EU wide Farm-level Carbon Calculator

Report on the data availability at farm level for farms across EU-27

FRAGARIA consortium

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Administrative summary

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EXECUTIVE SUMMARY

The European Parliament requested 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 greenhouse gas emissions from farming. In this effort, an EU Carbon Calculator tool was developed by Solagro in France for the Joint Research Centre (JRC) in Ispra (IT). The tool has been designed to calculate farm related emissions of greenhouse gases and suggest mitigation options to its user. The Fragaria consortium supported the JRC in this task with a study on "*EU wide data availability and testing of a low-carbon farming practices assessment tool".* This study tested the calculator and focussed on the data availability for the tool and identified improvements to the functioning of the tool and data supply.

This report describes the study on the data availability. A survey was conducted in seven different member states across EU that represent the climate and farming systems across EU27. In this phase of the project, farm advisors have been surveyed and interviewed with the aim to use the generally wide experience of the advisors from the many interactions with and visits to farms and farmers. The questions asked concerned the availability of data that are needed to complete a Carbon Calculator should this tool be implemented and used by the farmer community in Europe. Advisors were asked to assess whether data needed would be available from farm records or – in case not – if farmers would be able to estimate or data would not be available at all.

In general, advisors consider the Carbon Calculator tool as a complex tool that requires significant input by farmers of farm and other data on up to 80 entries to complete the tool. The majority of the data (>60%) that are required to complete the Carbon Calculator would be available from farm records. A significant fraction of the remaining data could be supplied by farmers in the form of an estimate bringing the total data available from farmers to approximately 90%. Advisors estimate that these estimates are accurate.

The analysis shows substantial differences on a per country basis across Europe. In general, farmers in the United Kingdom, Denmark and the Netherlands would have more data available from farm records than in Slovenia and Spain with Germany intermediate. Many farmers in Slovenia and Spain are confident in providing an estimate for data missing from farm records.

The data required to complete the Carbon Calculator on cropland and livestock are more available than data on energy use, organic matter and residue and manure management and soil carbon management and to some surprise on grassland management. Though less in records, data on feed and fertilizers can be readily supplied from estimates. In addition, the Carbon Calculator does require farmers to relate activities to the main products produced on farm and this is relatively difficult for farmers to achieve.

The extensive data requirements are expected to make the tool as relatively difficult to use and time consuming for individual farmers. Many farmers will have the computer skills but not all. Some may have to rely on advisory services to complete the tool. Farmers' interest in using and completing the tool would certainly improve should the tool be as much as possible user friendly and self-explanatory, include default values for data not readily available or instruction on how to estimate, and use of data already used and submitted to complete other forms or questionnaires, e.g. for CAP subsidies. Care should be taken to ensure that the results that a tool as the Carbon Calculator returns to farmers do apply to the specific conditions where the farmer is and that farmers recognize these results and suggested actions.

1 Introduction

1.1 Background

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 requested 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 Institute for Environment and Sustainability 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. On the one hand, Solagro (France) is developing the carbon calculator. On the other hand, our consortium will be testing the feasibility of the carbon calculator (at farm level) and assessing the possible policy options for promoting low carbon farming practices.

The consortium is composed of representatives/experts from: the University of Reading (United Kingdom); the University of Copenhagen (Denmark); the Autonomous University of Madrid (Spain); Ecologic Institute (Germany) and Alterra-WUR (Netherlands).

Before testing the carbon calculator on farms, a survey of Farm Advisers based on a questionnaire has been carried out in order to evaluate the availability of data required to operate the calculator at farms across the EU. The questionnaire in Appendix 1 forms part of this survey. This report presents the results of this survey.

1.2 Short description of the carbon calculator

The aim of the carbon calculator (CC) is to calculate GHG emissions arising from farm practices and to provide a way of testing the GHG impact of different mitigation actions that can be carried out at farm level. 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 1.1).

The data required for the CC are described in detail in a document entitled "Data needs to run the Carbon Calculator" published by Solagro (version 17th of April 2012). It is assumed that most of the data are usually available to farmers in various administrative documents (farm records such as the receipts for purchases made, the farm livestock register). Nevertheless some data might not be available and would require farmers to make estimates or for other proxies to be used (for example, estimates based on national statistics or estimates at national or regional level). Figure 1.1 illustrates the structure of the carbon calculator.

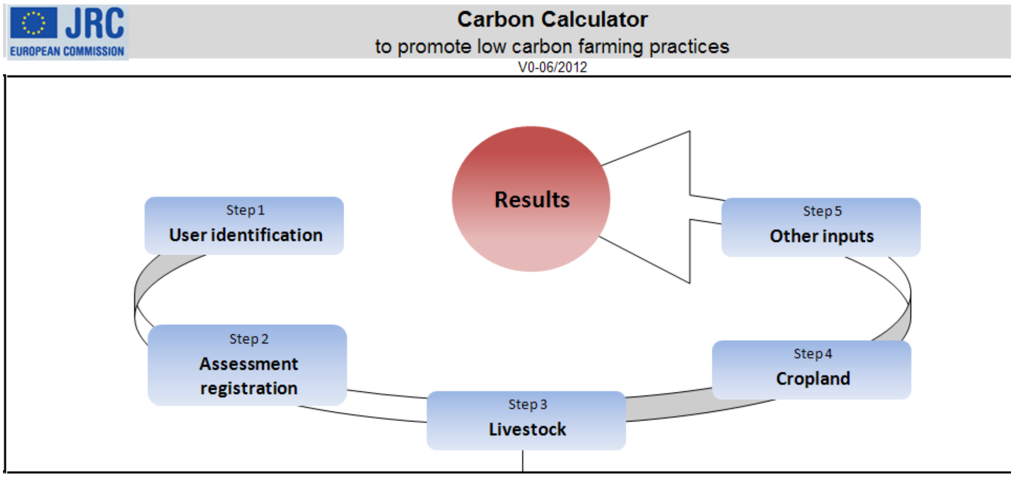


Figure 1.1 The structure (steps and modules) of the Carbon Calculator

1.3 The aim of the data survey

The aim of the data survey is to collect views of farm advisors on the likely availability of the data from farm records and needed to run the carbon calculator. In this part of the testing farm advisors were chosen over individual farmers to be surveyed as advisors would overview a wider range of farm types and intensities in their region. Also, Solagro expected that given the complexity of the Carbon Calculator farmers would use the Carbon Calculator most likely with a farm advisor present. In the second phase of the actual testing of the Carbon Calculator, individual famers would be invited for testing.

Based on this survey it was evaluated whether the data required by the calculator is easily available from records or by estimation at farm level, taking into consideration different bio-geographic situations and farming types and farm and associated differences in management activities. The primary purpose of this evaluation is to highlight situations where data availability is likely to be problematic because it would either be too time consuming or beyond administrative and technical capabilities of farmers etc.

2 Approach

2.1 Sampling strategy

As part of the data survey, we have successfully interviewed 22 farm advisors in five bio-geographical regions across the EU covering the most important farming types in these regions (see Table 2.1). The 22 advisors were located in Denmark (3), Sweden (3), United Kingdom (3), The Netherlands (3), Slovenia (2), Germany (2) and Spain (6).

Table 2.1 Bio-geographic regions across EU27 and farming types selected for the survey on data availability

Member State	Region	Bio-geo region (ENZ)	Farm type pattern
Sweden	Småland	Boreal (Nemoral)	Dairy
Denmark	Eastern Islands	Continental	Cereal & Mixed
United Kingdom	North West	Atlantic (North)	Sheep & Goat
United Kingdom	East England	Atlantic (Central)	Cereal & Mixed
Netherlands	Drenthe	Atlantic (North)	Dairy
Netherlands	Noord Brabant	Atlantic (Central)	Dairy
Germany	Brandenburg	Continental	Cereal & Mixed
Slovenia	Slovenia	Continental (Alpine)	Dairy
Spain	Castilla y Leon	Mediterrenean (North)	Cereal & Mixed
Spain	Andalucia	Mediterrenean (South)	Permanent crops

Data sources

The environmental zones used are the once developed by Metzger et al., 2005 detailing the official bio-geographic zones. In Table 2.1 the official regions are mentioned before the brackets and the detailed zones are mentioned in the bracket. For Slovenia the bio-geographical region differs from the official (Alpine instead of Continental). Map of the official zones can be found in Annex 1. The more detailed zoning has been used in the current suggestion on selection of case regions in the United Kingdom, the Netherlands and Spain.

Figure 2.1 Environmental zones as identified in SEAMLESS database mapped and in red areas and regions that have been used in this project.

In relation to representation of farm types we have used a typology of farm type pattern developed in the SEAMLESS project. See in Annex 2 for a map of clusters of farm type patterns and description of the most important farm types. The number of farm types per region in Annex 2 is limited by including only the most important in terms of agricultural area managed and representing main EU farm types. Detailed information on all farm types and farm types for which more than 15 samples are included in the Farm Accountancy Data Network (FADN) can be found in Andersen (2010)[1].

Impact on sampling

The availability of data to run the Carbon calculator has been tested by interviewing farm advisors. For each region, 3-5 advisors have been invited for an interview to include the most important farm types as listed in Annex 2. Typically, advisors covering either crop or different types of husbandry have been included. Advisors specialising on small as well as large farms have been included depending on the set up of the advisory system. All farm advisors have responded to our questions based on the full range of farm types they would provide advice to in their day-to-day business. For some questions advisors have specified whether their answers would apply to all farmers irrespective of the specific farm type (intensive versus extensive or farm business e.g. livestock ruminants or monogastrics or arable farming) where they felt major differences would exist.

2.2 Questionnaire (see Annex 5 for full text of the questionnaire)

This questionnaire was divided in the following broad sections, each section with a number of sub-sections:

Section 1 on general questions on socio-economic characteristics of the farms/farmers in the selected region (contextual information).

Section 2 on specific questions on the availability and likely reliability of the required data for the different modules of the carbon calculator.

Within this section 2, interviewees / advisors were asked for the **PERCENTAGE** of farmers in a given area/region that would be able to supply the data from farm records based on the experiences of that advisor in the area he is working in. It was sufficient to provide an approximate percentage of farmers that would, in the view of the advisor, be able to supply different types of information (e.g. 10%, 25%, 50%, 75% or 90%) and many have given more detailed estimates.

The term **FARM RECORDS** meant any information in written form (administrative documents, receipts, electronic data, and other paperwork). If >90% of the farmers would have access to information from farm records, it would not be needed to complete the questions on whether farmers can provide estimates for these same data and neither would they need to estimate how reliable these estimates would be. We have asked to reply on reliability on a scale of 1 – 5 (1 being unreliable and 5 reliable).

Section 3 with general questions on the feasibility of data access for the calculator and the willingness of farmers to use the calculator.

[1] See Andersen, E. (2010) **Regional typologies of farming systems contexts.** SEAMLESS report no. 53 at http://www.seamless-ip.org/Reports/Report_53_PD4.4.3.pdf

3 Results

3.1 Data availability on socio-economic and environmental characteristics

All or most (>95%) of the farmers will be able to supply data from farm records on the area used for agriculture on their farm and identify what farming practices are used from a list of examples e.g. organic, conventional, conservation or integrated farming (table 3.1).
The data on more specific questions on Annual Work Units (AWU) and on Nitrate Vulnerable Zone (NVZ) or Natura2000 areas are available from 76%, 88% and 87% respectively. The average is 89% and this figure is given as an indication only of the fraction of data required to characterize the farm that would be available in farm records. Some of these data may indeed be relevant to the calculation of the greenhouse gas emissions or mitigation options whereas other may not have any relevance. The data on AWU in particular is least available from farm records (76%) yet may not have any relevance to the calculation of greenhouse gas emission. This information on which data are used in the calculation or emissions of greenhouse gases or in the identification and calculations on mitigation options was not available at this stage of the testing of the Carbon Calculator.

When asked if farmers would be able to identify the 5 main farm products – in terms of either economic profit or based on volume, ton for e.g. meat and milk or cereals from a list provided – more than 95% of the farmers would be able to supply data from farm records according to the advisors interviewed.

Table 3.1 Data required to identify the farm characteristics for area, economy, environment and farming practices (given in % of the farmers, respondents n=22) and data to identify the 5 main products on farm on basis of economic profit or production volume.

Data required	**Data available from farm records (%)**
Utilised Agricultural Area (ha)	96
Number of Annual Work Units (AWU)	76
Nitrate Vulnerable Zone designation (whole farm, part of farm, or no designation)	88
Natura 2000 designations on their farm (whole farm, part of farm, or no designation)	87
Farming practices (organic, conventional, conservation or integrated farming)	96
Average	*89*
Economic profit (for up to 5 specific farm products)	>95
Production in terms of volume/ton (for up to 5 specific farm product)	>95
Average	*>95*

When asked for data on more specific (environmental) characteristics of the farm, a range of 28% to 89% with an average of 59% of the data would be available from farm records (table 3.2). Most of the data listed in table 3.2 would be available (as indicated in the Carbon Calculator) from free accessible data sources on the internet or via farm advisory services provided that location/postal code of the farmed land would be known.

Table 3.2 Data required to identify the farm characteristics for the environmental conditions, climate and soils (given in % of the farmers, respondents n=22) from a list with suggestions.

Data required	**Data available from farm records (%)**
Climate zone	30
Mineral dominant soil	28
Soil texture of the dominant soil of the farm	79
Dominant soil pH (>7 or <7)	53
Altitude (m)	89
Annual rainfall (mm)	72
Rainfall during winter (mm)	64
Rainfall during summer (mm)	64
Annual mean temperature (˚C)	61
Mean spring temperature (mean spring temperature in the 3 months after the first 400˚C days in ˚C)	50
Average	*59*

3.2 Data availability and reliability on farm activities and characteristics

On the total of more than 80 specific data entries provided in a listing from Solagro, required to complete the carbon calculator, advisors have responded that an average of 58% (average for all 80 questions on specific data entries required in the Carbon Calculator) of those data is available from farm records. This is more data available from farm records than we have hypothesized as being available (order of 50% of data required by Carbon Calculator) before setting up the questionnaire (figure 3.1).

Most data would be available in some form in databases (used elsewhere e.g. subsidy) or in farmers administration (payments for fuel, work) – yet filing these data in a tool would require major time effort from farmers (indications of 2-6 hours) and many consider this crucial point for willingness of farmers.

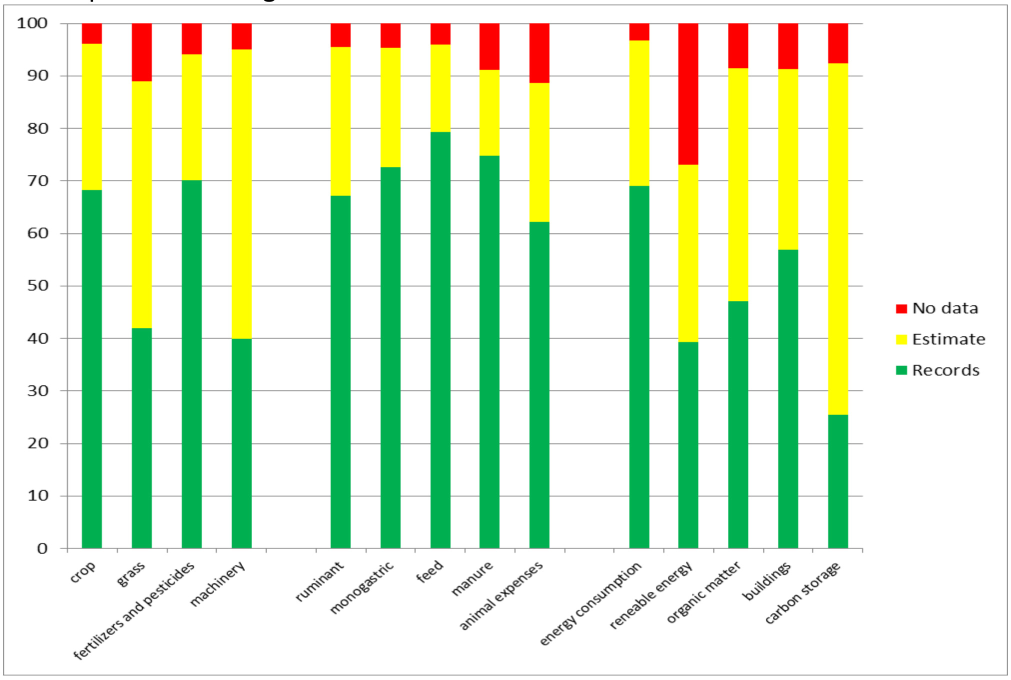


Figure 3.1 Data on farm characteristics, operations and management (given in % of farmers) that are available from farm records (bar bottom, GREEN), data that would be available from estimates by farmers (bar middle, YELLOW) and data that would be missing (bar top, RED) required to identify the farm characteristics for area, economy, environment and farming practices (given in % of the farmers, respondents n=22) and data to identify the 5 main products on farm on basis of economic profit or production volume.

If data are *not available* from farm records, we have asked how many of the remainder of the farmers would be able to provide an estimate and what the reliability of such an estimate would be (see Annex 5 for questionnaire). In those cases where data are missing, estimates would be achievable in 76% of the farmers that have no data from records and such estimates would be fairly reliable (with reliability rated at 3-4 with average of 3.4 on a scale of 1-5 for reliability). The average reliability for the data on *Other and carbon* is 3.1 and lower than the reliability for other data on *Livestock* (3.6) and *Cropland* (3.4) reported in figure 3.2. The remaining farmers (100% *minus* farmers with data in records *minus* farmers who provide an estimate) are assumed to have no data available from either records nor estimates.

There is no indication that sampling the data would be significantly more difficult for any specific group of farmers, e.g. arable farmers, livestock farmers or other. For livestock farmers the data would seem easier to find for monogastrics (70%) than for ruminants (60%) and the tool would thus be easiest to complete for farms with monogastrics. Data on livestock in general would seem easier for many farmers to complete from farm records than would data on cropland. However, the main cropland data, e.g. on area of crops and fertilizers and manure, needed to calculate the key emissions of greenhouse gases would be available from records at 70% and with estimated data from 95% of the farms.

The data on energy and machinery are most difficult to supply from farm records. Other inputs, e.g. energy use and machinery, do not show up as a technical or data problem but one could question whether farmers are willing to take this effort especially to supply the data on a per product basis. Data on renewable energy and on organic matter use and on soil carbon are most difficult to supply (from 23% to 31%). Estimates for the latter categories would not be more difficult to yield but would come at relatively low reliability (level 3 of 5 only and at the lower end of all reliability estimated by advisors).

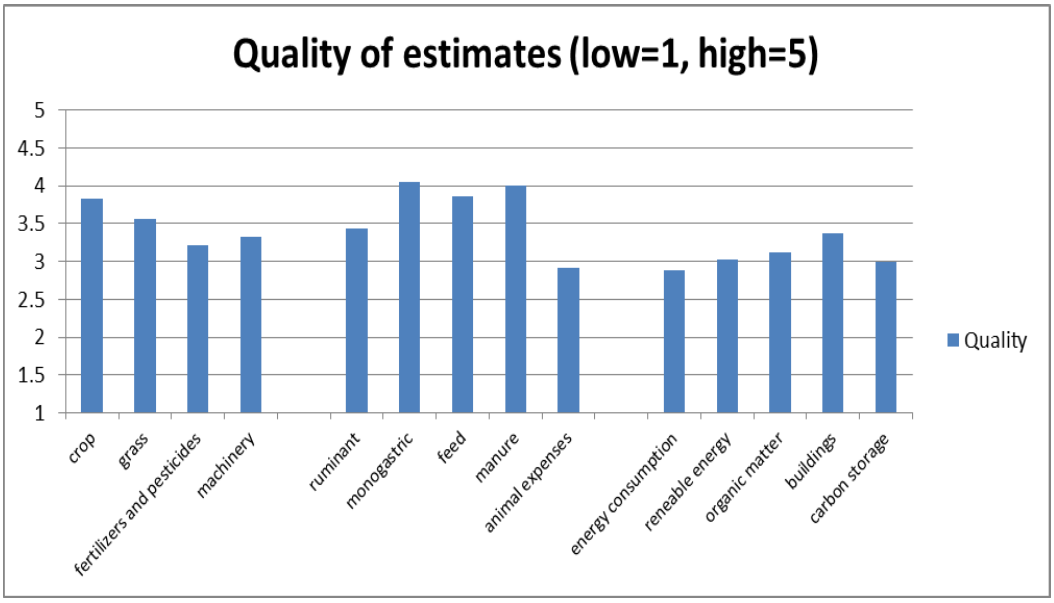


Figure 3.2 Data on the quality of the estimates that farmers would be able to provide if data are not available from farm records (quality is given on a scale from 1 – 5 with 1 being highly unreliable to 5 representing highly reliable, respondents n = 22).

If data would be missing then information on e.g. animal feed and conversion efficiency and growth of animal might be most crucial for the calculation of emissions of greenhouse gases. Further data on grassland management, fertilizer and manure management are among the key sources of greenhouse gas emissions. In particular this latter type of information might be more difficult to estimate than other types of information that may not be very relevant or highly significant to the calculation of emissions of greenhouse gases from the farm. Among the latter categories is information on building and construction materials, on machinery and equipment and on veterinary costs. Most of these sources have emissions that are linked to the off farm production of the materials and their transport.

3.3 Feasibility of the data access for the calculator and the willingness of farmers to use the calculator

Farmers – in general – have access to computers (approximately 50% or less is likely to have the skills to work with Excel sheets). The Carbon Calculator may not need farmers to be familiar with working with Excel but would require them to file data in an excel environment and in the excel program. Many farmers rely on farmer advisory services for e.g. preparing and submitting of subsidy forms. Farmers not only lack skills but are afraid of making any mistakes and rather rely on experts who take care of this administration for many more individual farmers. If data would be missing then information on e.g. animal feed or conversion efficiency and growth of animal might be most crucial; in particular this type of information might be more difficult to estimate than other information.

Farmers are not always able (or willing) to convert or differentiate numbers to the main 5 categories/products of their farms. Farmers generally don't keep records on a per product basis and would have difficulties to assign numbers to specific products. This would be true for those farmers who have more than 1 (or 2) products. As long all inputs and returns can be assigned to a single typical product (milk, specific crop e.g. olive) this should not be difficult to do.

3.4 Specific results on sub-sets of questions for the sections Cropland, Livestock, Other inputs and carbon in the Carbon Calculator

Cropland section

In this section on cropland and grassland (figure 3.3) the responses show that:

- 68% of farmers would be able to supply data from farm records required on cropland use (and of the other 32% of the farmers, 88% could estimate data that are missing in records at a reliability of 3.8 and the remainder would neither have data in records or could provide an estimate if asked).
- 42% of farmers would be able to supply data on grassland use and agroforestry (and of the other farmers, 81% could estimate data missing at reliability of 3.6)
- 70% of farmers would be able to supply data on fertilizers and pesticides (and of the other farmers, 80% could estimate data missing at reliability of 3.2)
- A minority of the farmers (<50%) would be able to attribute fertilizers and pesticides to the 5 main and specific farm products identified by a farmer
- 40% of farmers would be able to supply data from farm records required for farm machinery (and of the other farmers, 92% could estimate data missing at reliability of 3.3)
- Very few farmers (<20%) would be able to attribute machinery to the 5 main farm products identified.

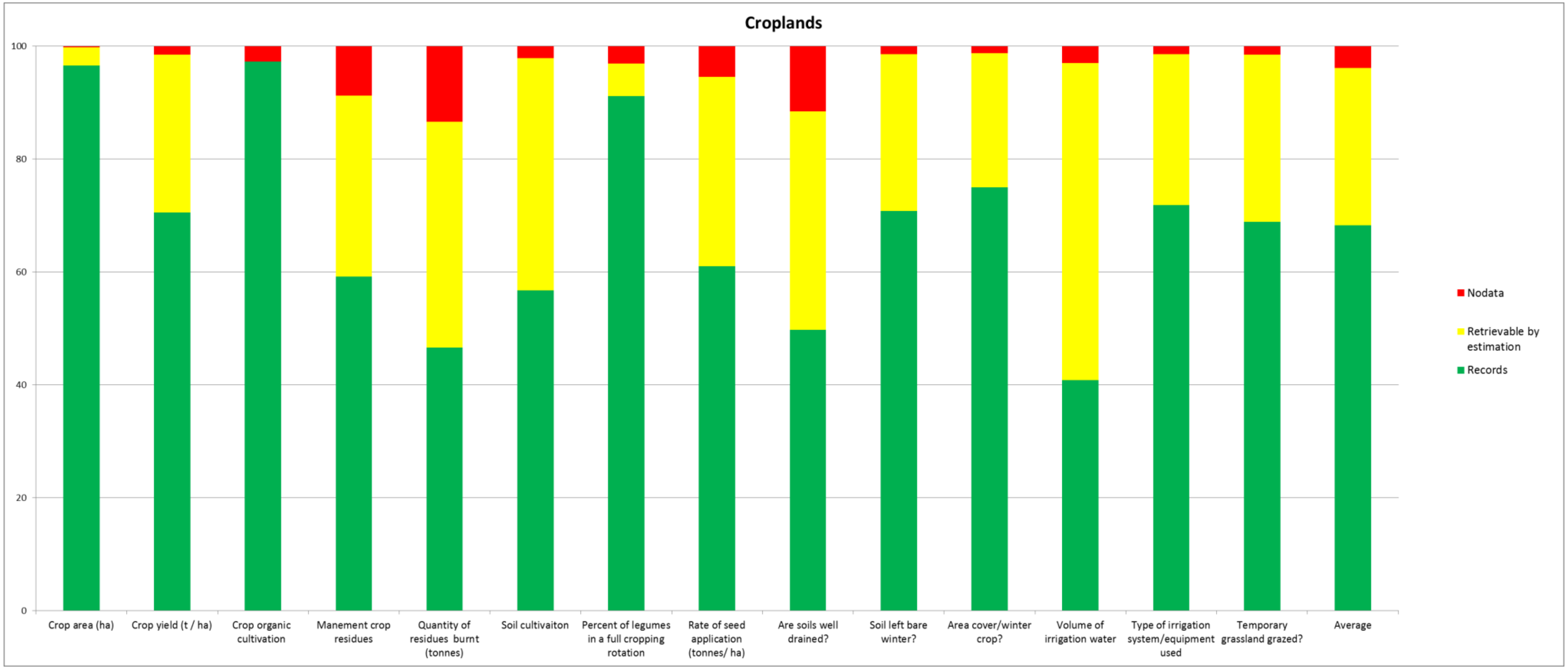


Figure 3.3 *Data on farm characteristics, operations and management in relevant to the section in the Carbon Calculator on cropland (given in % of farmers) that are available from farm records (GREEN) or from estimates by farmers (YELLOW) with the remainder (RED) up to 100% indicated as not available from farm records nor estimates (given in % of the farmers indicated by farmer advisors, respondents n=22).*

Livestock farming section

In the section Livestock farming (figure 3.4 for ruminants and figure 3.5 for monogastrics) the responses show that:

- 67% of ruminant farmers would be able to supply data from farm records required for the animal characteristics (and of the other farmers, 86% could estimate data missing at reliability of 3.4)
- 73% of monogastric farmers would be able to supply data from farm records required for the animal characteristics (and of the other farmers, 83% could estimate data missing at reliability of 4.1)
- 79% of livestock farmers would be able to supply data from farm records on feed characteristics (and of the other farmers, 81% could estimate data missing at reliability of 3.9)
- 75% of livestock farmers would be able to supply data from farm records for manure management (and of the other farmers, 65% could estimate data missing at reliability of 4.0)
- 62% of livestock farmers would be able to supply data from farm records required for animal expenses for e.g. veterinary costs (and of the other farmers, 70% could estimate data missing at reliability of 2.9)

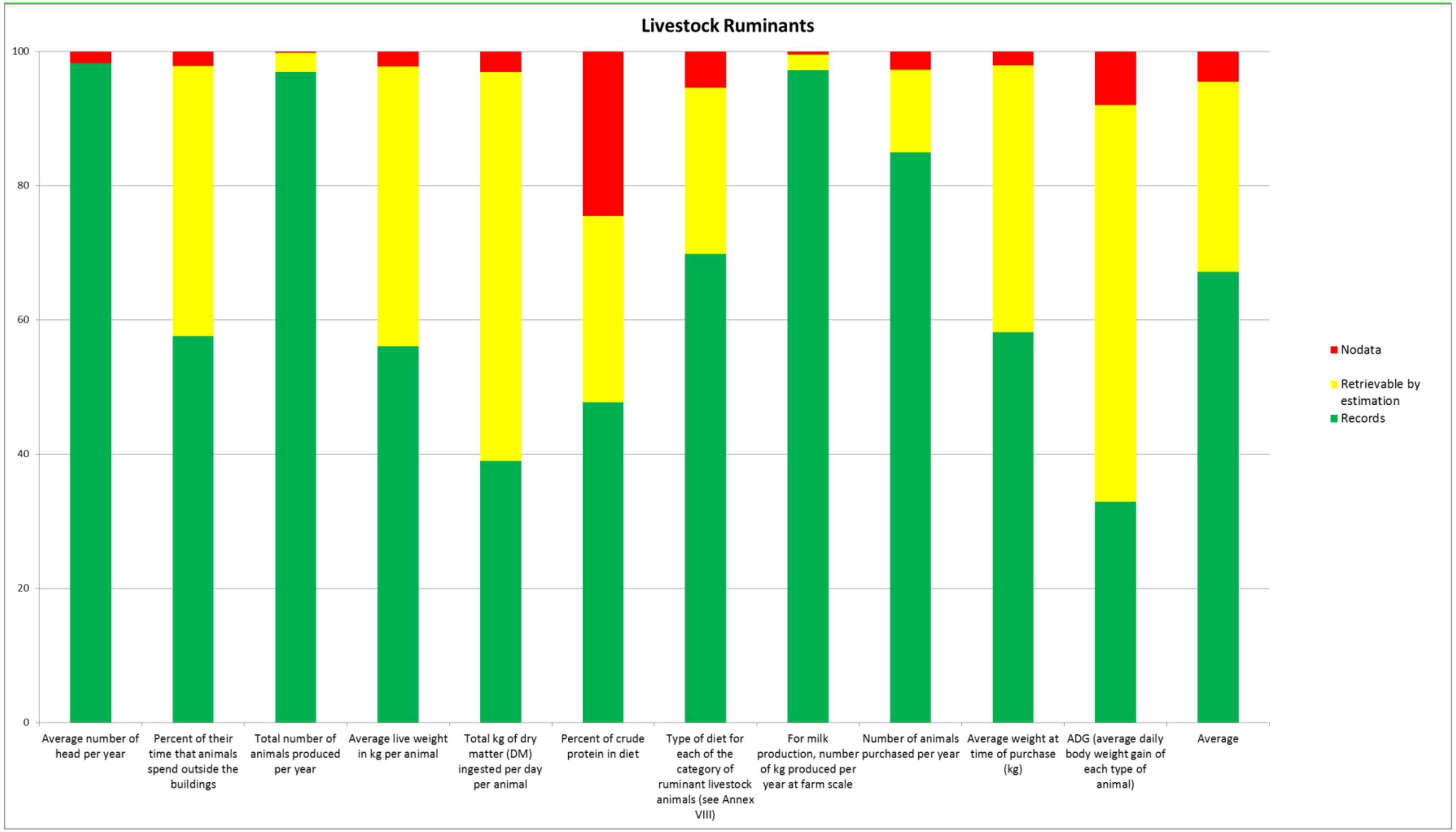


Figure 3.4 Data on farm characteristics, operations and management in relevant to the section in the Carbon Calculator on livestock ruminants (given in % of farmers) that are available from farm records (GREEN) or from estimates by farmers (YELLOW) with the remainder (RED) up to 100% indicated as not available from farm records nor estimates. (given in % of the farmers indicated by farmer advisors, respondents n=22).

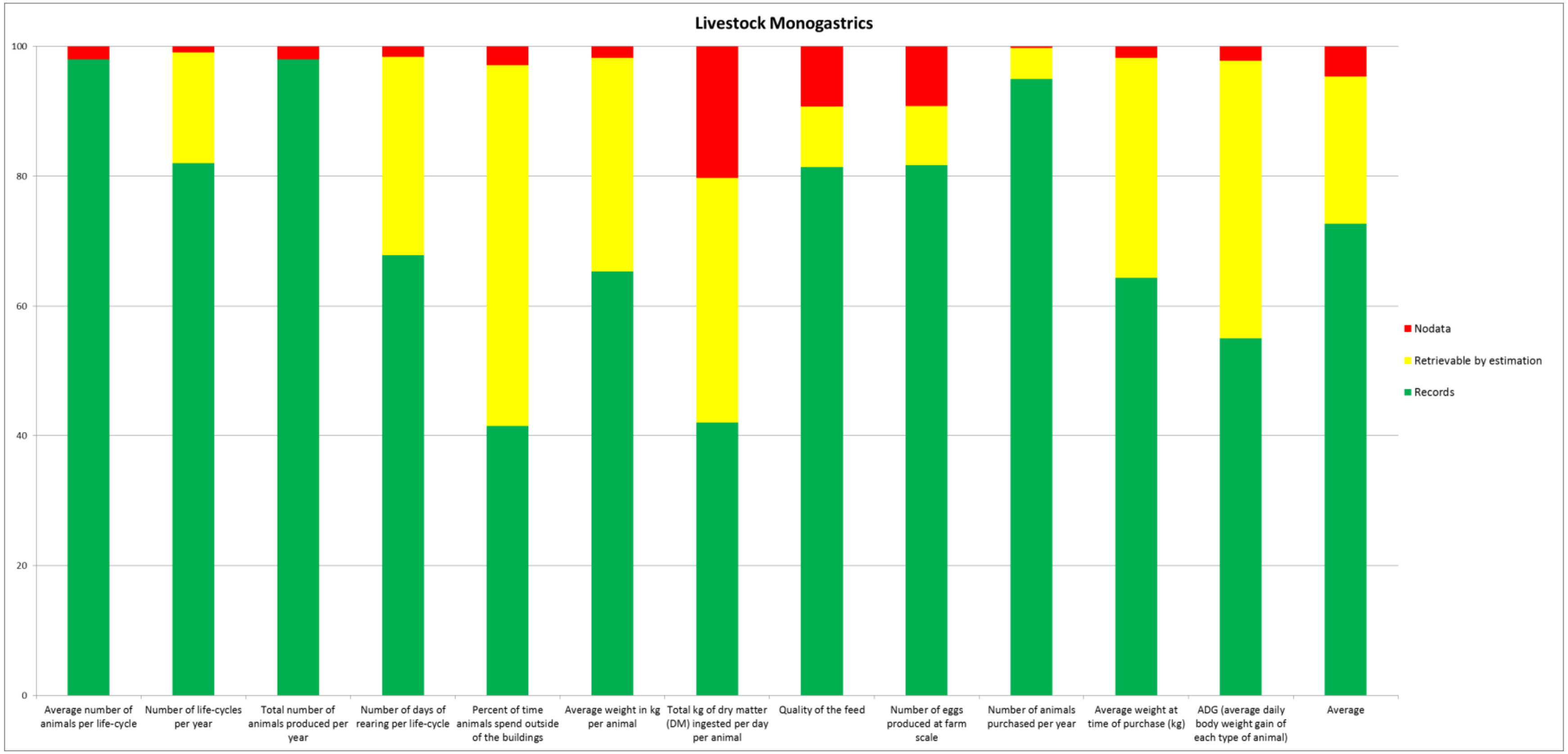


Figure 3.5 Data on farm characteristics, operations and management in relevant to the section in the Carbon Calculator on livestock monogastrics (given in % of farmers) that are available from farm records (GREEN) or from estimates by farmers (YELLOW) with the remainder (RED) up to 100% indicated as not available from farm records nor estimates. (given in % of the farmers indicated by farmer advisors, respondents n=22).

Section on other inputs and soil carbon

In a section on "Other inputs" (table 3.3) advisors were asked to respond to the questions and data assembled in the table below for categories ranging from direct (4.1) and renewable (4.2) energy to organic matter (4.3) and other inputs (4.4) and buildings and construction materials (4.5) and carbon storage (5) that are listed in the carbon calculator in sections 4 and 5.

Table 3.3 Questions and issues in the 'Other inputs' section of the Carbon Calculator. Data types are listed and the data availability (total of data from farm records PLUS data from estimate provided by farmers) (given as percentage) as well as the reliability on data (given as number on scale from 1 – 5 and unreliable to reliable)

Category	**Question on**	**Data from records %**	**Data from records + estimates %**	**Reliability of estimate (1-5)**
4.1 Direct energy consumption on farm	*Amount (litres, Kwh) purchased*	85	99	3.0
	Allocate energy over 5 main products	37	86	2.7
	Cost of purchases (Euros)	85	99	3.0
4.2 Renewable energy consumption at farm level	*Amount (litres, Kwh) purchased*	50	77	3.1
	Allocate energy over 5 main products	22	78	2.7
	Cost of purchases (Euros)	46	68	3.3
4.3 Type and flow of organic matter at farm level	*Tonnes of organic matter imported*	61	95	3.4
	Tonnes of organic matter exported	62	98	3.5
	Default values for N, P_2O_5, K_2O content per product	33	73	2.3
	Type of transport used and distance to the farm	44	97	3.3
	Allocation to the 5 main products and land uses	36	90	3.0
4.4 Other inputs at farm level	*Amount (kg, litres) purchased*	38	89	3.2
	Cost of purchases (Euros)	67	99	2.8
4.5.1 Buildings	*Age*	85	99	3.8
	Surface (m2)	82	99	3.8
	Time allocation to the 5 main products	43	84	3.5
4.5.2 Materials used in buildings	*Area, volume or weight and age of list of construction materials*	28	71	3.2
5. Carbon Storage	*Landscape elements on farms*	26	92	3.0

An average of 53% of the data can be supplied by farmers from farm records ranging from low numbers of 22% (allocation of renewable energy to 5 products), 26% (carbon storage) and 28% (characteristics for building materials) to high numbers of 85% (age of buildings), 82% (surface of buildings) and 85% (amount and cost of direct energy purchased).

The reported availability of estimates is high with an average at 80%. The total of data from records plus data from estimates is well over 85% at an average of 89%.
Only 5 questions/issues have total data availability from records and estimates of 85% or less. These typically include ‘ total amount’, ‘cost’ and ‘allocation to 5 main products’ for renewable energy, NPK content of organic matter used on farm and construction materials in buildings.

In the section ‘Other inputs and carbon’ the specific responses to our questionnaire (Figure 3.6) indicate that:

- 69% of farmers would be able to supply data required for direct energy use (and of the other farmers, 89% could estimate data missing at accuracy of 2.9)
- 39% of farmers would be able to supply data required for renewable energy use (and of the other farmers, 56% could estimate data missing at accuracy of 3.0)
- 47% for data from records on organic matter used (and of the other farmers, 84% could estimate data missing at accuracy of 3.1)
- 57% would be able to supply data from records required for other inputs such as building and construction materials and buildings (and of the other farmers, 80% could estimate data missing at accuracy of 3.4)
- 26% would be able to supply data from records required for soil carbon management (and of the other farmers, 90% could estimate data missing at accuracy of 3.0).

3.5 Data availability on farm activities and characteristics across regions and countries

Figure 3.7 shows a radar diagram on the overall results on the main groups of questions and data required in the Carbon Calculator for the 7 countries (data already shown in figure 3.3 earlier). In section 3.2 we reported that for livestock farming the data would seem easier to find for monogastrics (70%) than for ruminants (60%) and data for livestock in general would be easier to complete from farm records than data on cropland. All these data would be available from records in 70% or more (see green area on the right half of the diagram) whereas data on categories on e.g. machinery, buildings, organic matter and soil C would generally be available from less than 70% (see green area on the left half of the diagram). All but the data on renewable energy would either be available from records or from estimates at 85% of the farmers at least.

On countries and regions
We disaggregated these data so results for each of the 7 countries (Germany, Denmark, Sweden, Spain, the Netherlands, Slovenia and United Kingdom) where advisors have been interviewed (figure 3.8; the numbers are listed in table 3.4). Clearly, the data from records (green area, inner part) are more available for the questions in categories on the right half of the radar graphs for all countries. Most data would be available from records in Denmark, Sweden, the Netherlands and the United Kingdom and least in Slovenia and Spain. Germany is – unexpected – in between.

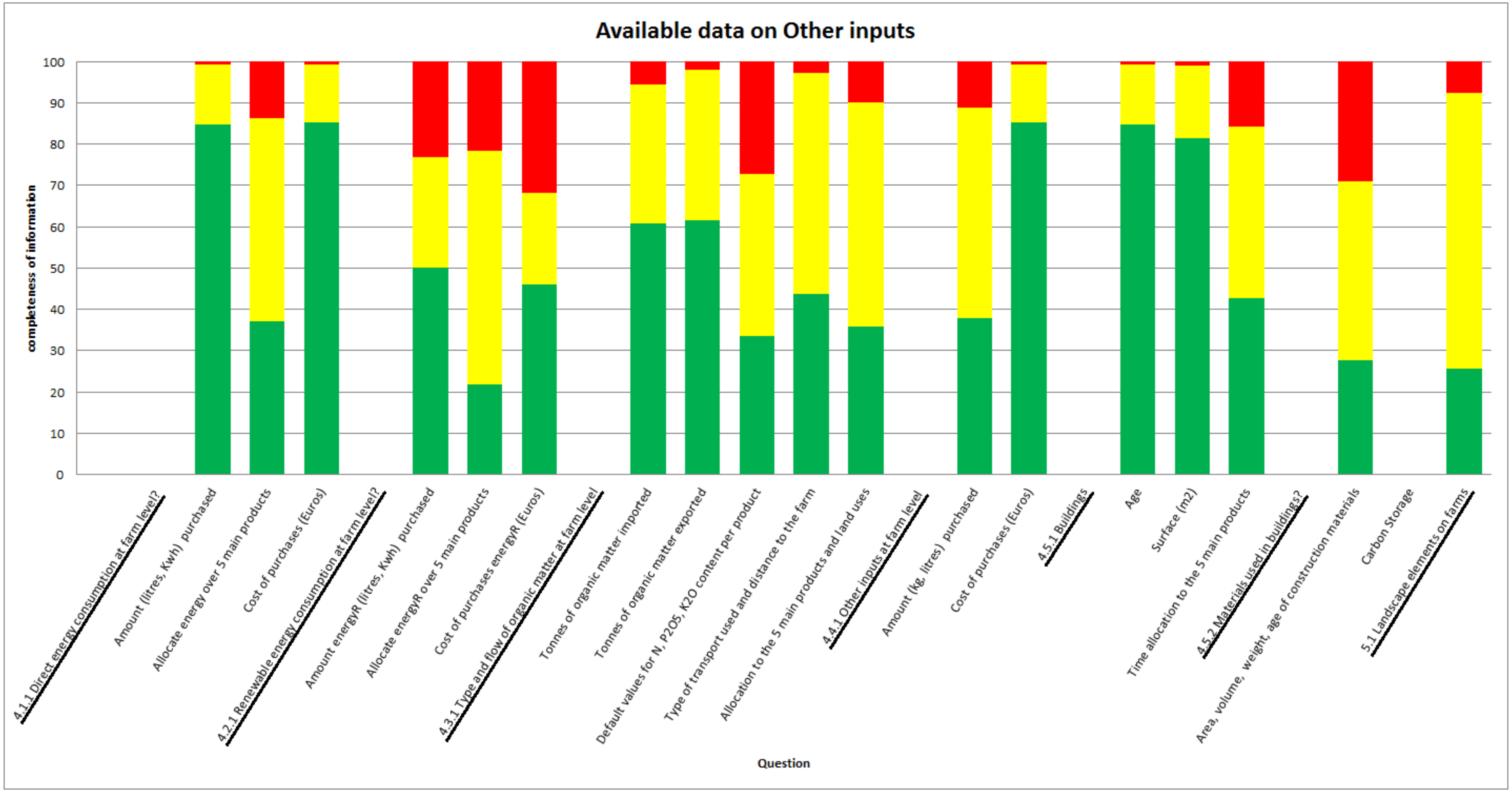


Figure 3.6 *Data availability (given as % of farmers that have data available from farm records) (GREEN) and on the estimates (given as % of those who have no data from records that could supply an estimate) (YELLOW) for the section in the Carbon Calculator on 'Other inputs' and the remainder (RED) for which no estimate or data are available (n=22). The questions cover energy, organic matter, buildings and construction and carbon storage.*

When one includes data from estimates, most results are different and most data from records plus estimates are available in Slovenia, the Netherlands, followed by the United Kingdom and Spain and least in Denmark and Germany. In the radar graph there are specific categories with major red (no data) for e.g. soil, grassland and machinery and renewable energy for Germany and Denmark. Some of these might be unexpected especially for Denmark and Germany given the required reporting that would follow from manure and fertilizer legislation in these countries. Further, it is reassuring that in Slovenia, where the least data are available from records most of the data required to complete the Carbon Calculator could be estimated by farmers according to the advisors. The main cropland data, e.g. on area of crops and the use of fertilizers and manure, and the livestock production data needed to calculate the key emissions of greenhouse gases would be available from records at 70% and with estimated data together from 90-95% of the farms. The exception (red area on the outside) being Germany. This difference between Germany (and Denmark) where advisors have indicated that more data would not be available than in the other countries cannot be explained by different farm types or activities. It could very well be possible that here advisors have taken a more conservative attitude. A second survey among farmers was done to test if this observation is either supported or not (Elbersen et al., 2013)[2].

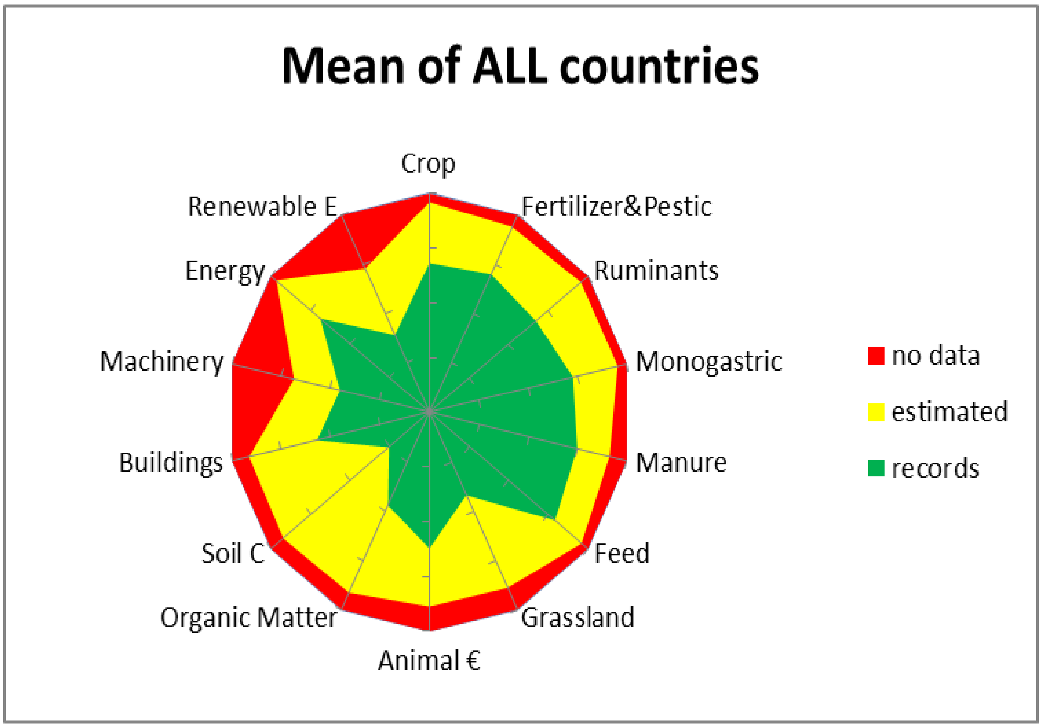
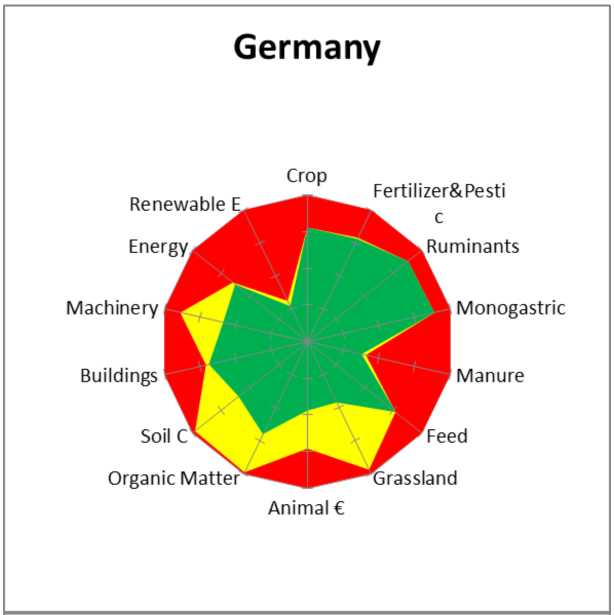


Figure 3.7 Data for the 7 countries (n=22) on the main categories of the data required in the Carbon Calculator. The categories are depicted and for each category the graph shows – from the inside with green via yellow to red on the outside - the data from records (GREEN, inside part), data that can be estimated (YELLOW, middle part) and the data not available from either records or estimations (RED, outside part).

[2] Elbersen, B.S. (Ed.); Andersen, E.; Frelih-Larsen, A.; Jones, P.; Kuikman, P.; Naumann, S.; Oñate, J; Staritsky, I.; Von Troggenburg, J. (2013). EU wide Farm-level Carbon Calculator. Lot 2: Testing the Carbon Calculator Deliverables 2.1 and 3.2. to the Institute of Environment and Sustainability (JRC/IES). Alterra-Wageningen UR, Wageningen, the Netherlands


Germany
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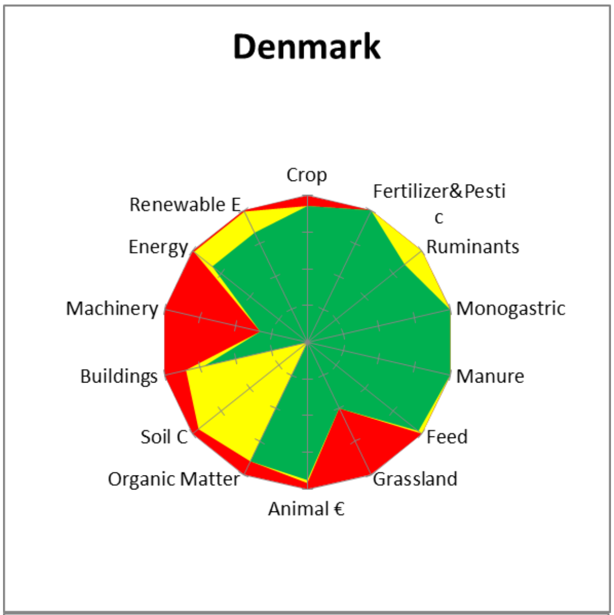
Renewable E


Denmark
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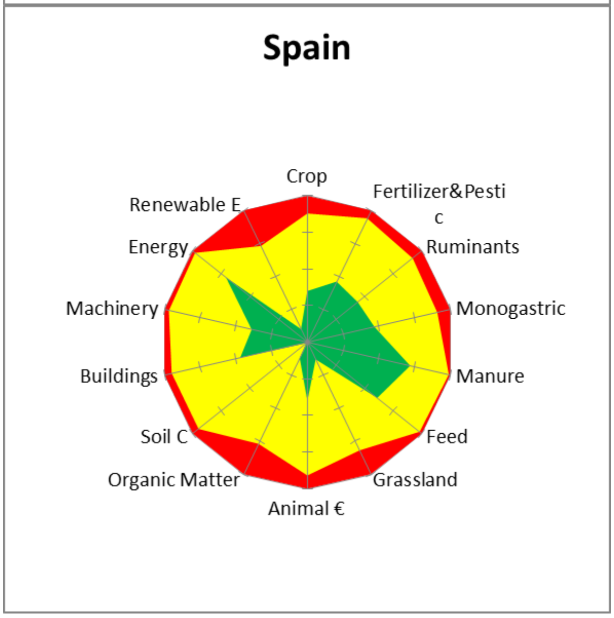
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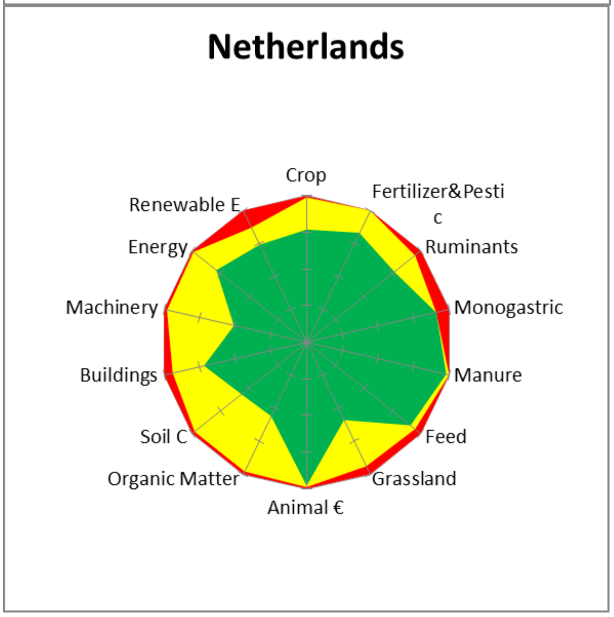
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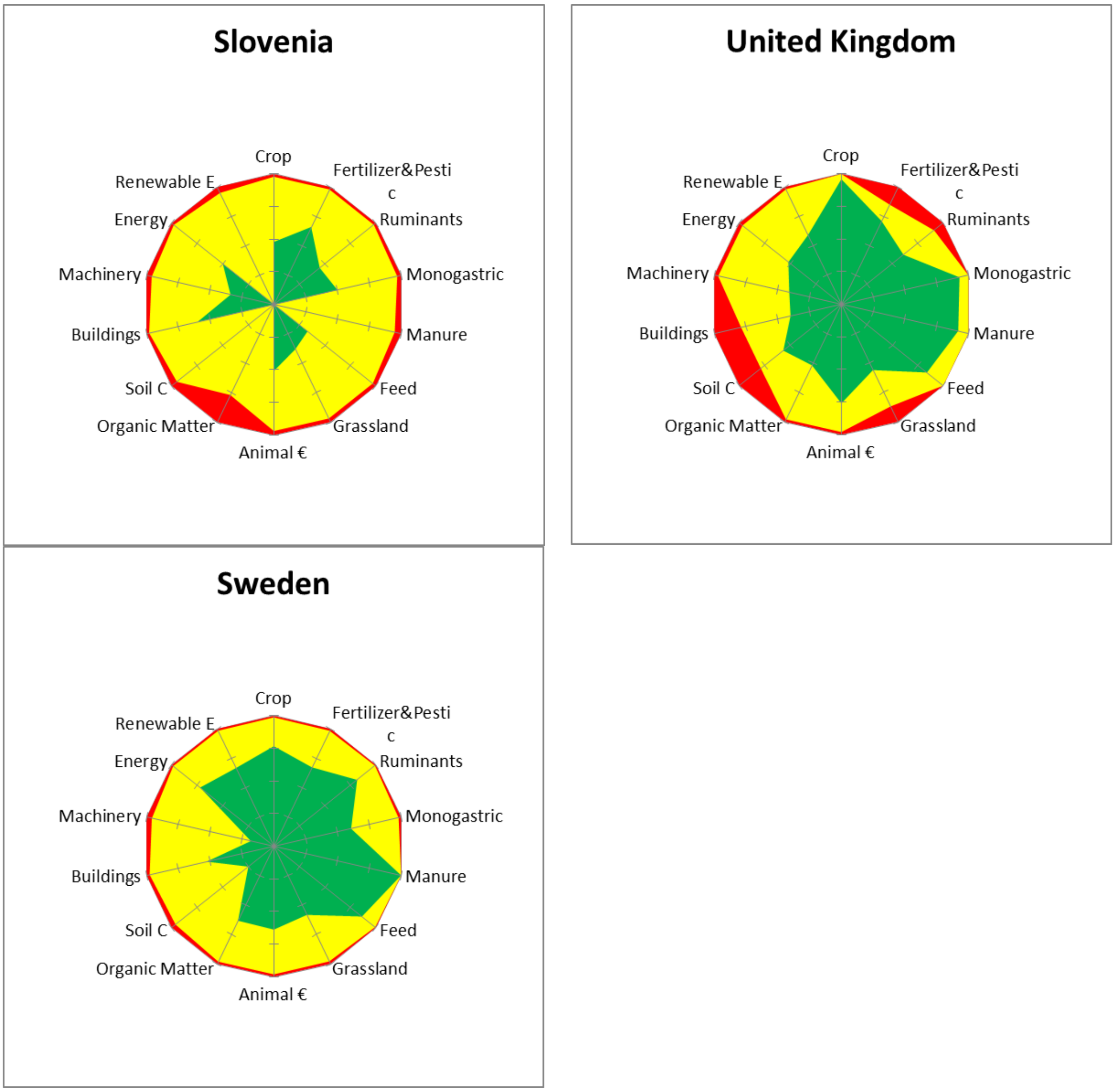


Figure 3.8 Results of the data availability on main categories in the Carbon Calculator per country in Germany (n=2), Denmark (n=3), Spain (n=6); Netherlands (n=3), Slovenia (n=2), United Kingdom (n=3), Sweden (n=3). From inside to outside in the radar diagrams data from records (inside, GREEN), from estimates (middle, YELLOW) to no data (outside, RED) are shown.

Table 3.4 The data on availability of data from records for all advisors (n=22) and for the specific countries across EU27 (n indicated in the top row). These numbers represent data from records in the green area in figure 3.8 above for Spain (ES), the Netherlands (NL), Germany (DE), Slovenia (SL), the United Kingdom (UK), Denmark (DK) and Sweden (SE).

	All 7 (n=22)	**ES (n=6)**	**NL (n=3)**	**DE (n=2)**	**SL (n=2)**	**UK (n=3)**	**DK (n=3)**	**SE (n=3)**
Crop	67	35	77	78	48	96	93	77
Grassland	39	13	59	46	38	56	50	58
Fertilizers&pesticides	73	46	83	78	66	71	100	67
Machinery	43	39	51	59	34	41	33	18
Ruminants	65	44	77	88	45	61	85	82
Monogastric	73	47	91	89	50	93	100	61
Feed	78	61	91	77	33	84	97	86
Manure	71	72	98	38	0	92	0	100
Anim € (expenses)	62	40	98	47	51	76	94	64
Energy	69	71	79	63	50	52	83	72
Renewable Energy	38	10	74	27	0	59	83	67
OM (organic matter)	44	12	56	70	0	52	90	63
Buildings	57	47	72	69	60	40	72	53
Soil Carbon	26	1	57	60	0	57	0	25

3.6 Grassland and grassland management

The Carbon Calculator requires four specific entries on grassland and grassland management that deal with i) fertilization of the grassland, ii) reseeding the grassland, iii) overgrazing of grassland and iv) loss of productivity. The data availability for these four entries is given in figure 3.9. This is an area where data from records are clearly scarce. In the Netherlands, the United Kingdom, Germany, Sweden and Denmark farmers would keep records on fertilization and reseeding (top panels left and right). Slovenia and Spain do not have data in records and could provide estimates. Farmers in any of the countries would not have records on overgrazing or loss of productivity of grassland. Farmers in the United Kingdom, Spain, the Netherlands and Slovenia could provide estimates and Germany and Denmark would not be able to provide estimates here.

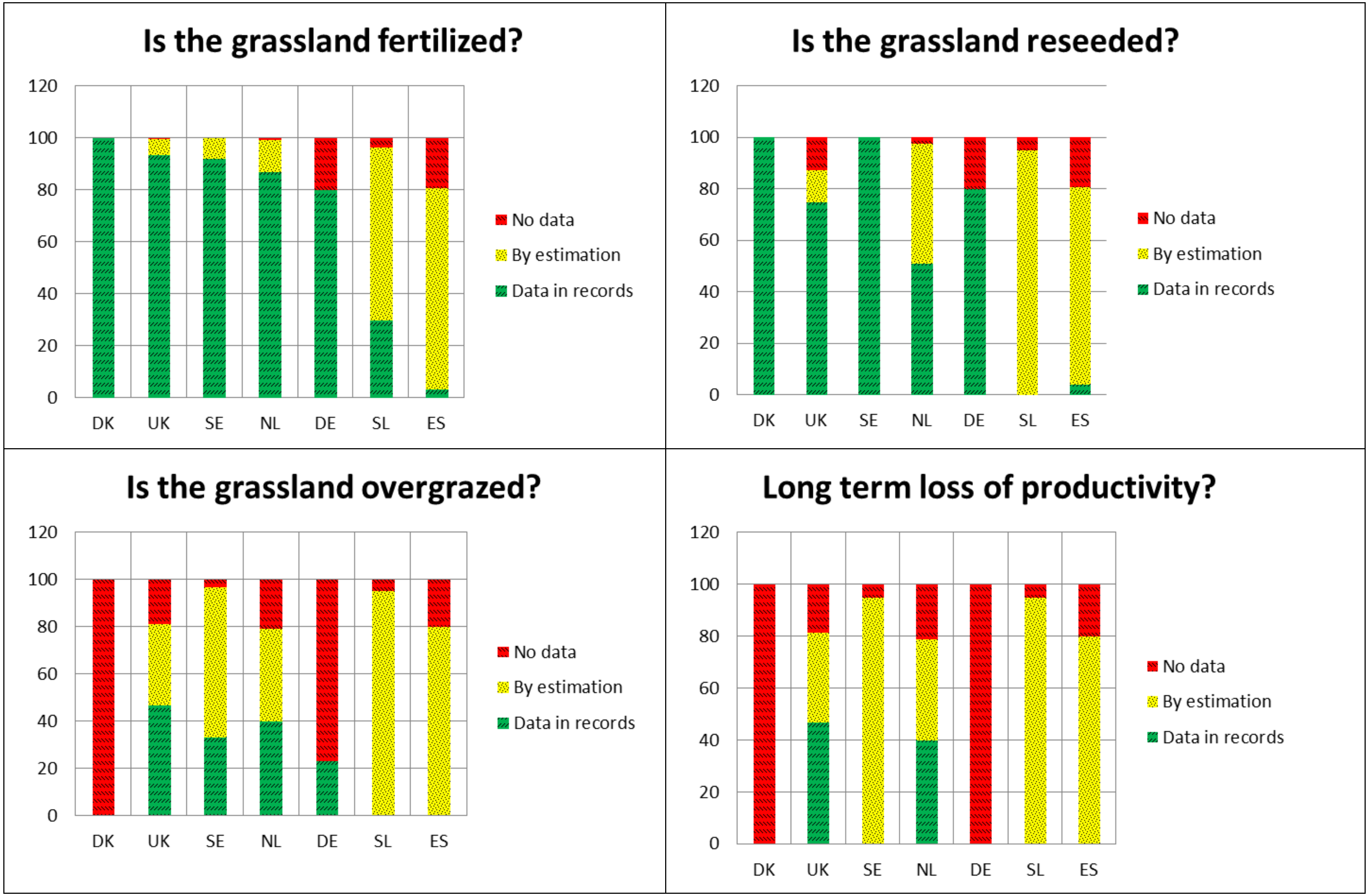


Figure 3.9 *Results of the data availability on the entries on grassland and grassland management in the Carbon Calculator From left to right countries have been listed according to the data availability for the question on fertilization of grasslands In all panels this order of presenting the 7 countries has been kept. Data (n=22) from records (GREEN), from estimates (YELLOW) to no data (RED) are shown.*

4 Conclusions

The Carbon Calculator Tool is a complex tool and requires significant input of data on very specific and detailed farm activities, materials use and equipment and machinery that could take up to 80 entries that would ideally come from records kept on farm.

According to the advisors that have completed a questionnaire, the majority of the data that are required to complete the Carbon Calculator would be available from farm records (60% or more). A significant fraction of the remainder could be supplied by farmers in the form of an estimate bringing up the total data available to approximately 90%. The reliability of these estimates is estimated by farm advisors at 3.4 on a scale of 1 – 5 (ranging from highly unreliable to highly reliable).

The analysis on a per country basis shows substantial differences between countries. In general, the the United Kingdom, the Netherlands and Denmark would have more data available from records than Slovenia and Spain with Germany intermediate. Farmers in Slovenia and Spain could make up this difference and supply estimates for many data entries. Compared to other countries, farmers in Germany and to some extent also in Denmark, would not be able to supply data for several of the categories. One could hypothesize that should the Carbon Calculator provide default values from a drop down menu, farmers in Denmark and Germany would also be able to complete the required data entries.

The data required for the cropland and livestock section of the Carbon Calculator are more available from farm records than data on the section on “Other Inputs” including the data on energy use, organic matter and carbon management and soil carbon and data on grassland and grassland management. Also for the section on “Other inputs” farmers may well provide relatively reliable (3 or more at scale of 1-5) estimates for the main data needed in the Carbon Calculator. The data most difficult to complete relate to allocation of activities or volumes to specific farm products identified, to renewable energy and to organic matter management and grassland data on loss of productivity and overgrazing. Less difficult but rather based on estimates than on farm records are data on feed, fertilizer and animal growth. These data would be highly relevant to the calculation of the on farm emissions of greenhouse gases and to the options farmers would have to adapt the farm management towards lower emissions of greenhouse gases. At this point it is not possible to conclude on whether specific data that are crucial to calculate greenhouse gas emission profiles for a farm and identify and assess effects of mitigation options are available as there is no insight in the data that are used in the calculations neither on greenhouse gas emissions nor on mitigation measures.

The extensive data requirement is expected to make the tool relatively difficult to use for farmers. Also, the computer use and required skills may not be well developed in many regions and farmers communities across EU27 MSs. According to advisors’ opinions, the carbon calculator complexity and the time required to complete it, that is estimated at 6 hours or more, cause a low probability that farmers will actually use the Carbon Calculator as it is.

Many farmers will rely on farmer advisory services for e.g. preparing and submitting subsidy forms. Farmers not only lack skills but are afraid of making any mistakes and rather rely on experts who take care of this administration for many more individual farmers. Many of the smaller farms do not have the required record keeping on all data required by the tool. The tool that was used for the interviews with farmers and advisors at this stage is not self-explanatory and this has made the assessment of user friendliness of the tool difficult.

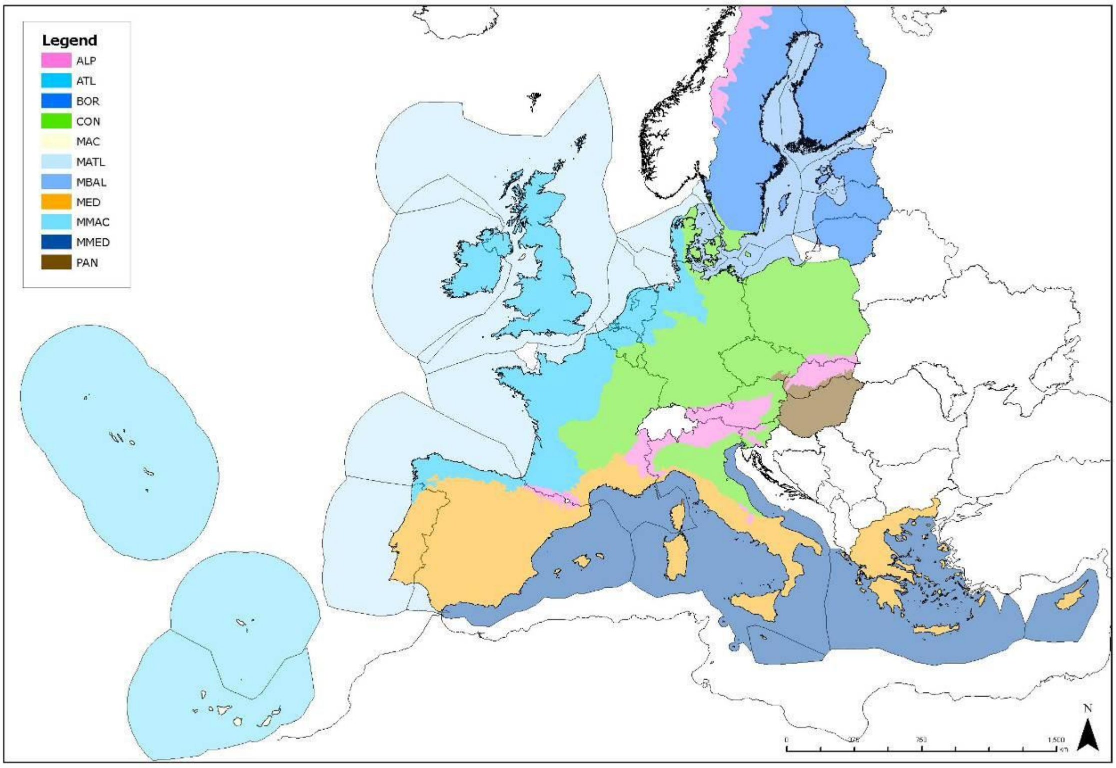
Advisors also indicate that, should there be a clear benefit from using the tool, many of the farmers would be willing to use the tool indeed. The likelihood of farmers using the carbon calculator would be better, should default values be available and could be selected by the farmers. On the other hand, this might return results that are not sufficiently specific. Care should be taken to ensure that farmers do recognize the results returned as applying to their conditions in order to avoid inaction on the mitigations measures suggested by the calculator to the farmer in question.

5 Recommendations

1. Advisors have expressed the need to use as much as possible other existing tools (e.g. OVERSEER NZ, other nutrient management tools together with data farmers already use, only in the United Kingdom alone there are 8 different carbon calculators for farmers) to increase the acceptability by farmers and to maintain the credibility of the advisory services. Advisors may feel less comfortable should they need to use more than one tool. This further would keep the administrative burden on farmers low and reduce additional need for training on farmers and advisors and may allow farmers to directly use the tool without help and support by advisors and even reduce cost to farmers.
2. The tool has characteristics of both a farm gate balance (feed, manure, organic matter) approach and a LCA approach (identification of 5 main products, building, machinery and construction); this combination may well lead to difficulties in interpretation and acceptability among stakeholders and in the end will not really work.
3. The tool as it was seen and used so far does provide little support or default values or suggestion on how to estimate or calculate specific values that would not be available directly from farm records and other documentation. This would greatly help and facilitate farmers in using the tool and getting used to a methodology and modus in completing a tool to calculate greenhouse gas profiles of (their) farm, their products and activities.
4. The average availability of data on farm and environmental characteristics range from an average of 73% to 87%. Data availability would benefit from linking the tool directly with existing databases (on e.g. weather, soils and other parameters such as milk produced) or data supplied to (electronic) forms already completed for application for CAP subsidies where the data are kept that farmers find difficult to complete or do need to keep records for.
5. The data need of the Carbon Calculator should be kept as low as possible. We have asked farmers to consider a maximum of approximately 80 data requested by the Carbon Calculator and as provided by a list from Solagro. Should some of these data not be needed for the calculation of the emission profile of the farm or not be part of the calculation of effect or cost of mitigation options, we suggest to not ask farmers to file these data.
6. Several advisors have given specific comments or suggestions to the Carbon Calculator that are listed included in per country report in Annex 3. These comments are often personal observations on the actual session with the questionnaire on data availability or based on remarks made by the advisor. We would recommend checking all comments carefully to see if and how a new version of the Carbon Calculator can accommodate the suggestions or remarks and relate possible actions to the relevancy for the calculations in the Carbon Calculator.
7. It may not get more pleasant but surely it can be made easier for farmers by providing e.g. scroll down menus that do include default values to farmers.
8. Some may argue that farmers would be best off with a full nutrient/farm management tool while others would argue that a targeted GHG tool might be better to get farmers to complete a greenhouse gas balance sheet for their farm.
9. So far it is unclear what the benefit to a farmer is and this is highlighted in many of the responses to the questionnaires. This issue will be part of the testing in a second phase of this project and has been commented and suggested on in Elbersen et al.(2013)[3]

[3] [3] Elbersen, B.S. (Ed.); Andersen, E.; Frelih-Larsen, A.; Jones, P.; Kuikman, P.; Naumann, S.; Oñate, J; Staritsky, I.; Von Troggenburg, J. (2013). EU wide Farm-level Carbon Calculator. Lot 2: Testing the Carbon Calculator Deliverables 2.1 and 3.2. to the Institute of Environment and Sustainability (JRC/IES). Alterra-Wageningen UR, Wageningen, the Netherlands

Annex 1: Bio-geographic Regions (COM/2209/358)

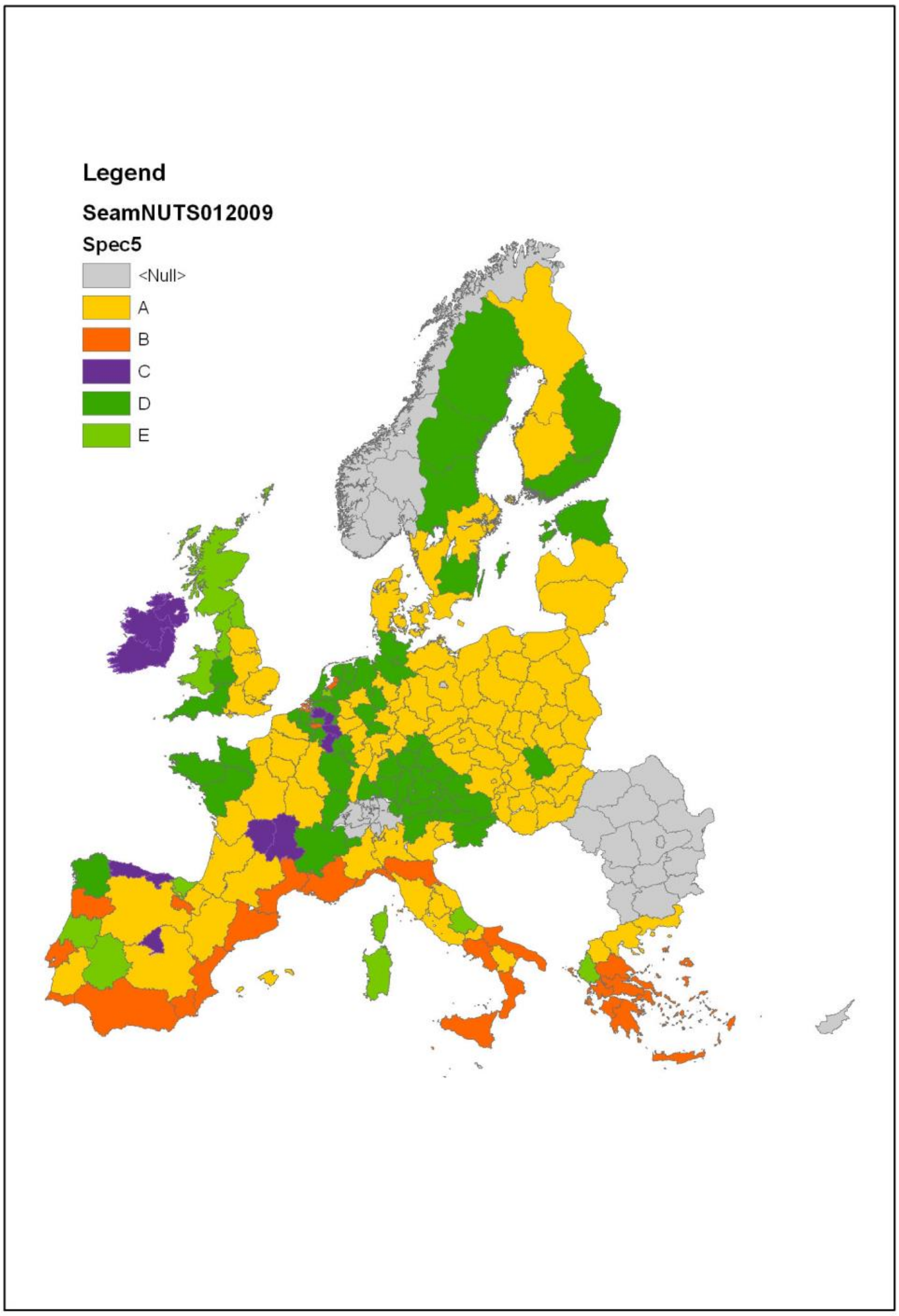


Key for the different bio-geographic regions.

ALP=Alpine; ATL=Atlantic; BOR=Boreal; CON=Continental; MAC=Macaronesian; MED=Mediterranean; PAN=Pannonian; MATL=Marine Atlantic; MBAL=Marine Baltic; MMAC=Marine Macaronesian; MED=Marine Mediterranean

Annex 2: Main farm type pattern. (Andersen. 2009)

http://www.seamless-ip.org/Reports/Report_53_PD4.4.3.pdf : Section 4



A. Regions dominated by arable/cereal and mixed farming systems (99 regions)
B. Regions dominated by permanent crops and arable/specialised crops farming systems (29 regions)
C. Regions dominated by beef and dairy cattle systems with permanent grassland (24 regions)
D. Regions dominated by dairy farms (60 regions)
E. Regions dominated by sheep and goats farms (11 regions)

Annex 3: Conclusions and feedback on specific regions across EU 27.

i) The UK experience

General

Advisors in the United Kingdom represent a range of farm characteristics with an average farm size of 120 ha. Nearly all sectors of agriculture have been covered and include milk and dairy, beef, cereals, sheep, horticulture, poultry and pigs. The type of farming is full-time and full market orientation and little or no subsistence farming. The average age of farmers is in the range of 50 – 55 years.

Data availability and reliability

- As a general conclusion, a majority of the data required by the calculator would be available in farm records. Most of the remainder of the data could be estimated by farmers with some reliability. The areas where farmers would need to provide estimates (i.e. less record keeping) would be, generally, the allocation of some variable inputs and all fixed and overhead costs to the 5 main farm enterprises and data relating to intermediate inputs (i.e. products not marketed off the farm), such as crop residues, organic nutrients etc. Farmers would have particular difficulty estimating physical volumes of:
  - Energy used by the 5 main enterprises
  - Materials used in building construction (even at the farm level)
  - the age and other characteristics of machinery/equipment used by contractors on their farm (even at the farm level).
- Carbon storage data (Table 3.3) would be readily obtainable on farms that are members of voluntary incentive schemes (such as Environment Stewardship) as the recording of such data is a scheme requirement. On non-member farms less reliable estimates would be all that was available.
- There is no strong feeling that either livestock or crop data would be easier or harder to supply than the other. Neither is there any sense that either livestock or crop farms would have more difficulty providing data for the calculator (or using it) than the other. The factors determining the likely ease of use of the calculator in the United Kingdom are the size of the farm business, the marketing channels used (such as membership of assurance schemes etc.) and the management intensity (and ability).
- Quite a lot of the data that the calculator requires is already being provided by farmers, either on paper or electronic forms for other purposes, for example for: Environment Stewardship scheme membership; CAP Single Farm Payment Scheme; Assurance and certification schemes (organic, animal welfare, retailer etc.); Animal Health (government agency) inspections. Farmers may be resistant to what they perceive to be a duplicating source of bureaucracy.

Computer availability and skills

- Most commercial farms in the United Kingdom have at least one computer-literate staff on farm. Using the carbon tool would not be too problematic, but the collection of the data from farm records would be very time consuming. Providing estimates from memory would be quicker than searching farm records. The rate of record keeping in the United Kingdom is high, so a requirement to use physical records, where these are available, would greatly increase the time needed to provide data. It would take 4-6 hours per farm to supply and enter this data.

Feasibility and willingness of farmers to use the CC

- On the likelihood that farmers in the United Kingdom would use the tool, we conclude that there is a positive linear relationship between the amount of effort required and need for perceived benefits, i.e. the greater the effort, the greater the perceived benefits will need to be. The farmers who would find this easiest in terms of acceptable burden (effort) would be larger farms with relatively simple farm systems, such as specialist cereals or specialist dairy. Small farms with diverse enterprises would find the requirements unacceptable and are more likely to need to be compelled to use it. It is unlikely that any farmer (of any description) would use this tool without being compelled to do so through regulation or certification scheme requirements.

- Use of carbon calculators is already fairly common on farms in the United Kingdom, as many certification schemes and retailers require their use. This fact has both positive and negative implications. On the positive side, it increases farmer understanding of the role and potential benefits of calculators and it also increases availability of some types of relevant data. On the negative side, the market place for calculators is already crowded and existing calculators are much easier to use.
- While farmers' understanding of C foot-printing is growing, the focus of farmers is very much on increasing resource use efficiency by increasing yields (and feed conversion rates). This is seen as a far simpler and less risky option than trying to cut GHG emissions by changing management practice.
- It is questionable whether the calculator provides the kind of data that farmers would find useful. On farms with diverse enterprises the calculator does not necessarily provide a whole-farm carbon footprint unless farmers would complete data for the full set of 5 products plus a category on other where all other inputs and activities would be included. On an individual crop basis, farmers would recognise that many of the allocations (to individual enterprises) that they have made are 'best guesses'. This fact must impact the perceived trustworthiness of these single product C estimates. It is unlikely that farmers would be willing to commit themselves to potentially costly changes to management practice on the basis of modelling estimates with such large margins for error.

Recommendations for the United Kingdom

1. Automation of distribution of whole-farm data to 5 main outputs/enterprises – this would make the data entry burden smaller and ironically, farmers might trust resulting single product C estimates more than if based on their own best-guess allocations of inputs to products.
2. Add value to outputs of the calculator in a conversation on the ideas and benefits of carbon foot printing with the farmers and showing them how the CC would produce more useful statistics and data for the farmer that he or she could use to develop farm management strategies.
3. Can the data collection be linked to the supply of related electronic data that farmers already undertake for other official and commercial reasons?
4. Simplify data requirements – farmer WILL NOT use the tool otherwise.

ii) The Dutch experience

General

Advisors in the Netherlands represent a range of farm characteristics in dairy farming with an average of 60 – 160 dairy cows and which represents the range of farm sizes. Farmers ages range from 20 – 60 and almost all are professional and full time farmers. Farmers in the Netherlands are familiar with using tools for management and quality control. Extensive book keeping is practiced to meet environmental standards, legislative requirements on e.g. use of manure and fertilizers and e.g. dairy industry benchmarks and standards in agri-environment programs; this would not depend on the size of the farm operations (intensive of extensive, small or large) as long as it concerns professional farmers (and not hobby farms).

Farmers do participate in initiatives on sustainable and environmentally quality and agricultural performance and these include: Focus Planet, Dairymen, Koeien en Kansen, SchoonWater, ZuiverWater and Legislation on housing systems. These generally target at reduction of nitrogen losses. Some understand their role in climate change from emissions of greenhouse gases. Many farmers do work on mitigation of climate change but not necessarily explicitly from climate targets or policy.

Data availability and reliability

- Most data required would be available or farmers could provide estimates at fair to good reliability. Livestock requires most data and information and data would in many cases be stored in (farm) management systems and programs; cropland would be the most time consuming to complete.

- In particular arable farmers would find difficulties to allocate information for different products across all the different modules. It would be very time consuming as the majority of farmers only keep data at farm level and many estimates on a per product basis would be unreliable. This would be true for allocation of resources used for feed production in livestock farms as well.
- As many farmers already keep and present data, using another tool would need farmers to file numbers more than once and exchange data already filed by farmers e.g. subsidy applications, quality standards for dairy industry, data on fertilizer and manure use for nutrient and manure legislation.
- Farmers would have difficulties in supplying data on:
    - Cropping module: details on rotations, grassland use and grassland management
    - Livestock module: number of life cycles, number of animals coming and going and details on weight and feed quality and quantities
    - Carbon storage
- The hardest information in modules to access from records includes:
    - Cropland: the estimates of yields and organic matter inputs other than manure would be very difficult and unreliable to get and attribute to specific farm products
    - In Other inputs: the required information on electricity and energy use is not specific to farming activities only and includes also household use; use of machinery (in hours) would be very time consuming and extremely difficult to estimate and render these estimates relatively unreliable; this in particular is difficult for work done by contractors with equipment not owned by the farmers

Feasibility and willingness of farmers to use the CC

- At the moment, it could take more than a day for the farmer to gather all the information required and file the information in a carbon calculator tool.
- The questionnaire will take a lot of time for advisors and certainly for the average Dutch farmer. Suggestion is given to use automatic data gathering for this purpose from other sources and data already filed for other purposes.
- Most farmers use computers and filling EXCEL spreadsheets digitally could be done successfully by more than 50% and this percentage would be higher if benefits to farm management decisions and strategy are clear; dairy farmers generally dislike filling out forms, certainly if not directly rewarding.

Recommendations for the Netherlands

1. The questionnaire took a lot of time for advisors and certainly for the average Dutch farmer. Suggestion is given to use automatic data gathering for this purpose from other sources and data already filed for other purposes.
2. Advisors say: *Keep it Simple*; the tool would certainly be more effective if it would show on farm level and in direct feedback after filling the forms (interactive) any benefit to the farmer; many (in particular) livestock farmers use existing tools (e.g. ‘kringloopwijzer’ or ‘Focus Planet Points’ by FrieslandCampina) and would not likely be willing to use another tool in addition to what is used and required in the Netherlands by major dairy industries
3. By showing the benefits of the calculator and calculation at farm level, farmers would certainly gain interest in completing a carbon calculator.
4. The most effective route would be by regulation but this is also the least desirable route; the most likely route would be by voluntary compensation schemes; several schemes will use existing tools and a carbon calculator would benefit from using this information.

iii) The Slovenian experience

General

Advisors in Slovenia represent the full range of farm sizes with an average farm size of 10 – 30 ha (between 20-30 cows). Only 2 farmers have up to 100 cows. Both part time and full time farmers are included with a mix of subsistence farming and market orientation. The age of farmers ranges from 35-55 years.

Farm types are dominated by livestock production with dairy production, secondly suckler cows with sale of calf meat or fattened beef, third beef meat production. Very few pig and poultry farms are found in the area. There are also few farms with arable production; most arable farming takes place on mixed livestock/arable farms where the main output is corn for feed (mostly silage and some grain) or potatoes for on-farm sale. Forestry is an important output on all farms. There are 6% organic farmers in the area.

The national advisory service programme requires regional specialist advisors to provide some training and activities related to climate change (5% of resources should be dedicated to climate change). Four hours of training is compulsory for farmers in the agri-environment programme, about half of farmers in the agri-environment programme would have attended the training on climate change and agriculture.

Awareness on Climate Change is growing (approximately 50%) as farmers are faced with more storms and droughts. In 2011-2012 advisors organized training within the agri-environment programme within their region that focused on reducing emissions in livestock production (manure management and nutrition).

Data availability and reliability

- Allocation of information for different products would be the most difficult point across all the different modules. It would be very time consuming as the majority of farmers only keep data at farm level and many estimates are unreliable.
- Several databases do exist e.g. for dairy, and dairy farmers receive monthly printed reports.
- The easiest and most complete information to access is available in subsidy applications, veterinary records and pesticide records. The following is available on all farms:
    - Cropping module: cropping area, rotations, grassland use, area under agro-forestry, pesticide applications
    - Livestock module: herd size and number of life cycles, number of animals coming and going, veterinary costs
    - Carbon storage: grassland orchards and vineyards (there are registers for these)
- The hardest information in modules to access:
    - Pedoclimatic conditions: weather related data is not available at farm level (would need to integrate with regional databases)
    - Cropland: Estimates of yields and organic matter inputs would be very difficult and unreliable
    - Livestock module: application of fertilizer (only on 30% of farms), growth and body weight gain, feed related information. However, estimates in the livestock module would be more reliable (average value of 3) than in the cropland module.
    - Other inputs: information on electricity use is not specific to farms (includes also household use) but can be estimated well; use of machinery (in hours) would be extremely difficult to estimate and estimates would be unreliable.
    - Carbon storage: information on other features beyond grassland orchards and vineyards are not available, but estimates could be made
- Professional larger farmers (of different production orientations), those in the Farm Accountancy Data Network (FADN) sample, and organic farmers (who have to keep detailed production records and have a higher degree of environmental interest) are likely to have better access to data. A rough estimate of the size of this category would be 10 – 15 % of holdings.
- Farms with a medium to small herd size and medium to small cropping area that do not fit in the above categories, are the least likely to have good access to data and interest in the use of the calculator = this equals about 60 – 70% of holdings.
- Farms in agri-environment programs (taking up other measures than organic farming) are also likely to have better access to information and interest in use, though to a lesser extent than the farms mentioned under the first bullet. This group would be about 5-10% of holdings.

The feasibility and willingness of farmers to use the CC

- Computer use is very limited. Less than 10% fills out subsidy applications online and fertilizer plans are not done online, but rather by agricultural advisers who have access to software. The limited computer use is a major barrier to potential use of the calculator.
- Initially, very few farmers would likely be interested in using the tool (10% at most). Farmers would only use the tool together with the advisors, very few (1-2%) would be interested in using it on their own. The calculator is more appropriate for use by advisory services in providing advice.
- At the moment, it could take more than a day for the farmer to gather all the information required

Farmers and climate change

- Young, professional farmers who are highly specialized and market-oriented, who could include carbon footprint in their marketing strategy would initially be interested in the tool, others not. Carbon storage is not perceived as a mitigation issue yet and the greater interest the focus in Slovenia is on manure management and animal nutrition, so livestock producers would be more interested
- The national advisory service programme requires regional specialist advisors to provide some training and activities related to climate change (5% of resources should be dedicated to climate change). Four hours of training is compulsory for farmers in the agri-environment programme, about half of farmers in the agri-environment programme would have attended the training on climate change and agriculture.
- Awareness on Climate Change is growing (approximately 50%) as farmers are faced with more storms and droughts. In 2011-2012 advisors organized training within the agri-environment programme within their region that focused on reducing emissions in livestock production (manure management and nutrition).

Recommendations for Slovenia

1. Effort on training and awareness for both farmers and advisors would be very crucial to a successful implementation of a tool as the Carbon Calculator.

iv) The Spain experience

General

In Spain two regions have been surveyed: Castilla y León and Andalucía. Both intensive livestock farms (dairy cattle) and extensive livestock farms (cattle and Iberian pig and sheep) and rain -fed cereal crop and range of fruit crop farms have been included in the survey.
In intensive farms (dairy cattle) there have been investments for modernization in regard to environmental issues and in many cases installing solar panels on the roofs of buildings.
Generally climate change is not seen as a problem, although there is some awareness among a minority. Some farmers perceive changes in climate, and they express some sensitivity about it and they are aware that e.g. harvest time comes earlier now as before it was in July and now it is in June. Most farmers (cooperative members) perceive climate change as less rain each year, but the weather each year is very variable. Climate change is generally not perceived as a priority issue. The first concern is economic: making ends meet. Young people are more sensitive, especially if it affects feed costs for livestock.

The Castilla y León region

Data availability and reliability

- Data availability in farm records is quite limited (below 40% in average). Particularly, the Carbon storage section and the cropland module would be the most difficult points (specially Q.2.1.2. on permanent pasture), while the info for the Assessment registration module would be much more available

- In average, almost 90% of farmers, however, would be capable of estimating the demanded info, with an appreciated reliability of 3.1 out of 5.
- The reliability of the information required to be estimated by farmers seems to depend on their education and training levels and their knowledge and sensitivity to climate change as a problem. However, the complexity of the requested data (data type, units used, and the availability of the Carbon Calculator in the native language of the farmers e.g. Spanish) would exert also an influence.
- The most complete records with data are in farms with organic and integrated production, intensive livestock (pigs and cattle) farms and those engaged in cooperatives or using advisors.

The feasibility and willingness of farmers to use the CC

- There is not good knowledge and awareness among farmers on the climate change problem or the role of agriculture for its mitigation.
- Computer use is very limited among farmers, except those related to intensive livestock production, constituting a major barrier to the potential use of the calculator.
- In average it would take farmers more than 3 hours to access the data if recorded for the different modules of the carbon tool.
- Willingness to use the CC would depend also on the potential economic profit that could be derived to the farmer.

The Andalucía región

Data availability and reliability

- Data availability in farm records is quite limited (below 45% in average). Particularly, the Carbon storage section and the Other inputs module (specially renewable energies and organic matter flows) would be the most difficult points, while the info for the Assessment and registration module would be much more available.
- In average, almost 86 % of farmers would however be capable of estimating the demanded info, with an appreciated reliability of 3.8 out of 5.
- The reliability of the information required to be estimated by farmers seems to depend on their education and training levels and their knowledge and sensitivity to climate change as a problem. However, the complexity of the requested data (data type, units used, and the language of the calculator) would exert also an influence.
- The most complete records with data are in farms with organic and integrated production, and those most modernized (irrigation) farms, intensive livestock (cattle), and large farms (dry land). Extensive livestock farms (cattle and Iberian pigs) would be those with less information recorded.

The feasibility and willingness of farmers to use the CC

- There is no good knowledge and awareness among farmers on the climate change problem, or the role of agriculture for its mitigation.
- Only a minority of farmers use computer programs (intensive livestock producers and large farms with rain fed and irrigated arable crops).
- In average it would take farmers less than 1 hour to access the data if recorded for the different modules of the carbon tool, particularly those farmers engaged in cooperatives (COVAP and Los Pedroches)
- Willingness to use the CC would depend also on the potential economic profit that could be derived to the farmer.

Recommendations for Spain

- The profile of farmers having greater willingness to use the carbon calculator corresponds to younger people which we assume in general more aware, educated and with computer knowledge, with sensitivity to environmental issues. Also larger farms benefiting with costs reductions and improved performance from its use would be more positive to its use. Extensive and smaller farms would be less prone to its use

- The cooperatives could assume an important role in the use of the CC, considering that they keep records of their associates for all the demanded variables.
- To implement the use of the calculator we would recommend previous general information campaigns and training on the problem of climate change and its relation to agriculture (with emphasis on its effect on production). Using the calculator could be generalized through cross-compliance or certification schemes.

v) The German experience

General

In Germany advisors who have been surveyed know and work for the full range of farm types and systems. The farm size ranges from 60 – 6000 ha and include the full range of livestock including dairy, pigs, sheep, goats, poultry and horses and crop and feed production plus wheat, barley, rape, sugar beet. The average age of farmers ranges from 40 – 60 years.

Data availability and reliability

- In general all farms have access to computers. The bigger and more specialized farmers tend to have more specialised book keeping systems and for some the administrative work is outsourced and examples of such book keeping systems were given.
- Not all advisors respond that climate change is an issue that farmers would recognize and accept to be real. The bigger and conventional farmers do not consider this as an issue while the organic farmers are much more aware of climate change.
- Farmers do understand that they contribute to emissions of greenhouse gases and climate change should it exist. Some farmers would recognize that they could contribute to mitigation and would expect (financial) support for these extra activities.
- Advisors don't see real wide spread initiatives in Germany, yet action has been taken on some farms e.g. building biogas-plants, coverage of fermentation tanks and modernisation of stables with climate friendly ventilation.
- In Germany, farmers are required to make nutritional balances, need to know how much N is in their soils and need to test the manure among other issues. They have generally access to a range of environmental relevant data and indicators.

The feasibility and willingness of farmers to use the CC

- Farmers are interested and willing to use the CC tool once it is ready and they perceive the tool as a means to control soil fertility measures; the majority of the farmers anticipate low benefits of using the tool to increase farm income
- Farmers perceive the time needed to complete the CC tool and the comprehensibility of the CC tool as a barrier to use it.
- Farmers would require the CC tool to be easy to understand and to be used stand alone without advisor needed to be present

Recommendations for Germany

- In Germany, farmers report frequently on range of issues other than climate change and linking the data required for a carbon calculator tool to data made available to farmers for other (environmental) schemes from data bases or forms will simplify the process of data retrieving and data entry.

vi) The Danish experience

General

In Denmark advisors represent farming businesses in livestock with cattle, dairy and pig from professional and market oriented businesses as well as smaller part time farming businesses. The average age of farmers is 50 – 55 years. The farmers generally have computer skills, but in some cases, e.g. for applications for financial support, fertilizer accounts, farmers prefer to pay agricultural advisors to fill in and submit the forms in order to avoid errors and subsequently repayments and/or fines. Denmark has a well-established advisory services and these offer services at reasonable prices. Such agricultural advisory services have insurances that cover liability in case something is not correct.

Data availability and reliability

- In Denmark, computer skills among farmers is not considered to be the limiting factor for the use of a tool such as the Carbon Calculator, but more likely the mismatch between the efforts needed and the value of the output for the farmer is.
- Estimates in relation to machinery, equipment and buildings are poor simply because the knowledge on these issues is poor. If farmers had the information or were able to give reliable estimates, they would be happy to do so. Also, there is almost no link between these issues and support schemes or fines through for example Cross-Compliance, which is the case for many other of the data required for the calculator.

The feasibility and willingness of farmers to use the CC

- In 2012, the major dairy company Arla announced that all their 'share holders' who deliver milk in Denmark and Sweden would be offered a so called climate check. Arla have paid for a carbon calculator tool that will be used to achieve this. Arla see it as a strategy in the competition with the other major dairy industries like Friesland Campina and Unilever and would help them to stay on the market.
- In general Danish farmers do not perceive climate changes as a problem and it has currently no consequences on their daily farm management. Instead climate change is seen as a challenge that ultimately provides new options for the Danish farmers. However, one advisor actually points out that most farmers have experienced problems with heavy showers in the summer, indicating that the issue is more complex.

Recommendations for Denmark

- Make sure that the use of the Carbon Calculator must be of (financial or production) benefit for the farmers. They do not want to provide information or use time and recourses on the calculator unless they can see a clear purpose of doing so.

vii) The Swedish experience

General

The three advisors interviewed in Sweden cover dairy farming, organic farming and all types of farms respectively. One of the advisors mainly dealt with full time professional farms, whereas the two others did not specialize on specific types of farms regarding these issues. There are some differences in the assessment of the advisors regarding use of information technology by the farmers. One advisor answered that almost all farmers used IT in their farm management, whereas the lowest estimate was around half of the farmers. In general the advisors assessed that the farmers would have the skills to run the Carbon Calculator.

Data availability and reliability

- Estimates on some of the issues relating to soil and climate were poor, probably due to the classifications suggested for the calculator.
- In relation to farm management some issues on grassland management, water use and the use of inputs could cause trouble for the farmers if to be based on farm records. However, for most of these data good estimations can be provided by the farmers.
- Also in relation to the estimates in relation to machinery, equipment and buildings knowledge is not complete in farm records. However, estimates could be provided with relatively high reliability.

The feasibility and willingness of farmers to use the CC

- The answers from the Swedish advisors indicate that many Swedish farmers see climate changes as a problem. However, the farmers are unsure of how big the problem actually is. The advisors also indicate that many of the suggested mitigation options are already known to the farmers.

Recommendations for Sweden

- The advisors pointed out that Sweden has a successful programme to reduce leaching of nutrients and pesticides. This programme is based on voluntary participation and a high degree of involvement of advisors. Two advisors pointed out that the use of the carbon calculator could be implemented as part of this programme. Simple tools are already used in this programme to calculate fertilizer application and a simpler climate check is also available as part of the options. Participation in the programme is free for the farmers. More information in English can be found on:
http://www.greppa.nu/omgreppa/omwebbplatsen/inenglish.4.32b12c7f12940112a7c800022239.html

Annex 4 Detailed results

Cropland and grassland management section 2 of the Carbon Calculator

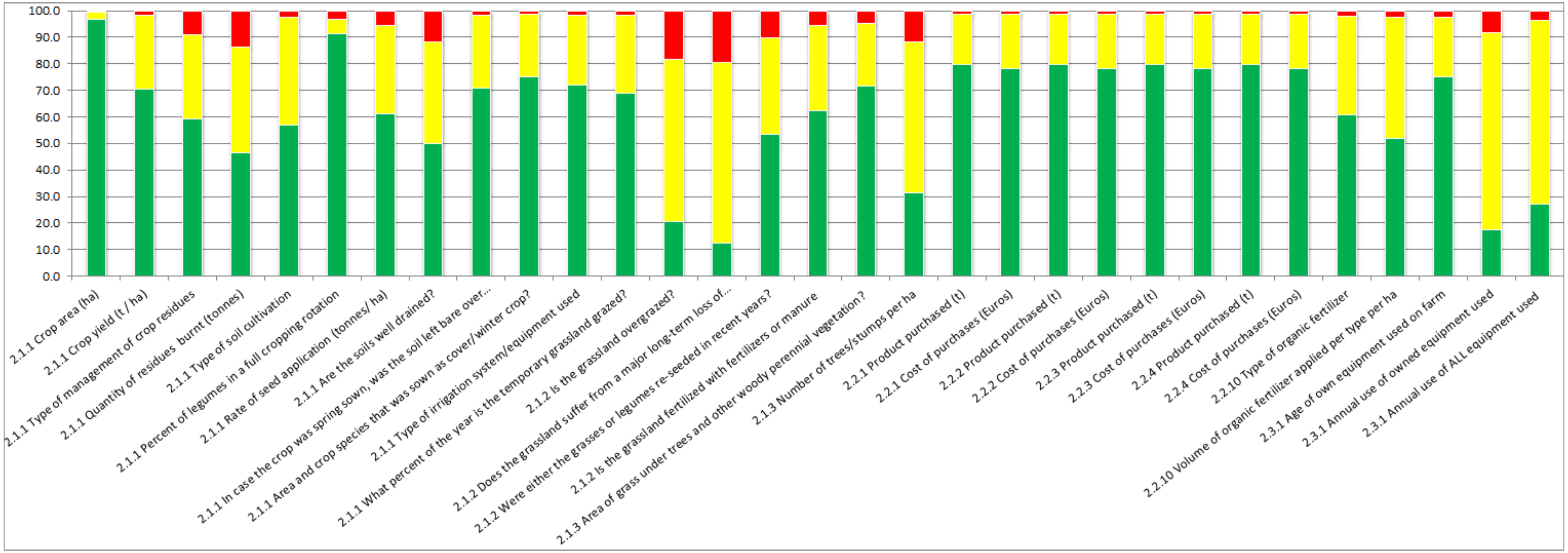


*Figure A4.1 Data on farm characteristics, operations and management in relevant to the section in the Carbon Calculator on **cropland** (given in % of farmers) that are available from farm records (GREEN) or can be estimated by farmers (YELLOW)and no data or estimates (RED) (given in % of the farmers indicated by farmer advisors, respondents n=22).*

Livestock (ruminants 3.1.x and monogastrics 3.2.x) in section 3 of the Carbon Calculator.

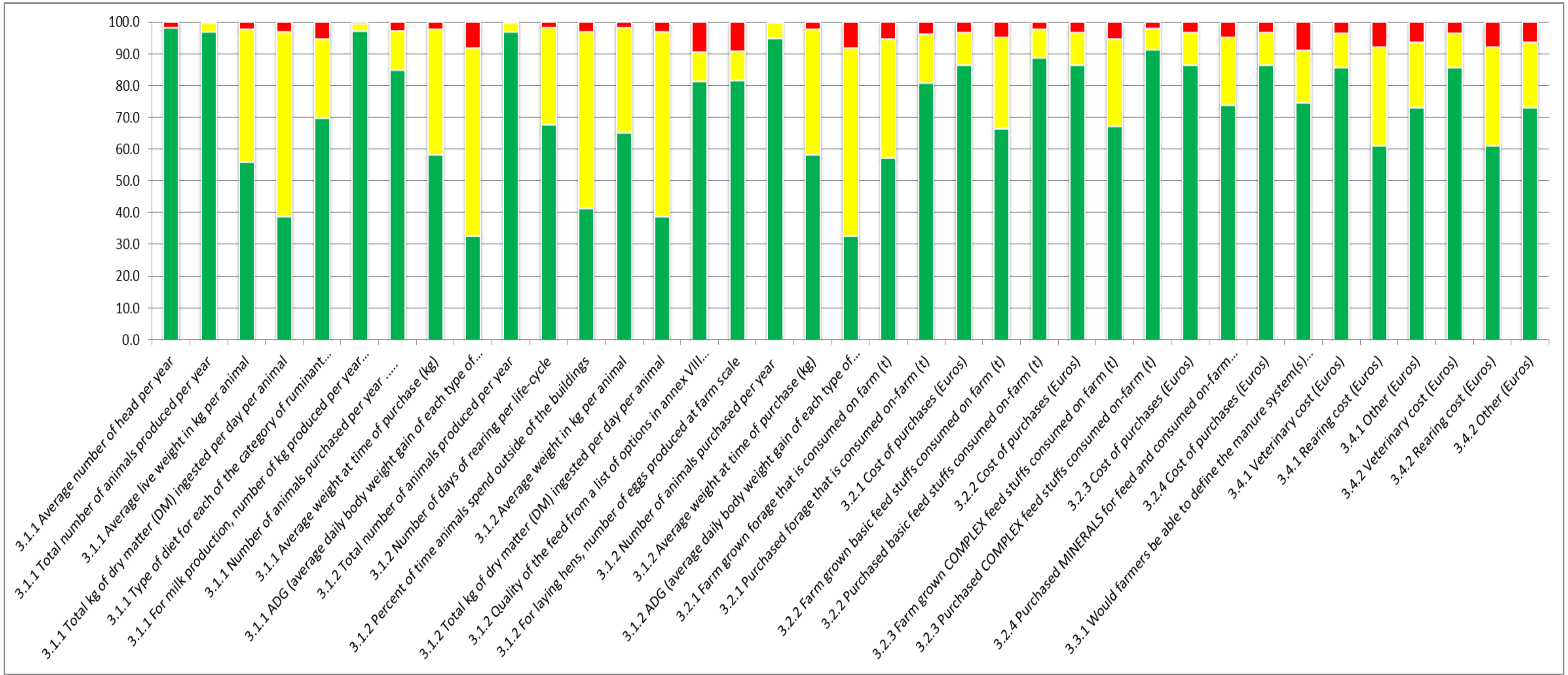


Figure A4.2 Data on farm characteristics, operations and management in relevant to the section in the Carbon Calculator on ***livestock – ruminants 3.1.x and monogastrics 3.2.x*** *(given in % of farmers) that are available from farm records (GREEN) or can be estimated by farmers (YELLOW) and no data from record or estimate (RED) (given in % of the farmers indicated by farmer advisors, respondents n=22).*

Annex 5 Questionnaire full text

EUROPEAN COMMISSION
JOINT RESEARCH CENTRE
Institute for Environment and Sustainability

FRAGARIA consortium

EU wide Farm-level Carbon Calculator

Questionnaire
on data availability at farms across EU-27

Contents

Short explanation of the questionnaire

This questionnaire is divided in the following broad sections, each section with a number of sub-sections:

Section 1 general questions on socio-economic characteristics of the farms/farmers in the selected region (contextual information).

Section 2 specific questions on the availability and likely reliability of the required data for the different modules of the carbon calculator.
Within this section we ask for the **PERCENTAGE** of farmers that would be able to supply the data from farm records for the area/region that you are working in. It would be sufficient to provide us with an approximate percentage of farmers that you advise that would, in your view, be able to supply different types of information (e.g. 10%, 25%, 50%, 75% or 90%).
The term **FARM RECORDS** means any information in written form (administrative documents, receipts, electronic data, and other paperwork).
If it is probable that you will not need to complete all elements of the questionnaire, for example if you consider that >90% of the farmers would have access to information from farm records, you would not need to complete the questions on whether farmers can provide estimates of these same data and neither will you need to estimate how reliable these estimates would be.

Section 3 general questions on the feasibility of data access for the calculator and the willingness of farmers to use the calculator.

Section 1 –Socio-economic characteristics of the farms/farmers in the selected region (contextual information)

1. Could you give an indication of what is the typical structure of farms that you advise? What are their characteristics according to the following criteria:

    a. Average farm size

    b. Predominant production output (type of crops, livestock)

    c. Management status (full-time, part-time, or hobby farms)

    d. Degree of market orientation (on the spectrum from full-market orientation to subsistence production)

    e. Average age of farmers

2. *Do farmers generally have access to and use Information Technologies?*

For example, do they use:

a. Computers (for example, to fill out subsidy applications online, or use online fertilizer plans or other decision-support tools to support farm management)

b. Software (would farmers have skills to work with EXCEL spread sheets)

c. Precision farming support technology (e.g. GPS)

d. Other e.g. FAO databases to find soil type, rainfall, degree days etc. such as:

3. To what extent do farmers perceive climate change to be a problem that is affecting or will affect them?

4. Do farmers understand the ways in which agriculture contributes to and can mitigate climate change?

5. What are the main environmental challenges for farming in your region (or the predominant farm sector that you deal with)? What are farmers doing, if anything, to address these at farm level?

6. Are there any active initiatives in your region for promoting mitigation of climate change in the agricultural sector? If so, can you please describe them and explain who is involved and how?

7. Do farmers have access to and use data from environmental indicators, for example measurements of the nitrogen content of their manures (for example for their fertilizer plans), or data on the carbon content of their soil (derived from field and farm samples analysed at specialized laboratories)?

Section 2 - Data availability and reliability (per module)

1. <u>Assessment registration module</u>

1.1 <u>Assessment identification</u>

1.1.1 Would farmers be able to supply the following data on the main characteristics of their farm for the assessment year (i.e. the last harvest year)?

Data required	**Farmers are capable to provide data Yes/no**
Utilised Agricultural Area (ha)	
Number of Annual Work Units (AWU)	
Nitrate Vulnerable Zone designation (whole farm, part of farm, or no designation)	
Natura 2000 designations on their farm (whole farm, part of farm, or no designation)	
Farming practices (organic, conventional, conservation or integrated farming)	

1.2 <u>Pedoclimatic conditions</u>

1.2.1 Would farmers be able to supply the following data on pedoclimatic conditions for a specific assessment year?

Most of these data are available in EU level datasets or from FAO websites, but data might also be available at national or farm level. What level of detail / scale would be best to use for this purpose (1 = most suitable – 3 least suitable)? For information about the level of detail required by the carbon calculator, see Annex I).

		Level of detail (please rank 1 – 3)		
Data required	**Farmers are capable to provide data (% who can)**	**Farm level (farm records/ response of the farmer)**	**National level (national data sources)**	**European level (European data sources)**
Climate zone				
Mineral dominant soil				
Soil texture of the dominant soil of the farm				
Dominant soil pH (>7 or <7)				
Altitude (m)				
Annual rainfall (mm)				
Rainfall during winter (mm)				
Rainfall during summer (mm)				
Annual mean temperature (˚C)				
Mean spring temperature (mean spring temperature in the 3 months after the first 400˚C days in ˚C)?				

1.3 <u>Farm products</u>

*1.3.1 Would farmers be able to identify –the **5 main farm products** (in terms of either economic profit or based on volume) for the assessment year at the level of detail shown in Annex II? Products are outputs, such as meat, and milk or cereals, as listed in Annex II*

Economic profit	Yes/No
Production in terms of volume/ton	Yes/No

2. Cropland module (includes crops and rotations that include temporary and permanent grassland)

2.1 Croplands and grasslands (the latter related to livestock products)

In this section we ask for data related to the five **main farm products** (see question 1.3.1) i.e. crops. as well as grassland that supports the livestock products.

*2.1.1 Would farmers be able to supply the following data for each **crop and grassland type that supports** the **5 main products** on their farm? (see illustration of level of detail required in Annex III)?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Crop area (ha)			
Crop yield (t / ha)			
Is the crop cultivated using organic methods of production?			
Type of management of crop residues, for example: burning / exported from the field / incorporated to the soil			
Quantity of residues burnt (tonnes)			
Type of soil cultivation, eg: no-till / reduced till / deep ploughing or other soil cultivation management			
Percent of legumes in a full cropping rotation			
Rate of seed application (tonnes/ ha)			
Are the soils well drained?			
In case the crop was spring sown, was the soil left bare over winter?			
Area and crop species that was sown as cover/winter crop?			
Volume of irrigation water used for the crop (m3 per ha)			
Type of irrigation system/equipment used			
What percent of the year is the temporary grassland grazed?			

2.1.2 *Would farmers be able to supply the following data **on those permanent pastures** that are related to the 5 **main products** on their farm? (see definition of permanent pasture and illustration of level of detail required in Annex IV)?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Is the grassland overgrazed?			
Does the grassland suffer from a major long-term loss of productivity?			
Were either the grasses or legumes re-seeded in recent years?			
Is the grassland fertilized with either synthetic fertilizers or manure other than from urine and droppings during grazing			

2.1.3 *Would farmers be able to supply the following data **on agro-forestry** in case related to the **5 main products** on their farm?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Area of grass under trees and other woody perennial vegetation			
Number of trees/sumps per ha			

2.2 Fertilizers and pesticides

Fertilizers and pesticides (amount) per farm

*2.2.1 Would farmers be able to supply data on their purchases of **fertilizers** (tonnes of product purchased and cost per farm in the last financial year) in **broad categories** shown in Annex VI?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Product purchased (t)			
Cost of purchases (Euros)			

*2.2.2 Would farmers be able to supply data on their purchases of **fertilizer**s (tonnes purchased and cost per farm in the last financial year) in **detailed categories** shown in Annex VI?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Product purchased (t)			
Cost of purchases (Euros)			

*2.2.3 Would farmers be able to supply data on their purchases of **pesticides** (tonnes purchased and cost per farm in the last financial year) in **broad categories** shown in Annex VI?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Product purchased (t)			
Cost of purchases (Euros)			

2.2.4 *Would farmers be able to supply data on their purchases of **pesticides** (tonnes purchased and cost per farm in the last financial year) in **detailed categories** shown in Annex VI?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Product purchased (t)			
Cost of purchases (Euros)			

Fertilizers and pesticides (amount) per farm divided over the 5 main farm products (see question 1.3.1)

2.2.5 *Would farmers be able to supply data on the amount (kg/ha) of their different **fertilizers** in **broad categories** shown in Annex VI applied to each of their **5 main farm products**, as illustrated in Annex II?*

Percent of farmers who would be able to access this information from farm records	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**

2.2.6 *Would farmers be able to supply data on the amount (kg/ha) of their different **fertilizers** in **detailed categories** shown in Annex VI applied to each of their **5 main farm products**, as illustrated below?*

Percent of farmers who would be able to access this information from farm records	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**

2.2.7 *Would farmers be able to supply data on the amount (kg/ha) of their different **pesticides** in **broad categories** shown in Annex VI applied to each of their **5 main farm products**?*

Percent of farmers who would be able to access this information from farm records	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**

2.2.8 *Would farmers be able to supply data on the amount (kg/ha) of their different **pesticides** in **detailed categories** shown in Annex VI applied to each of their **5 main farms products**?*

Percent of farmers who would be able to access this information from farm records	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**

Fertilizers and pesticides (number of applications) divided over the main 5 farm products (see 1.3.1)

*2.2.9 Would farmers be able to supply data on the number of fertilizer and pesticide applications made to each of their **5 main farm products**?*

Percent of farmers who would be able to access this information from farm records	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**

Organic fertilizers (type and volume) divided over the main 5 farm products (see question 1.3.1)

*2.2.10 Would farmers be able to supply data on the type and volume of organic fertilizers applied to each of their **5 main farm products**?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Type of organic fertilizer, e.g., slurry, manure, organic waste, such as digestate etc.			
Volume of organic fertilizer applied per type per ha			

2.3 Farm machinery

2.3.1 Would the farmer be able to supply the following data for all equipment and machinery used on the farm at the whole-farm level (including equipment and machinery not owned but used by hired workers) and provide information on the age of equipment and machinery used on farm whether owned or not owned? This information would have to be supplied for individual items of machinery drawn a defined list (an illustration of this list is presented at Annex VII).

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Age of own equipment used on farm			
Annual use (number of hours per year) of owned plus of not owned and provided by hired workers equipment that is used on farm			

2.3.2 Would famers be able to allocate the share of on-farm use of each of the pieces of equipment identified at 2.3.1 to the ***5 main farm products****? The allocation would be expressed as a percentage of total on-farm use.*

Percent of farmers who would be able to access this information from farm records	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**

2.3.3 Would farmers be able to differentiate (in terms of number of hours used per year between the machinery and equipment that they own and use on farm and the machinery that hired workers bring and use to their farm?

Percent of farmers who would be able to access this information from farm records	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**

3 Livestock module

3.1 Livestock

In livestock we distinguish 2 categories i.e. ruminants (3.1.1) and monogastrics (3.1.2) and subspecies for each category as outlined in ***Annex V****.*

Subspecies of ruminant livestock at farm level

3.1.1 Would farmers be able to supply the following data for the each category of ***subspecies of ruminant livestock*** *on their farm for a given year at the level of detail shown in* ***Annex V,*** *if applicable?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Average number of head per year			
Percent of their time that animals spend outside the buildings			
Total number of animals produced per year			
Average live weight in kg per animal			
Total kg of dry matter (DM) ingested per day per animal			
Percent of crude protein in diet			
Type of diet for each of the category of ruminant livestock animals (see Annex VIII)			
For milk production, number of kg produced per year at farm scale			
Number of animals purchased per year and average weight of these animals at the time of purchase (kg)			
ADG (average daily body weight gain of each type of animal)			

Subspecies of monogastric livestock at farm level

3.1.2 *Would farmers be able to supply the following data for the each category of* ***subspecies of monogastrics*** *on their farm for a given year at the level of detail shown in* ***Annex V,*** *if applicable?*

Data required	Percent of farmers who would be able to access this information from farm records	Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?	How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)
Average number of animals per life-cycle			
Number of life-cycles per year			
Total number of animals produced per year			
Number of days of rearing per life-cycle			
Percent of time animals spend outside of the buildings			
Average weight in kg per animal			
Total kg of dry matter (DM) ingested per day per animal			
Quality of the feed from a list of options in annex VIII (high, median, low quality)			
For laying hens, number of eggs produced at farm scale			
Number of animals purchased per year and average weight			
ADG (average daily body weight gain of each type of animal)			

3.2 Forage, feedstuff and minerals

In this section we ask for details on 4 types of feed (forage, basic feedstuffs, complex feedstuffs and minerals (see Annex VIII) for details on types considered.

Forage at farm level

3.2.1 Would farmers be able to supply data on both their purchases and farm grown forage that is consumed (tonnes) and cost for purchases per farm in the last financial year at the level of detail shown in Annex VIII?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Farm grown forage that is consumed on farm (t)			
Purchased forage that is consumed on-farm (t)			
Cost of purchases (Euros)			

Basic feed stuffs at farm level

3.2.2 Would farmers be able to supply data on both their purchases of and farm grown basic feed stuffs that is consumed (tonnes) and cost per farm in the last financial year at the level of detail shown in Annex VIII?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Farm grown basic feed stuffs consumed on farm (t)			
Purchased basic feed stuffs consumed on-farm (t)			
Cost of purchases (Euros)			

Complex feed stuffs at farm level

3.2.3 Would farmers be able to supply data on both their purchases and farm grown complex feed stuffs consumed (tonnes) and cost per farm in the last financial year at the level of detail shown in VIII?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Farm grown complex feed stuffs consumed on farm (t)			
Purchased complex feed stuffs and consumed on-farm (t)			
Cost of purchases (Euros)			

Minerals for feed at farm level

3.2.4 Would farmers be able to supply data on their purchased minerals consumed (tonnes) and cost per farm in the last financial year at the level of detail for minerals shown in annex VIII?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Purchased minerals for feed and consumed on-farm (t)			
Cost of purchases (Euros)			

3.3 Manure management system

Manure management system per livestock category at farm level

3.3.1 Would farmers be able to define the manure system(s) for each livestock category? See short list of coherent manure management systems in Annex IX?

Percent of farmers who would be able to access this information from farm records	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**

3.3.2 Can you provide us with information on what manure management systems are missing from the list in Annex IX for the main different livestock categories in Annex V and what other information would be relevant in your view for the calculation of the emissions of greenhouse gases from manure storage?

Suggestions:

3.4 Expenses for animal rearing and veterinary support

Animal expenses at farm level

3.4.1 Would farmers be able to supply data on the list of animal expenses at farm level and veterinary and rearing and other cost (artificial insemination, milk analyses, animal identification)?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Veterinary cost (Euros)			
Rearing cost (Euros)			
Other (Euros)			

Animal expenses attributed to the livestock that occur in the 5 main farm products

3.4.2 Would farmers be able to supply data on the list of animal expenses (shown in the table) distributed over the livestock in their 5 main products?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Veterinary cost (Euros)			
Rearing cost (Euros)			
Other (Euros)			

4 Other inputs module

4.1 Direct energy consumption at farm level

*4.1.1 Would farmers be able to supply data on **direct energy consumption** (farm level) for the cost categories shown in Annex X?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Amount (in terms of litres, Kwh etc.) purchased			
Would farmers be able to allocate the amount of energy used for each of the categories			
Cost of purchases (Euros)			

4.2 Renewable energies

*4.2.1 Would farmers be able to supply data on **renewable energies** consumption (farm level) at the level of detail shown in Annex X?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Amount (in terms of litres, kWh etc.) purchased			kWh
Would farmers be able to allocate the amount of energy used for each of the categories			
Cost of purchases (Euros)			

4.3 Organic matter flows at farm level

4.3.1 Would farmers be able to supply data on organic matter flows per type of organic matter (farm level) at the level of detail shown in Annex X?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Quantity (tonnes) of organic matter imported (other than the organic matter for *animal feed*)			
Quantity (tonnes) of organic matter exported			
Default values for N, P_2O_5, K_2O content for each product			
Type of transport used and distance to the farm			
Allocation to the 5 main products and land uses, i.e. % distribution over each product and land use			

4.4 Other inputs

4.4.1 Would farmers be able to supply data on other inputs (farm level) at the level of detail shown in Annex X?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Amount (in terms of kg, litres, etc.) purchased			
Cost of purchases (Euros)			

4.5 Buildings

4.5.1 Would farmers be able to supply data on buildings at the level of detail shown in Annex X?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Age			
Surface (m^2)			
% usage (time allocation) for the 5 main products			

*4.5.2 Would farmers be able to supply data on the area, volume or weight and of age of construction materials used in the **farm buildings** at the level of detail shown in the final table with list of materials in Annex X ?*

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**
Area, volume or weight and age of a list of construction materials identified in the final table of Annex X)			

5. <u>Carbon storage</u>

5.1 Would farmers be able to supply data ((in terms of HA per farm) landscape elements on their farm and estimate the area for details of the definition of these 'elements' see Annex XI?

Data required	**Percent of farmers who would be able to access this information from farm records**	**Would those famers that have no data in farm records be willing to provide some kind of estimate (Y/N)?**	**How reliable would an estimate be? (Rank, where 5=highly reliable and 1=highly unreliable)**

5.2 Can you suggest any landscape elements that we have missed and provide us with the names?

Suggestions: ……

Section 3 - Feasibility of data access for the calculator and the willingness of farmers to use the calculator

1. What do you see as the main barriers to the use of a carbon calculator by farmers, and by advisory services?

2. What types of farms may be interested in using this calculator?

3. What types of farms would not be interested at all?

4. How long do you think it would take farmers, on average, to access/find the data for each module of the carbon tool:

Module	Time required (minutes)
Assessment registration module	
Cropland module	
Livestock module	
Other inputs module	
Carbon storage	

5. What type of data for the modules on crops, livestock, other inputs etc. would be the most time consuming for farmers to access the information for?

6. What type of data for the modules on crops, livestock, other inputs etc. would be the most time consuming for farmers to access the information for?

Theme	Actions	Type of action (A/B)
Agronomics	Introduction of legumes in the rotation	A
	Introduction of legumes in grasslands	A
	Adjust N fertiliser balance	A
	No-tillage	A
	Soils covered all the year	A
	Agroforestry	A
	Avoid burning residues	A
	Diversification of the system (mixed farms livestock/crops)	B
Livestock	Improve livestock productivity	B
	Optimisation of grazing	A
	Optimisation of the stocking rate (animal number per ha)	A
	Change in slurry management system: cover/crust	A
	Coverage of solid manure pile	
	Reduce methane from enteric fermentation	B
	Composting solid manure	A
	Biogas production	A
Energy (direct energy)	Reduce engines fuel consumption (test and eco driving)	A
	Reduction of electricity consumption of the milking system	A
	Optimisation of ventilation during grain storage	A
	Improving heated buildings insulation (pigs, poultry)	A
	Implementation of thermal screens in greenhouses	A
	More efficient heating system	A
	Solar panel on suitable buildings	A
	Heat water with solar panels	A
	Wood boiler	A
Carbon storage (soils and hedges)	Implementation of hedges and others landscape elements	A

7. What would be the most likely route to maximising the use of the calculator by farmers, for example, through voluntary certification schemes, voluntary compensation schemes, regulation, or education campaigns?

8. Do you have any other comments or suggestions on the data collection requirements as outlined in this questionnaire?

My other comments or suggestions are:

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