use of a carbon calculator.

Table 3.4 Reasons for not willing to use the CC (more reasons mentioned per respondent) (N=number of respondents not willing to use the CC once the final version is available)

Country	Case study region	Not willing to use CC after completion (N)	No benefits perceived/clear	Too time consuming	No financial benefit linked	Other
Germany	Brandenburg	2	0%	50%	50%	50%
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	5	40%	100%	20%	20%
Denmark	Eastern Islands	2	50%	0%	0%	50%
Sweden	Småland	2	0%	0%	0%	100%
Slovenia	Slovenia	n.a.	Time needed, difficulty getting data, and lack of financial incentive given the time and effort needed (farmers don't have enough time to add yet another administrative task to their work)			

In Table 3.4 an overview is given of the reasons given by the farmers for not willing to use the CC once the final version is available. The number of regions for which answers are given is limited as only in Germany Poland, Denmark, Sweden and Slovenia there were farmers that explicitly indicated not wanting to use the

CC after the final version would be available. In Germany, Poland and Slovenia the reason mostly mentioned is time investment to collect all farm data which was not considered worthwhile. This answer was usually given in combination with another reason which was lack of financial or other benefits. In Denmark and Sweden the reasons were more related to not seeing any benefit of using it, particularly from the perspective of their own farming situation. So this lack of benefit was not necessarily a general statement. From the answer given by the group of farmers interviewed in Slovenia it seems clear that they are of the opinion that as long as there is no financial incentive to use the tool, the benefits of the tool (if any) do not outweigh absence of a financial incentive to start using it.

Finally it was asked whether farmers would be willing to provide data for their farm to test the CC in this survey. It turns out that this willingness differs very strongly per case (see Table 3.5). Of the 90 interviewed farmers eventually 48 were willing to provide data for their farms to test the CC. The 42 farmers not willing to provide data gave different reasons for this.

Table 3.5 Willingness to provide data for testing the CC and reasons given for not willing to provide data (more reasons mentioned per respondent)

Case study:	Region	Yes willing (N)	Not willing (N)	Too time consuming/ difficulty with data requirement (%/N not willing)	Not clear what benefit it delivers (%/N not willing)	Privacy concerns (%/N not willing)	No reason given (%/N not willing)
Germany	Brandenburg	2	7	29%	14%	14%	43%
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	2	8	88%	0%	0%	13%
Slovenia	Slovenia	1	11	100%			
UK	England	19	0	n.a.	n.a.	n.a.	n.a.
Spain	Andalucia	10	0	n.a.	n.a.	n.a.	n.a.
Spain-	Castilla y Leon	10	0	n.a.	n.a.	n.a.	n.a.
Netherlands	Overijssel, Gelderland & Utrecht	4	6	100%	0%	0%	0%
Denmark	Eastern Islands	0	5	80%	20%	0%	0%
Sweden	Småland	0	5	100%	0%	0%	0%
Total*		48	42	83%	6%	2%	9%

*Weighted average (according to number of respondents (N is respondents not willing to provide data)

By far the most important reason given in all case regions for not wanting to provide the data for testing the CC is the time investment which was generally perceived as very large. In Slovenia this was the key reason given by all and to this reason it was added that the type of data asked were very difficult to be provided at farm level. So lack of directly available data would even increase the time investment as farmers would need to invest a lot of additional effort to also identify the correct indicators for their farm. This problem of data availability in general was also mentioned several times by the smaller Polish farmers interviewed. Small farms and often also the organic farms in Poland, do not record much data, except for the data required for accounting purposes. Farmers considered the required inputs to the calculator difficult to understand and/or impossible to provide. Although most farmers have the general figures in their heads, it was often difficult for them to answer the questions and/or provide the specific data to fit into the categories of the CC. The presence of the advisor helped to understand and subsequently estimate some of the data requirements. The only exception in the Polish case was one large farm which produced for the German market. The farmer was very interested in the carbon calculator, because his clients increasingly ask for carbon certified products.

Privacy concerns about providing data for the testing of the CC were only given as a reason for not providing data in the German situation and were not mentioned in other regions. Apparently this is not a big issue in relation to the data needed for the CC.

4 Awareness of and willingness to take up mitigation options

4.1 Introduction

Once the farmers were confronted with specific results calculated by the CC for their farms or they were given a demonstration of the CC with an impression of the type of output in relation to emission levels and mitigation options, they were asked to answer the second part of the questionnaire (see Annex 2 and mitigation options in Annex 3).

Much effort in getting the CC working was needed for the English situation as the English farmers were reluctant to complete the survey that accompanied the CC during the farm visit, as they were of the opinion that before they could offer an informed view on the value of the CC to their business and their willingness to use it, they needed to see what mitigation options were generated and, as explained above, these were not immediately available. The evaluation questions were therefore presented to the UK farmers only after returning the results of the individual CC farm calculations to the farmers. The farmers really saw the emission calculations for their farms and were able to look carefully at the mitigation options the carbon calculator had proposed for their farms. In the Spanish case regions the same procedure was intended to be followed as in England, although the data collected per farm were not directly entered in the CC with the farmer present, but were collected through a large questionnaire list (see Table 4.1). Getting the CC working with these Spanish farm data turned out to be rather problematic and the deadline agreed with the farmers to return the results was missed. Spanish farmers were therefore no longer willing to answer the evaluation questions on the CC.

Table 4.1 Overview of procedure of evaluating the CC performance with the farmers

Case study:	**Case study region**	CC directly filled at farm visit	Data collected by farm advisor through questionnaire during farm visit	Data for CC send by farmer after interviews (no help of advisor)	CC results presented to farmers for answering evaluation questions	No. of lot2 questionnaires filled out
Germany	Brandenburg	0	0	2	prototype	4
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	0	0	2	prototype	9
Slovenia	Slovenia	0	0	1	prototype	0
UK	England	19	0	0	Farm specific CC results (response for 7 farms)	7
Spain	Andalucia	0	10	0	No results obtained in time	0
Spain	Castilla y Leon	0	10	0	No results obtained in time	0
Netherlands	Overijssel, Gelderland & Utrecht	0	0	6	Farm specific CC results & prototype	10
Denmark	Eastern Islands	0	0	0	prototype	5
Sweden	Småland	0	0	0	prototype	5

In the Netherlands two workshops were organised for 6 or more farmers to complete and provide the data for the CC. Before these workshops, two individual farmers on sheep and intensive pig production respectively, provided data for the CC which were used to fill out the CC during the demonstration of the CC at the workshop. In the Netherlands farmers were willing to provide data that the CC does require and

provided these with the promise to get feedback for their specific farms upon completion of a working version of the CC.

In all other case studies the interviewed farmers were only confronted with a prototype demonstration of the CC showing emissions and mitigation advice based on real farm data specifically for the type of farms relevant for the farmers participating in the interviews (see Table 4.1). The reason for this difference in approach is the problems encountered with getting the carbon calculator run emission and mitigation results with the specific farm data delivered by the interviewed farmers. In all case study regions it turned out to be quite problematic to enter farm data in the CC and calculate emissions and mitigation measures with the prototype version offered to the Fragaria consortium. The problems encountered while getting the CC running are discussed extensively in Chapter 5 and 6, but it should be emphasised here that because of these problems it also turned out to be difficult to present farmers with calculated results for their farm within the time limits of the project and get their answers back to the evaluation questions in the second part of the LOT2 questionnaire (Annex 2).

To ensure that evaluation response was still gained in Germany, Slovenia, Poland, the Netherlands, Denmark and Sweden the choice was made to demonstrate a prototype result to the farmers and ask the evaluation questions after this demonstration. This was done in order to ensure that evaluation results could be collected in time and to not raise high expectation amongst the farmers without being sure that these could be accommodated in time. This procedure was however not followed in the case of the Spanish and the English regions. By the time the emission results for Spain could be calculated with an improved version of the CC, there was no time left and/or no willingness among the farmers to answer the evaluation questions on the CC performance at all and/or within the time limits. So eventually the Spanish respondents did not see the CC in operation, so that there are few recommendations collected from these farmers on the evaluation questions or the concept of the CC transmitted by the interviewer. In England, the English partner still managed to get mitigation options working in time for 14 of the 19 interviewed farmers, although these included only the mitigation options that were implemented in the CC (i.e. 7 of the 27 options that are listed in Annex 3).

In the UK the interviewer returned the CC results to the farmers by email with follow-up telephone calls, asking them to complete the questionnaire and, in particular, provide their views on the mitigation options indicated for their farms. Because of the long interval between the interviews and the availability of the mitigations options a number of farmers had lost interest in the project and declined the request to provide feedback on the mitigation options. Several other farmers expressed disappointment with the very limited number of mitigation options that were generated for their farms and when it was explained to them that the CC was not fully functional, they also declined to provide feedback on the CC. A total of 7 (out of 19) farmers gave a full response to all evaluation questions in the second part of the LOT2 questionnaire.

4.2 Results of evaluation questions

The first question asked to the farmers was about how helpful the farmers consider the calculation results produced by the CC (see Table 4.2). It turns out that in the Netherlands and Poland the results produced by the CC are evaluated by the interviewed farmers as most helpful, while in England the evaluation comes out very low. This is striking as in England the farmers were really presented with result specific to their farms, while in the other case regions the farmers only saw prototype results for a similar farm type. On the other hand the UK farmers were most exposed to the problems encountered with working with a prototype system. At the first visit they expected to receive mitigation advise for all the mitigation options in the list (Annex 3), while when visited for the second time it became apparent that only 7 of the mitigation options were really implemented in the prototype. In other words, many improvements are

needed to the CC in order to make farmers appreciate it and make it an attractive tool for providing useful mitigation advice to farmers. In chapter 5 and 6 these improvements will be discussed.

Table 4.2 Rating of helpfulness of CC mitigation option results perceived by the farmer (score 1-10, 1 not helpful, 10 very helpful)

Case study:	Case study region	Average score	N	Minimum score	Maximum score
Germany	Brandenburg	4.8	4	3	8
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	5.9	7	3	8
Slovenia	Slovenia	n.a.	n.a.	n.a.	n.a.
UK	England	3.5	7	1	7
Spain-Andalucia	Andalucia	n.a.	n.a.	n.a.	n.a.
Spain-Castilla y Leon	Castilla y Léon	n.a.	n.a.	n.a.	n.a.
Netherlands	Overijssel, Gelderland & Utrecht	7.0	6	6	8
Denmark	Eastern Islands	4.6	5	3	7
Sweden	Småland	4.8	5	2	7
Total*		5.1	34	1	8

*Weighted average (according to number of respondents (N))

The next questions in the second part of the Lot 2 questionnaire are about the evaluation of the mitigation options and whether the options are already used by the farmer or not. Of the regions for which evaluation responses were collected (see Table 4.3) we see that the majority of the farmers are already familiar with most of the mitigation option suggested by the CC and many are already applying similar mitigation options suggested by the CC. This high score on already using some of the mitigation options is related to the fact that at the time of testing in he CC only the most common mitigation options were implemented. These are often not very challenging to include in the farm management and are often already part of legal obligations and/or Good Agricultural and Environmental condition standards in EU. An overview of the type of already used mitigation options is summarized in Table 4.4. The list for Poland is particularly large which can be explained by the larger response but also by the fact that the farmers involved in the interviews were already the ones with a more than average interest in improving the environmental performance of their farms. In Sweden and Denmark this was probably not the case as the farmers did not elaborate very strongly on the mitigation options they were already taking. Possibly it is related to the fact that all interviewed farmers in Denmark answered that the benefits from using the CC would be expected to be minor in terms of income, management and environmental impact. Arguments were that their management was already optimized or that they did not see much room for improvement. A few respondents expected that if the CC would advise them to introduce certain mitigation the chances would increase that they would become candidate for participating in a financial incentive scheme.

The familiarity with the mitigation options included in the CC is lower in the English cases and this also applies to the willingness to use (new) mitigation options. The higher share in farmers not continuing with the use of mitigation options in Germany and Netherlands is all related to no-till which turned out to give problems with soil condition and management of herbs after several years of applying it. In the UK this was mostly related to higher costs which were not earned back in higher profit (see also Table 4.6).

Table 4.3 Familiarity with the mitigation options and willingness to use them in the future (more answers per farmer possible).

Case study:	Case study region	Familiar with mitigation options	Consider use of mitigation options?	Used similar mitigation options already in the past	Still using these options	N
Germany	Brandenburg	100%	100%	100%	75%	4
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	100%	100%	100%	100%	9
UK	England	71%	71%	71%	57%	7
Netherlands	Overijssel, Gelderland & Utrecht	90%	100%	90%	80%	10
Denmark	Eastern Islands	100%	100%	100%	100%	5
Sweden	Småland	100%	100%	100%	100%	5
Total*		88%	95%	95%	85%	40

*Weighted average (according to number of respondents (N))

Table 4.4 Overview of already implemented mitigation options mentioned by the interviewed farmers

Case study:	Case study region	Type of measures mentioned
Germany	Brandenburg	No-tillage and direct seeding; introduction of legumes in grasslands; all year soil coverage; catch crops
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	Adjust N fertilizer; all year soil coverage, no-tillage; avoid burning residues; reduce engine fuel consumption; purchase of organic fertilizer to replace chemical fertilizers, introduce legumes, establish landscape elements (hedges & other landscape elements), optimise stocking rate and grazing practice, improve livestock productivity, change in slurry manure management and coverage of the solid manure pile, invest in energy efficient machinery, insolate buildings, make adjustments in the N-fertiliser balance, optimise ventilation in the grain storage.
UK	England	Install solar panels, introduction of legumes in rotation and clover in grass, maintain a soil balance, lower N application
Netherlands	Overijssel, Gelderland & Utrecht	Zero-tillage; Adjust N fertilizer/only use organic fertilizer, establish landscape elements (hedges & other landscape elem.), coverage of solid manure pile, leave straw on land, heat water with wood biomass
Denmark	Eastern Islands	Adjust N fertilizer; all year soil coverage, no-tillage; change in slurry manure management, make adjustments in the N-fertiliser balance
Sweden	Småland	Adjust N fertilizer; all year soil coverage, no-tillage; change in slurry manure management, make adjustments in the N-fertiliser balance

In general the Swedish farmers showed a general interest in the climate issues rather than a specific in the carbon calculator. Overall they had good knowledge on mitigation options that is seen as good agricultural practice, which means that the carbon calculator does not provide a lot of new knowledge.

Though only a very small number of farms were interviewed it is indicated that the carbon calculator might not be suitable for all types of farms. The interest of older farmers to initiate mitigation options might be limited. Furthermore, smaller farms might not have the room of manoeuvre to adopt bigger changes.

The farmers already using some mitigation measures included in the CC were asked whether they perceived the effects of it as positive and they were also asked to specify which benefits they experienced (see Table 4.5). It became clear that generally all perceived the benefits positively, although this did not always apply to all mitigation measures that were taken. As was also stated in the former, in Germany and the Netherlands using no-till practices for a longer period of time did lead to complications and in the UK the mitigation measures did not always turn out cost-effective. Of the positive benefits mentioned it is clear that the maintenance/improvement of soil fertility and the saving of cost were mentioned a bit more often. Yield increase effects were also mentioned often, but only in Brandenburg. In Sweden and Denmark the mitigation options already in place are included in legal obligations and are not necessarily evaluated positively by the farmers.

Figure 4.5 Perceived positive benefits of existing mitigation measures

Case study:	Case study region	Experienced positive benefits of used mitigation option	Perceived benefits mentioned					N
			Increased yields	Maintained/ increased soil fertility	Save costs	Part of certification/legal obligation	Other	
Germany	Brandenburg	100%	100%	100%	75%	0%	0%	4
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	100%	0%	0%	22%	22%	22%	9
UK	England	57%	0%	0%	14%	0%	0%	7
Netherlands	Overijssel, Gelderland & Utrecht	50%	0%	20%	0%	0%	0%	10
Denmark	Eastern Islands	20%	0%	0%	0%	80%	0%	5
Sweden	Småland	40%	0%	0%	0%	60%	0%	5
Total		63%	10%	15%	15%	22%	5%	40

Table 4.6 Reasons for not continuing with mitigation options used or not using mitigation options until now?

Case study:	Case study region	Financial (costs)	Lack of training/ education	No support to solve technical problems	Other	N
Germany	Brandenburg	50%	50%	50%		2
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	66%	0%	0%	33%	3
UK	England	75%	0%	0%	25%	4
Netherlands	Overijssel, Gelderland & Utrecht	50%	10%	10%	0%	10
Denmark	Eastern Islands	0%	20%	0%	20%	5
Sweden	Småland	0%	40%	0%	20%	5
Total		38%	17%	7%	14%	29

The reasons given for not continuing with existing mitigation measures and/or not willing to start implementing mitigation measures are presented in Table 4.6. They confirm that the costs are the reason most often mentioned, at least in Germany, Poland, UK and the Netherlands, followed by technical problems. The latter especially refer to problems encountered with no-till after several years of use, but also other technical problems which are more related to not having the optimal technical know-how to implement it well. In Sweden and Denmark it's not so much the financial aspects, but more lack of training and technical support.

Finally it was asked which incentives were needed to make farmers continue or newly implement mitigation measures. In the Danish, Swedish and UK regions there was not a large interest and/or clear response to this question. In the other regions the financial support either through compensation for higher costs or for investments was mentioned most often and practically by all farmers interviewed. The education, training and demonstration were also mentioned several times.

Table 4.7 Which incentives are needed to use the new options/continue using the past options (more answers possible)

Case study	case study region:	No interest	Financial support	More education/training/ demonstration	Technical support (of farm advisor)	No support needed/not specified	N
Germany	Brandenburg	0%	75%	25%	0%	0%	4
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	0%	66%	33%	11%	0%	9
UK	England	14%	14%	14%	0%	57%	7
Nether-lands	Overijssel, Gelderland & Utrecht	10%	90%	20%	0%	10%	10
Denmark	Eastern Islands	40%	40%	0%	0%	20%	5
Sweden	Småland	40%	60%	20%	0%	0%	5
Total		15%	60%	20%	2%	15%	40

In the Netherlands it was specifically mentioned that financial support was needed both to compensate for potential losses especially in the beginning of the introduction of a measure, but also to stimulate larger participation in the implementation of mitigation measures. In Poland financial support was more often referring to investment support.

Finally, it should be mentioned that often there is a big difference in how the farmers evaluated the relevance of the CC for their farm business and their willingness to use the CC in the future. In Denmark and Sweden for example there were farmers that valuated the relevance of the CC very low (score 2). In spite of this, some of them would still be open to use the CC in the future when there would be a final version while others did not have this interest. When the CC was scored at a medium level (score 4-5) some of the farmers would still be willing to use the CC in the future and some would not. The farmers that scored the relevance of the CC relatively high (score 7 and higher) were almost all willing to use the CC in the future once a final version would become available.

5 Evaluation of the performance of the current carbon calculator

5.1 Introduction

The final part of the questionnaire (Annex 2 questions 18 and 19) is about the evaluation of the use of the CC and of the performance until now. This is discussed through presenting the response to the last 2 questions in the Lot 2 questionnaire and through an overview of the evaluation of the results for emissions and mitigation options calculated by the CC with the data provided by the 28 farmers to test the CC.

Overall it should be mentioned again that many problems occurred with getting the current prototype version of the CC running and this has become apparent very clearly to farmers that were interviewed in the earlier phases of the project (e.g. Germany, Slovenia, Poland, England and Spain) rather than in the later phases (Netherlands, Sweden and Denmark) in which problems with the using of the prototype version were clear and were not revealed directly to the farmers. In this light the response to evaluation questions should also be placed.

In Table 5.1 an overview is given of the way the filling of data in the CC is perceived. These questions were answered in several levels of detail depending on the detailed view the famers had derived beforehand of the data requirements for the CC and the experience farmers have with providing data on their farms for other purposes. Overall it is clear that the least problems with understanding the data requirements and providing data were encountered among the English farmers. They of course were at an advantage as the CC was in English, and therefore, it was possible to present it to them in its original version, without the need to first translating the specifications on the data input needs. What also became clear is that farmers in England, but also the ones in Germany, the Netherlands, Denmark and Sweden are more used to maintaining detailed farm records which they need to report anyway in other systems (e.g. IACS) and to their accountants. Therefore they reported fewer problems with providing data than the farmers in Spain, Poland and Slovenia. As a matter of fact many farmers in the UK are already familiar with the use of farm-level carbon foot-printing, and indeed many already supply data for use in carbon calculators, either through certification scheme membership, or as a requirement of supplying to a supermarket buyer. When asked about the level of difficulty associated with providing data for the CC it was universally agreed that the data requirements were relatively easy to understand and respond to. It was even reported that some of this type of data was already being generated for a carbon calculator operated by a supermarket buyer.

On the other hand an overall complaint which was mentioned in all of the case studies, except for the UK, Denmark and Sweden, was the use of specific terminology and technical terms which were difficult to understand for many farmers. This could partly be related to the translation of terms, as for the non-UK farmers a questionnaire was developed covering all data needs to fill out the CC in their own languages. Another complaint already reported in several other places is the extremely long list of data needs. Many farmers indicate that data requirements should be made more specific to the farm types addressed. It would also be efficient to first fill out the farm data with data already available in farm records for that farm before bothering the farmer for the remainder data needs. This would prevent double work which creates irritation. On the other hand the data collection for the non-UK farmers was done through a questionnaire instead of filling-out the CC directly. When using the CC farmers can be better guided to the questions that are relevant to their specific farm type. In spite of this, the data requirement is still very large, also when using the CC to provide the data. Links to existing databases would make the CC more user-friendly and efficient to use.

Another issue mentioned several times was that although most farmers have the data in their heads, it was often difficult for them to answer the questions / provide the data so it would fit into the categories of the

carbon calculator. The presence of the advisor helped to understand and subsequently estimate some of the data requirements. However, also with this help it turned out to be very difficult to get the CC run emissions and mitigation recommendations with the entered data.

As to the type of data identified as difficult to provide from farm records or estimates, it was seen that this differs per region. However data that were reported as difficult in more of the case regions were the fuel use distribution over activities, information on natural infrastructure, details on (extensive) grazing practices and data on other inputs (see Annex 4, for details on data categories). Further details on this can also be found in Table 5.1.

The experience with data collection in England, where the largest effort was invested in collecting farm data for the CC shows that overall there was no significant difference between the two English case regions in terms of the ability of provide data for the CC. As the two regions are strongly identified with particular farming systems, mixed livestock and specialist arable, this finding suggests no difference in the ability of arable and livestock farmers (in the UK) to provide the data necessary for the operation of the CC. Farmers were able to provide all data required for the operation of the CC, although some further explanation of the data requirements was needed in order to achieve this, especially for some categories of data.

As a general rule, data were easiest to obtain when it was available from farmer memory, i.e. the sort of data that farmers use in everyday decision making, although one can indeed question the correctness of these types of answers. Beyond this it was necessary for the farmer to consult farm records. This increased the amount of time needed to provide data, but maintained a high level of data accuracy and reliability. The requirement to consult farm records for some data items did not appear to diminish the interest of farmers in using the CC. The most difficult data to collect were those items that were not familiar to the farmer, i.e. they neither used in normal farm accounting practices, or everyday record-keeping. An example of this type of data would be allocations of fuel usage to individual farm enterprises, where fuel usage is normally only accounted for at the farm level.

Table 5.1 Overview of main difficulties mentioned for filling the CC

Difficult questions to:	Brandenburg	Spain-Andalucia & Castilla y Léon	Slovenia	Poland - Zachodnio-pomorskie and Wielkopolskie	North and East England	Netherlands	Denmark	Sweden
Respond to:	Description of ruminants monogastric animals raised on the farm, consumption of electricity on the farm	Overall comment is that terminology and technical terms used are not always clear.	n.a.	Questions on natural farm infrastructure, secondary inputs and materials, type of diet per livestock type, types of fertilisers used, forage produced and consumed on farm, dry matter estimates. Overall the data request should be more adapted to type of farm (sectoral, but also organic-non-organic) and it should be much clearer which entity to use and punctuations. What to fill when question not relevant (0, leave empty?). All additional data questions are difficult (e.g. packaging of pesticides)	Generally seen as easy to respond to. The only problems encountered were the choice of entities (e.g. m2 or ha.?)	Overall comment is that terminology and technical terms used are not always clear.	Some of the soil and climate data, other inputs and land use changes.	Questions on other inputs
Understand:	Nothing reported	Overall comment is that wording is too technical which makes it difficult to fully understand.	n.a.	Questions on materials, grassland management, natural infrastructure.	Generally well understood	Overall comment is that wording is too technical which makes it difficult to fully understand.	Some of the mitigation options are difficult to understand in relation to purpose	Some of the mitigation options are difficult to understand in relation to purpose
Provide data from farm records for:	Nothing reported	Data on materials used in farm buildings; amount of solid and liquid manure produced, grazing management	n.a.	Most farm data asked for was not readily available for most farmers (particularly small ones) and so they were / would not be able to provide data easily. Specifically mentioned were water use, livestock module figures, feedstuff intake (particularly when much comes from grazing outside), organic matter contents, annual use in hours of machinery.	Nothing reported	Fuel and Diesel use over products/activities, Organic matter, Natural infrastructures, .weight of animals,	Other inputs	Other inputs
Provide an estimate for	Nothing reported	Data on extensive grazing; machinery use among different products; distribution of fuel among products; yields	n.a.	Renewable energy, dry matter	Nothing reported	Pedoclimatic conditions and natural infrastructures, allocation of resources to different products which is not monitored on Dutch farms in general.	Other inputs	Other inputs

Overall data entry in the CC also turned out to be difficult. This was particularly identified by the partners from England and Spain who collected most of the farm data for testing the CC and who had invested most work with getting the CC run with these data. The problems encountered were related to the completeness (level of development) of the user front-end that hampered the use of the CC in this study. For example, there were issues relating to the formatting conventions employed by the CC being unfamiliar to UK users for example, such as the use of the 'comma' symbol in place of the decimal point that caused some confusion. Most problematic however, was a lack of accuracy and/or explanatory detail supporting data entry. It remains unclear in many places what units should be used in the provision of quantities data and there was sometimes a lack of clarity over which data were essential for the proper functioning of the CC and which were optional.

5.2 Testing results of the carbon calculator with farm data

As specified in the former 50 farms from 7 countries provided farm data set for the CC. However, the CC did not produce results or data was not entered in the CC for all of these farms (see Table 5.2)

Table 5.2 Overview of data sets collected and final calculation and mitigation results

Country	Case study region	Number of farm data sets completed to test the calculator	Number of working CC producing emissions and mitigation results
Germany	Brandenburg	2	2
Poland	Zachodnio-pomorskie, Wielkopolskie & Matapolskie	2	2
Slovenia	Slovenia	1	1
UK	England	19	14
Spain	Andalucia	10	3
Spain	Castilla y Leon	10	2
Netherlands	Overijssel, Gelderland & Utrecht	6	2
Denmark	Eastern Islands	0	0
Sweden	Småland	0	0
Total		**50**	**26**

Particularly by the English partner a lot of effort was invested to run calculation results for all the 19 data sets. Although data were fully entered into all CCs during the farm visits in the English regions, mitigation option results were not at that point obtainable in any case due to technical and other problems with the CC. The interviewer was therefore required to take the results back to the office and correct the CC. This took several weeks as it proved to be a laborious and difficult process and required the direct input of Solagro, the developer of the CC. Similar experiences with getting the CC working with the specific farm data were also derived in the German, Slovenian, Polish and Spanish situation. For the first 3 regions, the CC produced results for all farm data collected In the Spanish regions only for 5 farms final results were produced.

A summary of the testing results per farm per region is reported in Annex 5 of this report. In the following a summary of the main problems encountered and the validity of the calculation results in relation to emissions and mitigations are reported. These will be strongly based on the English experience as this was the region where the largest number of tests was done.

5.2.1 Calculation of emissions

The Carbon calculator calculates the total emissions of the farm and also specifies the emissions per product on the farm. For the farm calculations with the CC the results on emission calculations were evaluated. It turns out that the checking is very complicated as the CC produces results even if certain input data are missing or have not been specified correctly. As a consequence the CC produces results, which at this stage need very carefully checking.

The source of the problem is that there is a lack of accuracy and/or explanatory detail supporting data entry in the CC. It remains unclear in places what units should be used in the provision of quantities data and there was sometimes a lack of clarity over which data were essential for the proper functioning of the CC and which are optional.

That erroneous emissions were calculated becomes clear for example in the case of the CC testing with Slovenian farm data. In this testing it was detected that the overall GHG emission of the farm is far below the minimum value possible for emissions for this type of farming as assessed in other studies which is simply unrealistic given the structure of production and management practices. At the same, the GHG profile at farm scale in terms of GHG gases shows that no N_20 emissions are produced on the farm, which doesn't seem to be right since there is arable farming which for sure produces these types of emissions. The CC results also show 0 for CO_2 emissions. This is wrong since there is use of machinery and electricity on the farm so there should at least be some emissions in this category.

For a German farm the testing showed that the CC doesn't seem to take into account the carbon sequestration through landscape elements.

5.2.2 What mitigation options were suggested?

In the present version of the CC on 7 mitigation options are really operational. These are indicated in Annex 4. These 7 mitigation options are generally not the type of options that lead to large GHG savings. This is clearly illustrated by the evaluations done for the English farms.

Six of the seven working mitigation options are suggested on farms in England – these are shown on a farm by farm basis in table 5.3. The most commonly suggested options are introduction of agro-forestry and adjustment of N fertilizer balance, with both of these being suggested on all 14 farms for which any mitigation options were generated. This was also seen for the Spanish, Slovenian, German, Dutch and Polish CC testing results. It is doubted whether these options are always the most optimal and realistic ones to suggest for all these different farming systems and environments.

The least frequently suggested is ‘No tillage’, which appears just three (out of 14) times. The most effective option, in terms of C savings is the introduction of legumes into the farm rotation, which is projected to save an average of 0.93% of the whole farm level emissions.

Table 5.3 Mitigation options provided by the CC for 14 UK farms (C saving % of whole farm level emissions)

	Farm													
Mitigation option	A	F	G	H	I	K	L	M	N	O	P	Q	R	S
Introduce legumes into rotation	1.3		0.1	2.6	3.1		0		0.8	3.6		0.1	0.4	1.0
Agro-forestry	0.1	0.1	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0
Adjust N fertilizer balance	0	0.1	0.8	0	0	0.5	0	0.1	0	0	0.1	0	0	0
Keep soils covered all year		0	0	0		0		0			0			
No tillage				0.1		0.3			0.6					
Introduce legumes into grassland			0	0		0			0.1	0.1	0.1	0.2	0	0

Notes to table:
Note: zero values probably indicate that the mitigation options generates very small positive C savings, i.e. <0.1.
Note: blank cell indicates that the mitigation options was not generated by the CC on that farm
Note: there are no working mitigation options for farms B, C, D, E, J, S.

As a result there was a broad level of dissatisfaction with the mitigation options generated by the CC, with these viewed as being very limited in number and unimaginative in scope, i.e. they are all familiar actions, of limited scope and simple in design. Many of the mitigation options suggested by the CC were already implemented at the farms surveyed. As a consequence, there was a view that some of the more interesting and potentially significant (in terms of carbon footprint and economic implications) mitigation options listed by the CC are not yet functioning in the version provided by Solagro for this study, or not even included in the list. Examples of the latter are conversions to forestry, perennial biomass cropping, extensification of grazing, introduction of riparian buffer strips and other landscape elements.

6 Conclusions and recommendations for improvement of the carbon calculator and enhancement of its use

In this Chapter we report on the recommendations for improvement of the CC and we formulate recommendations on enhancement of its use.

6.1 Recommendations for improvement of the Carbon Calculator

The recommendations to be presented here are based on the answers to the last question in the Lot 2 questionnaire (part 2 see Annex 2) and on the observations and conclusions of the project partners derived during the collection of interview results in the different case study regions. The recommendations are discussed in the following in relation to overall design of the CC, data requirements and data entry.

Design and implementation of the carbon calculator:

- The CC must be easy to understand and use (i.e. avoid the use of complicated jargon, technical terms and formulas) and the farmers should be able to use the CC without an advisor needing to be present. This implies the development of a good user-guide in every farmer's own language, a clear help function and an on-line help office that can be mailed or called.
- A clear message is needed regarding: i) the aim of the CC and ii) what farmers should do to address climate change.
- The methodology behind the calculator and the system boundaries need to be presented in clear / schematic ways when introducing the calculator (or be part of the calculator itself). Apparently the pictures presented in current user handbook are not considered sufficiently clear. Farmers need a more attractive and practical presentation of the Carbon Calculator that links more strongly to their day to day practices.
- The definitions of the mitigation options suggested/recommended at the end should be clearly outlined and should be accompanied by good explanations. It is recommended to revisit the current handbook and make the description more practical, in that examples are given of how day to day practices at the farm could be altered to avoid emissions and store carbon.

Data requirements and data entry:

- More development work is needed on the data entry sheets – this clearly hasn't been properly 'road tested' prior to this project and accurate input sheets are crucial to ensuring the emission footprint operates correctly. Data entry should be straight forward to ensure that correct entities are used immediately (e.g. kg dry matter per hectare per year, livestock in livestock units or heads etc.), predefined categories, use of '.'or ','' etc.
- More use of prompts/warning is necessary for identifying and correcting errors or missing data at the stage of entering data.

- Help files need to be developed – these files need to be country specific, too much terminology is not relevant for UK farmers; clarity is needed in terms of the input data and the form and categories it needs to be entered in.
- A key issue for increasing use is to simplify data entry. Much of the data required by the calculator are already available in FADN, central registers (animals, land registers) and the CAP subsidy applications. The hydrological and soil data are available in national registers. Farmers find it unproductive and frustrating (in addition to the time issue itself), if data entry has to be duplicated or entered from scratch when it is already collected or available in other systems. 'They would rather pay for something to get it done, than to have to spend extra time on figuring it out from scratch.'
- Simplification would also involve, e.g. automatic calculation of NPK values from brand names of mineral fertilizers (farmer would only enter the brand name and amount, and the calculator would automatically convert). Integration with software for manure management would be beneficial.
- The pre-defined climate and soil classes are not always coinciding with the classes used by the farmers themselves. This was for example the case in Denmark and Sweden.
- The calculator should enable automatic conversion of certain units (for example, in the case of fodder or forage it should enable quantities be entered in cubic meters and these would be converted into tones dry mass and for this information should be provided on water contents). This would save time.
- Some very specific data issues were also mentioned during the interviews with the farmers. Some examples of these are listed below:
    - For data entry on characteristics of animals on the farm, it would make things easier for farmers to leave the option to farmers to specify for the annual average number of animals on the farm or to specify the situation in the beginning and end of the year.
    - In relation to data on consumption of forage: “Type of forage and amount in tonnes of dry matter produced and consumed on the farm”: Answering this question is problematic, as for many forage categories it is very difficult to make reliable estimates of the dry matter contents. A help function should provide better support for providing more accurate data to the CC (e.g. pulp from beetroot used as forage which contains approx. 50% of dry matter).
    - Table 13 in Annex 4, specifying the data requirements for the CC on types of fertilizer used: should the indication be in gross or net? i.e. the whole amount of fertilizer used, or just the amount of for example ammonium nitrate (thus only 33.5%).
    - Sometimes the units provided or available were not the same as the ones required (kg instead of amount per piece and metres). A solution to this problem would be to build in automatic conversion procedures.

- Amount of pesticide packaging - these bags are returned to the company providing the pesticides. Should this then be recorded?

Livestock module:

- The CC should allow for data import from HIT[4] (Identification and Information System for Animals), which farmers are obliged to implement anyway;
- Data requests for manure management should be linked to nutrient balance and fertilizer balance calculations (as those include data on input and output and information on dry mass content of liquid/solid manure)

Cropland module:

- Allow for data import (on N/K/P input per ha) from field index system[5]
- Allow for data import (N/K/P input per farm) from fertiliser balance[6] (sheet)

Other inputs:

- Forested areas are not included in the CC, but should be given that it is typically a measure that is encouraged through RDP payments as it is expected to deliver large GHG savings.
- In some cases, the consumption of fuel is very difficult to estimate as some farms are using machinery ring/machinery cooperatives, resulting in many activities being carried out by contracting workers (particularly on large farms). How to address for this?
- For the quantities (in kg or liters) of plastics and oils on the farm that are used in production (asked under "Secondary inputs"), two further columns to tick should be included: "recycling" and "disposal"
- If the farm has a large share of forest cover, and some of the arable land is being converted into forest through abandonment, where is the carbon content of this area recorded? The conversion options under green infrastructure elements do not include conversion from grassland to forest / bushes.

Improve functionalities for the CC

- The calculator needs to ensure it will generate mitigations for all of the listed options. Currently, there are only 6-7 functioning options which tend to be quite general in nature, i.e. are not specific enough for individual farms. These options tend to be overly simple, with many already being considered by farmers, often being part of Cross Compliance standards. While some of the more interesting and useful options, such as improved farm productivity or reducing enteric fermentation aren't available.

[4] In German: Herkunftssicherungs- und Informationssystem Tiere
[5] In German: Ackerschlagkartei
[6] In German: Düngebilanz

- Calculation results should include further relevant mitigation options such as: optimise/maximise soil biodiversity; optimise/maximise plant root capacity/biomass; application of nitrogen-fixing bacteria (e.g. Azoarcus)
- Results page – the graphs need to be more specific in that more explanation should be given on how to interpret the results. Farmers are generally not used to interpret such complicated graphs. Furthermore the result graphs should be comparable and should therefore use the same minimum and maximum values in the x- and y axis and should work with similar size classes. Mitigation results should not be calculated if data sheets are not completely filled in. Otherwise results are presented which are incorrect, but interpreted as correct. This is dangerous and could make farmers decide to change their management based on incorrect information.

6.2 Recommendations for enhancement of the use of the Carbon Calculator

- As the farmers also need to adapt to climate change and contribute to climate policy, the CC should also provide support in targeting farmers towards the most efficient adaptation actions which are also supported in the new CAP post-2013. This also implies that the CC should cover:
    - land use change actions at farm that have large emission and mitigation impacts such as conversions to forestry, perennial biomass cropping, extensification of grazing
    - renewable energy production at farm.

  These actions are not implemented in CC yet and/or not even included in the extensive list of 27 mitigation actions (in Annex 3).
- Certification does not have much tradition in many countries of the EU particularly in the CEEC such as Slovenia. This implies that the use of a carbon calculator is less likely in the countries where certification is not wide practice. Therefore it makes more sense to tie the introduction of the calculator to existing or newly established agri-environment and wider RD measures.
- Carbon footprint needs to be packaged as part of a whole environmental footprint of farms, otherwise it gives a skewed picture.
- The implementation of the CC must be voluntary and it is important that the farmer benefits from its use and does not incur any disadvantages. On the other hand, other farmers would prefer a compulsory use of the CC.
- The best option for CC implementation would be to provide i) software which is free of charge and ii) a tool which suggests measures helping to decrease costs, while also benefiting soil carbon and the GHG balance.
- Data entry to the CC would be too time-consuming for many farmers to be willing to use the CC independently. However, most of the data required by the CC is already available (via calculation/reporting tools; see below), thus the data requested should be linked to existing farm records and information systems. This will take away the burden of the enormous data entry needs and will enhance the use of the CC among farmers.

- There is still a sizeable level of cynicism amongst farmers as to the benefits of footprinting. There is no formal requirement on farmers to do this work. Big strides have been made in the UK but it is still a very difficult topic to engage and interest farmers in.
- It is suggested to change the language from 'mitigation' to 'business / farm resilience planning'. The term 'mitigation' switches farmers off, they find it meaningless, whereas 'resilience planning' demonstrates suggests to farmers the notion of being 'prepared and acting positively' rather than being reactive.

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Annex 1 Questionnaire for first round

Question on willingness to use the calculator and perceived benefits for the farm

1.	Can you indicate how relevant you consider the Carbon Calculator for your farm business (scale 1-10, 1 not relevant, 10 very relevant)?	
2.	Would you be willing to participate and use a carbon calculator to assess your Greenhouse gas emissions and carbon sequestration of your farm in the future, once a final version of the calculator is available?	
3.	What benefit in terms of income and farm management, environmental impact of your farm, would you anticipate, if any, from using the CC?	
4.	How much time would you be prepared to spend on preparing the necessary information and filling in the data in a calculator (alone, with advisor)?	
5.	Please indicate (scale 1-10) your confidence in using the carbon calculator by yourself without any advisor present?	
6.	If you would want or require support, what support would you prefer (HELP function, manual in your own language or in English, advisor present, advisor to complete the carbon calculator on the basis of your input data, other)?	

7.	If you are not willing to use the calculator in the future, can you please explain why?	
8.	If you are not able or willing to supply data, what is the reason (e.g. privacy, complicated, confidential, time constraint, uncertain, other)? Would you be willing to use the calculator if data requirements were less?	

Annex 2 Questionnaire for second round (after the CC calculation results have been demonstrated to the farmer)

Recommendations and choice of mitigation options

9.	Can you indicate how helpful you consider the Carbon Calculator to assess and choose mitigation options (scale 1-10)?	
10.	Are you familiar with the options suggested to you?	
11.	Would you consider such mitigation options at all?	
12.	Do you have any experience with using these options in the past?	
13.	If so, what has your experience been with these options?	
14.	Are you still using these options?	
15.	Can you give reasons why you have not continued to use or do not use the options at all (i.e. technical problems, financial issues, socio-economic or time issues, capacity?)	
16.	What would be needed for you to re-consider using these options?	

17.	What support would you need to implement one or more of the options (e.g. financial support, education, training, technology transfer)?	

Table 3 Improvements to the calculator and support needed

18.	Which questions are difficult to respond to (1), or understand (2), or provide data from records (3) or provide an estimate for (4).	
19.	Can you suggest any (technical or other) changes to the Carbon Calculator as we have presented and you have used it that would make the Carbon Calculator a more attractive and more useful tool?	

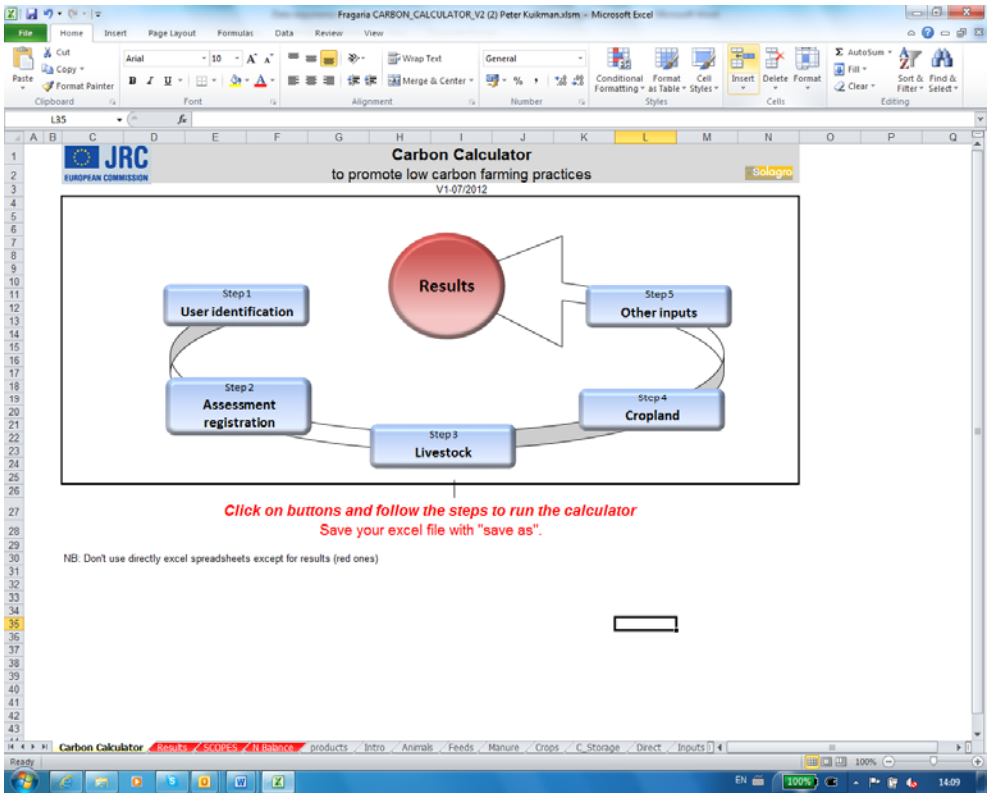
Annex 3 Overview of mitigation option offered by the Carbon Calculator

Calculation available in current CC?	rank	Code	Actions
yes	#N/A	A1	Adjust N fertiliser balance
yes	#N/A	A2	Soils covered all the year
yes	#N/A	A3	Introduction of legumes in the rotation
yes	#N/A	A4	Introduction of legumes in grasslands
yes	#N/A	A5	No-tillage
yes	#N/A	A6	Agroforestry
no	#N/A	A7	Grass in orchards and vineyards
no	#N/A	A8	Avoid burning residues
yes	#N/A	B1	Reduce methane from enteric fermentation
yes	#N/A	B2	Change in slurry management system: cover/crust
no	#N/A	B3	Coverage of solid manure pile
no	#N/A	B4	Biogas production
no	#N/A	B5	Optimisation of grazing
no	#N/A	B6	Improve livestock productivity
no	#N/A	B7	Optimisation of the stocking rate (animal number per ha)
no	#N/A	B8	Composting solid manure
no	#N/A		Forage drying
yes	#N/A	C1	Reduction of electricity consumption of the milking system
no	#N/A	C2	Optimisation of ventilation during grain storage
no	#N/A	C3	Improving heated buildings insulation (pigs, poultry)
no	#N/A	C4	Implementation of thermal screens in greenhouses
yes	#N/A	C5	Reduce engines fuel consumption (test and eco driving)
no	#N/A	C6	Solar panel on suitable buildings
no	#N/A	C7	Heat water with solar panel
no	#N/A	C8	Wood boiler
no	#N/A	D1	Implementation of hedges and other landscape elements
no	#N/A		Purchase of organic fertiliser to replace chemical fertiliser

Annex 4 Full list of data needed for the Carbon Calculator

The Carbon Calculator can be used by farmers to assess the greenhouse gas emissions and carbon sequestration for their farming business. The Carbon Calculator is a spreadsheet based system; the data input is organized in 5 steps with each up to 6 sheets to be completed. In many cases and depending on the specialization of a farm, only some of the sheets are relevant to a specialized farming business, e.g. arable farming or dairy farm, and the remainder of the sheets and information/data can be ignored.

The 5 steps are; user identification, assessment registration, livestock, cropland and other inputs.



The calculator first asks to identify a maximum of five (5) main products that a farmer sells to market, e.g. milk, animals (for meat), eggs, or seeds (from crops) or whole crops. The crop that is used for silage or feed is NOT a product but used on-farms. Please note: this refers only to products sold from the farm and does not relate to subsistence production (e.g. eggs or vegetables) for own use. In the (rare) event of more than 5 products, products 6 and more can be reported in a category "other".

The Livestock module takes all information on animal production including the animal intake (from grazing or from feed or feedstuffs and the manure management). The cropland module takes all information on growing crops, feed crops and pasture or grassland including the soil management (tillage, residue management) and fertilization (mineral fertilizer, organic fertilizer and chalk as well as fertilizers and pesticides). As a consequence, livestock farmers who grow crops (including fodder) or use residues for feed need to complete the relevant parts of the crop module as well.

To assess the emissions, data need to be supplied to the Carbon Calculator. The EU Commission would like to see that data are retrieved from farm records. To do so and to assess whether data are indeed available from on-farm data record keeping, we ask you to indicate for any number that you could not retrieve from written records but where you provide an estimate to flag this and add tick the box 'Estimate?' in the right most column of the tables.

1. User Identification (step 1)

Name and organisation of assessor (Add name of the researcher conducting interviews)
Name and location of the farm, Email address, Phone Number:
Date:
Year of reference (year that the data are supplied for):

2. Assessment Registration (step 2) – data to identify the farm and its location

Table 1

For each question below, circle the appropriate answer or provide a suggestions to open questions from farm records or records kept otherwise or indicate NA (not available).

Question	Answer: provide information or circle from list mark	Estimate?
Country of the farm assessed:		
Climate zone: a map will be provided and the user will have to choose one climatic zone in the following list:	Warm Temperate Moist, Warm Temperate Dry, Cool Temperate Moist, Cool Temperate Dry, Boreal Moist, Boreal Dry, Polar Moist, Polar Dry.	
Dominant soil: the user can consult a map (Google Earth File) to identify the needed type of soil (only one type of soil for the whole farm) or identify from the following list:	Acrisol, Albeluvisol, Andosol, Anthrosol, Arenosol, Calcisol, Cambisol, Chernozem, Cryosol, Fluvisol, Gleysol, Gypsisol, Histosol, Kastanozem, Leptosol, Luvisol, Phaeozem, Planosol, Podzol, Regosol, Solonchak, Solonetz, Umbrisol, Vertisol	
For organic soils (Histosol): has it been drained?	Yes / No	
Texture of the soil (select from listing that includes from sand to loam to clay and intermediates:		
Altitude (m):		
Rain fall		
Annual rain fall (mm):		
Rain fall (mm) during winter:		
Rain fall (mm) during summer:		
Temperature		
Average temperature (in C):		
Soil pH (average for whole farm):	> 7 or < 7	
Agricultural area (of the farm or enterprise) (and including land not owned but rented for farming):		
AWU (agricultural working unit = 1 AWU equals 1 full time job for 1 year):		
(Agricultural) **Practices** (from a list): organic, integrated, conservation, conventional, other		
Nitrate Vulnerable zones (from list): total area, part of area (in %) or none		
Area designated as Natura 2000 (in %)		

Table 2: Farm products

Select 5 products from the list provided that includes all possible farm/agricultural products in EU and give 1 – 5 in the order of most important to least important of 5 products:

Possible types of products	**Give numbers 1 – 5 in the order of importance (1 is the most important)**
Cow milk *	
Sheep milk	
Goat milk	
Beef	
Pork meat	
Poultry meat	
Sheep meat	
Eggs	
Cereals (including oleaginous and proteinous) **	
Industrial crops (potatoes, tobacco, flax fibre, miscanthus…)	
Wine	
Fruits	
Vegetables	
Fodder (hay, silage…)	
Other	

** Meat from dairy cows and goats or sheep that produce milk are considered as an obligatory product of the farm if the user selects cow, sheep or goat milk.*

*** It's possible to analyse all cereals together as one batch or to separate each of the cereals by selection from a list: barley, black wheat, corn for grain, grain sorghum, hard wheat, lupine, millet, oat, peas, rape, rice, rye, soft wheat, soya, sunflower, triticale, spring field bean and winter field bean*

For each product, a functional unit will be used (ton of milk, ton of meat live weight, ton of dry matter (e.g. cereals and silage) or ton of fresh matter (eggs, vegetables, fruits, wine and industrial crops e.g potatoes, tobacco).

3. Data required for livestock module

RUMINANTS

Table 3: Ruminants raised on the farm

For each category / subspecies of ruminants, please provide the information as to what category of animals is kept on your farm by ticking the box with the relevant animal category; for each category then complete the information in table 4 with details on that animal category.

Animal Category	Number	Kept on the farm (tick √ if yes)
Dairy cattle:		
cows less than 5000kg per year milk	1	
cows 5000-7000	2	
cows 7000-9000	3	
cows with, over 9000 kg milk per year	4	
<1 year old heifers	5	
1-2 year old heifers	6	
heifers over 2 years old	7	
0-1 year old bullocks	8	
Sheep for milk:		
ewes (to be developed)	9	
strain female lambs	10	
rams	11	
fattening lambs	12	
Sheep for meat:		
Ewes	13	
strain female lambs	14	
rams	15	
fattening lambs	16	
Goats for milk:		
strain female young goat	17	
male goat	18	
fattening young goats	19	
Goats for meat:		
Goats	20	
strain female young goat	21	
male goat	22	
fattening young goats	23	
Beef cattle:		
Suckling cows	24	
cull cows	25	
calves sold young (e.g. for breeding or fattening)	26	
0-1 year old heifers	27	
1-2 years old heifers	28	
heifers over 2 years old	29	
0-1 year old bullocks	30	
1-2 years old bulls	31	
bulls over 2 years old.	32	
Horses:		
Draught horses	33	
saddle horses	34	

Table 4: Description of ruminants raised on farm

For each category of animals, please provide the following information. Please copy (duplicate the table) if you need more space.

	Category of ruminants (add the number from the table above in each column and answer the questions for each category)									**Estimate? (tick √ if yes)**
Nr of animals on 1 Jan and their avg live weight										
Nr of animals on 31 Dec and their avg live weight										
Avg number of days on the farm in reference year										
% of time in the year spent outside grazing										
Number of sold animals and avg live weight at time of sale										
Number of purchased animals and avg live weight at time of purchase										
Annual cost of purchased animals (in euros)										
Annual milk production in kg, average fat content and protein content										
Annual milk powder purchased for calves (in kg)										

Table 5: Forage intake[7]

	Please indicate type of forage used to feed the categories of animals. Please specify the type of animals that feed on the forage (in percentages of use)	**Dairy cattle**	**Beef cattle**	**Sheep dairy**	**Sheep meat**	**Goats milk**	**Goats meat**	**Horses**	**Estimate? (tick √ if yes)**
Type of forage and amount in tonnes dry matter produced and consumed on farm Pls allocate this among different categories of animals (in %)									
Amount consumed through grazing (in tones dry matter Pls allocate this among different categories of animals (in %)									
Type of forage and amount in tonnes dry matter purchased and consumed on the farm Pls allocate this among different categories of animals (in %)									
Price for purchased forage Pls allocate this among different categories of animals (in %)									

[7] **Grass-based:** Fresh grazing, Grass silage, Hay (from natural or temporary grass), Hay (from lucerne), Hay (barn dried), **Crops-based:** Maize silage, Beet feed, Green rape, Sorghum feed, Fodder kale, **By-products**: Dehydrated beet pulp, Squeezed beet pulp, Sugar beet molasses, Squeezed brewing dregs and waste, Dehydrated Lucerne, Fresh beet pulp, NH3 treated straw, Non-treated straw

Table 6: Feedstuffs[8]

	Indicate type of feedstuff from list in footnote to this table; if more than one category is used please specify for which categories of animals it is used (in percentages).	**Dairy cattle**	**Beef cattle**	**Sheep dairy**	**Sheep meat**	**Goats milk**	**Goats meat**	**Horses**	**Estimate? (tick √ if yes)**
Simple feedstuffs produced and consumed on the farm in tones fresh or raw matter / year Pls allocate the types among different categories of animals (in %)									
Simple feedstuffs bought and consumed on the farm in tones fresh or raw matter / year Pls allocate the types among different categories of animals (in %)									
Personal mix feedstuffs in tones of fresh or raw matter / year Pls allocate the types among different categories of animals (in %)									
Individual composed feedstuff mixtures in tonnes/year									

[8] **Feedstuff** intake. *Wheat, barley, corn for grain, triticale, oat, sorghum, soya, peas, rapeseed, sunflower, soya bean cake, rapeseed cake, sunflower cake, flax cake, mill feeds, corn gluten feed, dry beet flesh, hard wheat*).

Pls allocate the types among different categories of animals (in %)									
Total annual cost of feedstuffs									

Table 7: Manure management

	Type of manure management system	**Estimate? (tick √ if yes)**
Please indicate the type of manure management system – and if it varies between types of animals, please indicate Animal categories are: dairy cattle, beef cattle, sheep dairy, sheep meat, goats milk, horses		
Identify the amount of dry matter that is managed in each of the systems on farm.		

MONOGASTRIC ANIMALS

For each categories / subspecies of monogastric animals, please provide the information as to what category of animals is kept on your farm by ticking the box with the relevant animal category; for each category then complete the information in table 9 with details on that animal category.

Table 8: Animal categories for monogastric animals

Animal Type	Number	Kept on the farm (tick √ if yes)
Pigs subspecies:		
Standard sows	1	
outdoor sows	2	
standard boars	3	
outdoor boars	4	
standard gilts	5	
outdoor gilts	6	
PW standard piglets	7	
outdoor PW piglets	8	
Standard pigs after Post-weaning)	9	
outdoor pigs	10	
Poultry and rabbits subspecies:		
Laying hens (places)	11	
chickens reared	12	
fattening chickens	13	
quality label-free-range chickens	14	
quality-label-free-range Guinea fowl	15	
Capon, farm-breeding turkeys	16	
fattening turkeys	17	
roasting ducks	18	
ready to cram outdoor ducks	19	
crammed ducks	20	
roasting geese	21	
ready to cram geese	22	
crammed geese	23	
female rabbit	24	
young rabbit	25	

Table 9: Description of monogastric animals on farm

	Category of monogastric animals (indicate number available in the list above and answer the questions for each category)									Estimate? (tick √ if yes)
Number of total animals produced on the year										
Number of rotations per year										
Number of days of rearing per rotation										
Average number of animals per rotation										
% of time for animal outside the buildings										
Average live weight in kg per animal										
For laying hens, number of kg of eggs produced at farm scale										
Number of animals purchased and average weight in kg										
Number of animals sold per year										
For pigs, indicate the food conversion ratio (FCR)										

Table 10: Forage intake[9]

		Pigs	Laying hens (meat and eggs)	Poultries (meat)	Estimate? (tick √ if yes)
Type of forage and amount in tonnes dry matter produced and consumed on farm Pls allocate this among different categories of animals (in %)					
Amount consumed through grazing (in tones dry matter) Pls allocate this among different categories of animals (in %)					
Type of forage and amount in tonnes dry matter purchased and consumed on the farm Pls allocate this among different categories of animals (in %)					
Price for purchased forage Pls allocate this among different categories of animals (in %)					

[9] **Grass-based:** Fresh grazing, Grass silage, Hay (from natural or temporary grass), Hay (from lucerne), Hay (barn dried), **Crops-based:** Maize silage, Beet feed, Green rape, Sorghum feed, Fodder kale, **By-products**: Dehydrated beet pulp, Squeezed beet pulp, Sugar beet molasses, Squeezed brewing dregs and waste, Dehydrated Lucerne, Fresh beet pulp, NH3 treated straw, Non-treated straw

Table 11: Feedstuffs[10]

		Pigs	Laying hens (meat and eggs)	Poultries (meat)	Estimate? (tick √ if yes)
Simple feedstuffs produced and consumed on the farm in tones fresh or raw matter / year Pls allocate the types among different categories of animals (in %)					
Personal mix feedstuffs in tones of fresh or raw matter / year Pls allocate the types among different categories of animals (in %)					
Total annual cost of feedstuffs					

[10] **Feedstuff** intake. *Wheat, barley, corn for grain, triticale, oat, sorghum, soya, peas, rapeseed, sunflower, soya bean cake, rapeseed cake, sunflower cake, flax cake, mill feeds, corn gluten feed, dry beet flesh, hard wheat*).

Table 12: Type of manure management system

		Pigs	Laying hens (meat and eggs)	Poultries (meat)	Estimate? (tick √ if yes)
Type of manure management system – if it varies between types of animals, please indicate					
identify the amount of dry matter that is managed in each of the systems on farm.					

4. Data required for cropland module

Table 13: Cropland data (including grassland!!!)

		Crops (write in the type of crops grown on farm, including grass, other forage)								Estimate?
	Total for farm									
Description of crops on farm										
Area per crop:										
Yield per ha per crop:										
Total yield on the farm										
Use of crops for the 5 main farm products: Indicate for which of five products and if used for more than one product, indicate what percentage for each										
Type of mineral fertilizer applied (from a list provided) in kg per ha										
Ammonium nitrate (N 33,5%)										
Ammonium phosphate (N 18%, P 46%)										
Ammonium sulphate (N 21%, SO3 23%)										
Calcium ammonium nitrate (N 26,5%)										
Dolomite (CaO 30%, MgO 20%)										
Lime (CaO 52%)										
Nitrogen solution (N 30%)										
NPK compound (N 15%, P 15%, K 15%)										

		Crops (write in the type of crops grown on farm, including grass, other forage)								Estimate?
	Total for farm									
Potassium chloride (K 60%)										
Urea (N 46%)										
If other fertilizers are applied detail on N, P fertilizer and in kg per ha:										
Nitrogen fertilisers (kg of nitrogen/ha)										
Phosphate fertilizer (kg of phosphorus/ha)										
Potassium fertilisers (kg of potassium/ha)										
Organic manure: Yes, No										
Type of organic manure: liquid or solid?										
Crop cultivated on organic soil: Yes, No										
Pesticides, herbicides and fungicides: number of treatments per year										
Cropland management:										
Management of crop residues (select from list): burnt / removed/ incorporated										
Quantity of burnt residues (tonnes per ha):										
Tillage operations (select from list): no tillage / reduced tillage / full tillage										
Percentage legumes in this crop:										

		Crops (write in the type of crops grown on farm, including grass, other forage)								Estimate?
	Total for farm									
Purchased seeds (in kg per hectare):										
Land covered during winter: Yes, No										
Residues from cover crop are incorporated: Yes, No?										
Land is pastured by animals: Yes, No										
The soils are drained: Yes, No										
Fuel consumption for operations (in litres per hectare):										
For Agroforestry, vineyard and orchard										
If the crop is vineyard or orchard how much is the surface of grass under these crops (in ha):										
If agroforestry what is number of trees/stumps per ha:										
Grassland management										
Is the grassland overgrazed: Yes, No										
Major long-term loss of productivity: Yes, No										
Productive grass varieties or legumes were seeded in recent years: Yes, No										
Irrigation										
Irrigated surface (in ha):										
Volume of water for irrigation in m^3:										
Type of energy used for irrigation: electricity, fuel, gravity?										

		Crops (write in the type of crops grown on farm, including grass, other forage)								Estimate?
	Total for farm									
Operations Indicate number of operations per year for:										
Soil tillage:										
Seeding & planting:										
Manure spreading:										
Pesticide, fungicide or other control treatments:										
Mineral fertilizer application:										
Forage and hay harvest:										
Crop harvest:										
Residue and hay harvest:										

5. Other inputs to the Carbon Calculator:

Energy and renewable energy

Table 14: Fuel (Gasoline & Diesel) consumption in litres per year

		Attribution to 5 main products (in percentage)					Estimate? (tick √ if yes)
	Total use on farm (litres / year)						
Tractors and machinery:							
Heating:							
Pumping:							
Other uses on farm:							
Cars and trucks:							
Fuel for animal buildings							
Consumption on farm by third parties (eg rental of equipment)							
Consumption for third parties (renting out equipment, eg)							
Annual cost for Fuel & Diesel (in Euro):							

Petrol, Propane/Butane Gas, natural Gas & Coal

Table 15: Annual consumption of petrol, propane / butane gas, natural gas, coal in liters, kg, or m^3

			Attribution to 5 main products (in percentage)					Estimate? (tick √ if yes)
	Total consumption in litres, kg, or m3 / year	Annual cost in Euro						
Petrol								
Propane / butane gas								
Natural gas								
Coal								

Electricity

Table 16: Consumption of electricity on the farm

		Attribution to 5 main products (in percentage)				Estimate? (tick √ if yes)
	Total on farm					
Annual consumption in kWh for all uses (except irrigation):						
Annual consumption in kWh for irrigation (individual pumping systems):						
Annual cost of Electricity Purchased:						

Water use

Table 17: Water use on the farm

		Attribution to 5 main products (in percentage)				Estimate? (tick √ if yes)
	Total on farm					
Annual consumption in (m3):						
Annual cost of water Purchased:						
Irrigation water from a collective pumping system – annual coast in Euros (no need to allocate to five products)						

Renewable energy

Table 18: Consumed quantity of renewable energy

	Quantity consumed (purchased or produced on farm)	**Sold**	**Energy substitutes for[11]**	**Estimate? (tick √ if yes)**
Firewood (tonnes):				
Wood chips (tonnes):				
Solar energy (m^2):				
Photovoltaic energy (kWh):				

[11] Electricity, fuel (heating), diessel, petrol/gasoline (regular), propane gas (bottle, tank), natural gas, coal

	Quantity consumed (purchased or produced on farm)	Sold	Energy substitutes for[11]	Estimate? (tick √ if yes)
Wind energy (kWh):				
Biofuels (Litres):				
Electricity from biogas (kWh):				
Heat from biogas (kWh):				
Biogas (m^3 gas):				

Organic matter (input/output at farm level)

Table 19: type of organic matter exchanged

Organic matter type	IMPORT to FARM(in relevant units e.g. tonnes, m^3 of litres)	EXPORT to other FARM (sold etc, in relevant units e.g. tonnes, m^3 of litres)	Estimate? (tick √ if yes)
Bedding straw			
Cattle manure (solid)			
Horse manure (solid)			
Sheep manure			
Pig manure (solid)			
Poultry manure (solid)			
Duck manure (solid)			
Poultry dropping (dry)			
Poultry liquid manure			
Pig liquid manure			
Cattle liquid manure			
Mixt liquid manure			
Sewage sludge			
Compost (N%)			
Vinasse of beet (Dry matter 55%)			
Scum brewery			
Digestate from biogas plant			
Other			

Natural infrastructure and Land Use Change (to calculate Carbon content and CO2 emissions and sequestration)

Table 20: Natural infrastructures at the farm

Infrastructure	Width x length	Quality[12]	Estimate? (tick √ if yes)
Vineyards/orchards (width x length and quality):			
Trees and hedges (width x length and quality):			
Shrubby natural elements (width x length and quality):			
Low natural elements(width x length and quality):			
Forest area (ha)			

Table 21: Land Use Changes in the last 20 years at the farm (in ha)

Land use CHANGE	ha	Estimate? (tick √ if yes)
Conversion of forest to cropland (ha):		
Conversion of forest to grassland (ha):		
Conversion of grassland to cropland (ha):		
Conversion of cropland to grassland (ha):		
Conversion of cropland to forest (ha):		
Conversion of grassland to forest (ha):		

Secondary inputs

Table 22: Quantities (in kg or litres) of the following supplies of plastics and oils on the farm used in production

		Attribution to 5 main products (in percentage)					Estimate? (tick √ if yes)
Type of input	Amount						
Quantity of big bag fertilizer PP in kg:							
Quantity of big bag fertilizer PET in kg:							
Plastic for mulch in kg:							

[12] Favourable, average, unfavourable

Silage plastic furrow in kg:							
Hay plastic furrow in kg:							
Strings for hay and straw in kg:							
Cardboard packagings:							
Pesticides packagings:							
Lye can:							
Plastic hose, PVC in kg:							
Plastic bags:							
Paper bags:							
Glass:							
Lubricants, hydraulic in litres:							
Oils for pesticides in litres:							

Buildings

Table 23: Farm buildings

Buildings	Age (in years)	(Ground) Surface area (in m^2)	Use for the following of 5 main products (please name product and percentage)	Estimate? (tick √ if yes)
Dairy cow/straw litter (mainly timber)				
Dairy cow/cubicles, slurry (mainly steel)				
Meat cow / straw litter (timber mainly)				
Meat cow / straw litter (steel mainly)				
Poultry house, natural ventilation				
Pighouse with Concentrate feeder with concrete walls				
Shed storage (indicate if steel, concrete, timber. Concrete floor or bare soil)				
Concrete silo				
Covered manure storage, with a pit				

Milking parlour, plus dairy				
Cold room (truck container)				
Please describe shortly what kind of materials are used in these buildings (i.e. mostly concrete, or timber, or steel)				

Materials used on the farm

Table 24: All materials used on the farm including buildings)

Material	**Age**	**Quantity (m^2 or kg or m^3)**	**Attribution to 5 main products (in percentage)**					**Estimate? (tick √ if yes)**
concrete area								
cement								
steel								
agricultural plastics								
aluminum								
Alloy								
Stainless steel								
glass								

Machinery

Table 25: Machinery used on the farm

Type of machinery	Please describe basic characteristics of the equipment	Age (years)	annual use in hours	Percent of total use of machine [13]	Use for the following of 5 main products (please name product(s) and percentage)	Estimate? (tick √ if yes)
Tractors (indicate horsepower (hp) and 2- of 4-wheel drive)						
Soil tillage						
Sowing/planting						
Fertilising/spreading						
Equipment for harvesting						
Equipment for hay/straw						
Livestock husbandry materials including silos, unloading equipment etc.						

[13] The use of machinery on the farm (of the total use, which can also include rental or services to other farms)

Type of machinery	Please describe basic characteristics of the equipment	Age (years)	annual use in hours	Percent of total use of machine [13]	Use for the following of 5 main products (please name product(s) and percentage)	Estimate? (tick √ if yes)
Handling and transporting equipment						
Other equipment						

Annex 5 Evaluation of Carbon calculations with farm data per case region

Germany

In Germany, two farm data sets were collected to test the CC.

Evaluation of these results is as follows: in one file there is a separate sheet only on proposed "actions", while the other file doesn't have one and just provides an overview under "results" on mitigation options. In one case the options are being proposed which the farmer has already implemented.

For both tested farm CC there is no overall result on GHG emissions for the most of the "main products ". The calculator doesn't take into account the carbon sequestration through landscape elements at one of the farms, while the area is quite significant.

Poland

In Poland farm data were collected for two of the 10 farms. In the following, an evaluation is given of the testing of the CC with these farm specific data.

FARM 1: Relatively large mixed farm, with different types of animals and crops.
The interview was conducted as early as mid-October, when only version 2_2 of the Carbon calculator was available. This version still had considerable problems. Therefore, no clear emission figures resulted from the testing with specific farm data. As it is difficult to judge which fields in the Carbon Calculator are compulsory and which are optional, the farmer could not prioritize data requirements and did not have time to provide sufficient detail.
It probably did not produce results because the data provided was to a large extent based on estimates and was partly incomplete.
No clear mitigation results were produced. However, some of the data provided was used by the calculator to indicate that no-tillage and agroforestry would be simple actions that would allow to save a considerable amount of tCO2e. It was difficult to interpret the results and therefore impossible to judge if these results were the only ones recommended or if others results would be more appropriate.
One can question however whether these mitigation recommendations were useful. There is no forest on the farm to carry out agro-forestry and afforestation is not an option for the farmer, as his cropland is already quite small and afforestation would require considerable investment. The farmer recently bought a new soil tillage machine, therefore it is unlikely that he will invest in specialized seeding equipment that is needed for no-tillage.
Since the calculator did not produce farm testing results, only few mitigation measures, which are based on these results, were indicated.

FARM 2: relatively small mixed farm (27ha) and mainly grows sugar beet and has a small meat cattle herd.
Interviews were conducted as early as mid-October, when only version 2_2 of the Carbon calculator was available. This version still had considerable problems. Therefore, no clear emission figures resulted from the testing with specific farm data.
The carbon calculator did not produce clear results, because this was an early version of the calculator and because data was to a large extent based on estimates and was partly incomplete. As it is difficult to judge which fields in the Carbon Calculator are compulsory and which are optional, the farmer could not prioritize data requirements and did not have time to provide sufficient detail.
No clear mitigation results were produced either. However, some of the data provided was used by the calculator to indicate that no-tillage and agroforestry would be simple actions that would allow to save a considerable amount of tCO2e. It was difficult to interpret the results and therefore impossible to judge if these results were the only ones recommended or if others results would be more appropriate.

This farmer is a subsistence farmer, close to retirement. He was not eager to change his agricultural practices, nor did he have the necessary funds to invest in agro-forestry or no-tillage techniques, although he recognized that no tillage would be a sound technique to reduce the level of tCO2e. He did not think that agro-forestry was applicable to his farm, which is only 27ha.

Since the calculator did not produce farm testing results, only few mitigation measures, which are based on these results, were indicated.

Slovenia

In Slovenia farm data was derived for one farm. This concerned a cattle-goat system. Underneath the evaluation of the CC calculation for this farm.

In the first phase, it didn't produce emission figures. Solagro helped with a couple of bugs, and once the N input (synthetic) was changed from 0 to a non-zero unit (a minimum value of 1kg was used) the emission results were calculated.

The calculation of emissions seems correct in terms of apportioning the sources of GHG to the right categories. This is an organic farm with cattle and goats, the enteric fermentation category is the highest source of emissions, followed by manure management and machinery. This makes sense. In overall, there are doubts about the correctness of the GHG emission assessments. The minimum and maximum values are not implemented and therefore there is no reference available (yet) to compare it against, but from other assessments the emissions come out unrealistically high or low for many activities.

The GHG profile at farm scale in terms of GHG gases shows that N_2O emissions are not produced on the farm, which doesn't seem to be right since they there is arable land.

The CC results also show 0 for CO_2 emissions. This is incorrect since there is use of machinery and electricity on the farm. The CO_2 sequestration is high but not surprising since at this farm there were several hectares of land converted from arable to forest in the last few decades.

Mitigation results were also produced for this farm. Five practices were suggested. These were:

No-tillage
Agroforestry
Adjust N fertiliser balance
Introduction of legumes in the rotation
Introduction of legumes in grasslands

These seem not quite in line with the main sources of GHG, and while useful as general good soil management practices, they don't address the main sources. Also, the farm already includes legumes in grasslands and rotation so these don't quite make sense. This farm already has a large forest cover and some areas that are being overgrown from grassland to forest/bushes. It therefore seems more logical that the CC advices one or more of the following mitigation measures:

Reduce methane from enteric fermentation
Change in slurry management system: cover/crust
Coverage of solid manure pile
Biogas production
Optimisation of grazing
Improve livestock productivity
Optimisation of the stocking rate (animal number per ha)
Composting solid manure

The calculator doesn't take into account forest management which is understandable. However, for countries such as Slovenia where farms manage quite significant forest areas, their contribution in terms of forest management, which has a large potential for carbon sequestration and is an important source of renewable energy is left out. This is not logical for the perspective of the climate mitigation and overall resource efficiency targets of the EU.

England

Farm	Enterprise mix	Emission values estimated?	Number of mitigation options generated	Reason for zero lack of mitigation options
A	Mixed cropping	Yes	3	
B	Dairy	Yes	0	Despite resolving issues with digestibility of forages and yields per hectare of crops grown, calculator still does not produce mitigation options.

C	Mixed livestock & arable	Yes	0	Despite resolving issues with digestibility of forages and yields per hectare of crops grown, calculator still does not produce mitigation options.
D	Beef and pigs	Yes	0	Despite resolving issues with digestibility of forages and yields per hectare of crops grown, calculator still does not produce mitigation options.
E	Dairy and beef	Yes	0	Despite resolving issues with digestibility of forages and yields per hectare of crops grown, calculator still does not produce mitigation options.
F	Beef and sheep	Yes	3	
G	Mixed arable	Yes	5	
H	Dairy and arable	Yes	5	
I	Mixed livestock and arable	Yes	3	
J	Dairy, beef, cereals	Yes	0	Despite resolving issues with digestibility of forages and yields per hectare of crops grown, calculator still does not produce mitigation options.
K	Mixed livestock & arable	Yes	6	
L	Mixed livestock	Yes	3	
M	Dairy and arable	Yes	4	
N	Mixed livestock & arable	Yes	5	
O	Dairy	Yes	4	
P	Dairy and arable	Yes	5	
Q	Dairy	Yes	4	
R	Dairy	Yes	4	
S	Dairy	Yes	4	

Spain

Using the last version of the CC, 5 excel files were produced corresponding to the CC run of the 5 farmers whose data were the most complete.

CyL-2. Cereal farm with fallow. Emission figures and mitigation results were not produced, because the CC does not have an option to enter fallow land in the 'assessment registration' screen. If one however writes *Fallow land* (or variations) and selects *One year fallow* in the 'Cropland' screen then an error message #13 appears when one tries to edit.

CyL-3. Cereal farm without fallow. The CC works and produces emission figures which are apparently correct. Mitigation results are also produced. Calculated mitigation actions were:

- Adjust N fertiliser balance
- Soils covered all the year
- Introduction of legumes in the rotation
- Agroforestry
- Reduce engines fuel consumption (test and eco driving)

CyL-7. Mixed farm, with pigs, barley, soft wheat, rye and sugar beet. The CC works and delivers emission figures and mitigation options correctly. Calculated mitigation actions were:

- Adjust N fertiliser balance
- No-tillage
- Agroforestry
- Reduce engines fuel consumption (test and eco driving)

AND-3. Olive farm. Emission figures and mitigation results were not produced, because the CC does not have an option to enter *olives* in the 'assessment registration' screen. If however one writes *olives* (or variations) and selects *olive tree (black olive)* in the 'Cropland' screen, then an error message #13 appears when one tries to edit.

AND-7. Dairy farm. The CC works and produces emission figures which are apparently correct. Mitigation results are also produced. Calculated mitigation actions were:

- No-tillage
- Agroforestry
- Reduction of electricity consumption of the milking system
- Reduce engines fuel consumption (test and eco driving)

Netherlands

In the Netherlands two workshops were successfully organised for dairy farmers to complete and provide the data for the CC (version 2-6/2013). Both workshops were held in the region *Achterhoek* on sandy soils with relatively small but very intensive dairy farming businesses ranging from 60 – 200 LU. For the two workshops 6 and 4 farmers were invited and 4/6 and 2/4 showed up.
A first series of 2 workshops with dairy farmer networks did not work as we did not have a working version of the Carbon Calculator that would be easy to complete without fatal errors to occur and would provide feedback on mitigation options to the farmers. This was anticipated as crucial for Dutch farmers to be willing to join in such a presentation and provide the required data. Farmers also asked for farm advisors to be present during the meeting and their expenses needed to be covered.

In addition to the workshops, two individual farmers on sheep and intensive pig production representative for these areas, respectively, provided data for the CC (version 2-2/2012). The data were provided on paper documents and 1 set was used to fill out the CC during the demonstration at the workshop and CC from the other data were completed in a later stage. The Farmers in the Netherlands were willing to provide data that the CC requires and provided these with the promise from Alterra to get the feedback for their specific farms upon completion of a working version of the CC. A total of 6 completed CC's are available from the Netherlands (1 for sheep, 1 for pigs, 4 for dairy farming).

As to the data needed by the calculator, all data requirement sheets and the 2 completed CC's were each done in appr. 3 hours. Many of the data asked for, farmers

would be able to supply from their memories; most of the farmers did bring an archive with data and were able to extract the required data within 3-4 hours.

The results of the completed CC from individual farmers did not show a complete GHG profile for their farm businesses and many errors (div/0) were still shown in the results section. As a result the farmers found the feedback very difficult to interpret. In terms of mitigation options, several were returned and the most prominent options are Agroforestry, reduction electricity and fuel use all with numbers and reduce enteric fermentation without a number but unexpected for pigs. The results for the dairy farmers were not very different and few more options were returned with a number attached e.g. on reduce fertilizer and tillage. The feedback provided at this stage by version 2-6 of March 2013 was not evaluated by the farmers as very helpful. However, they recognized the options listed are indeed very interested in the feedback should this be made possible. In fact, this was a pre-requisite of the farmers to join in the workshop and complete the data requirements sheets.

Denmark

No CC data collected as no farmer was found willing to provide data

Sweden

No CC data collected as no farmer was found willing to provide data