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Final Technical Report: Certification of Low Carbon Farming Practices

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by Vincenzo Angileri on 7th April 2011

Final Technical Report: Certification of low carbon farming practices

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“Certification of low-carbon farming practices”

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Preface

The objective of the 'Certification of low-carbon farming practices' -project was to assess policy options for promoting low-carbon farming practices in the European Union. The project also included development of an EU-wide farm-level carbon calculator that assesses a carbon footprint of a farm and its products and recommends mitigation options to reduce greenhouse gas emissions. This document gives an overview of the whole project. The detailed reports of each part of the project are provided in the annexes. This final report is an updated and extended version of the mid-term technical report that was approved by DG ENV on 26 September 2012.

Executive summary

Description of the project The direct emissions of greenhouse gases (GHG) from agriculture account for approximately 10% of total European Union (EU) emissions. In 2010, the European Parliament asked the European Commission to carry out a pilot project on the "certification of low-carbon farming practices in the European Union" to promote reductions of GHG emissions from farming. The overall aim was to assess how efforts of European farmers to produce agricultural products with carbon-neutral or low-carbon-footprint farming practices might be incorporated into policy approaches (possibly via certification), so as to promote the reduction of GHG emissions from agriculture. The project included: i) a review of existing farm-level lifecycle-based climate-related certification and labelling schemes, ii) the development and testing of a user friendly open-source carbon calculator suitable for assessing the lifecycle GHG emissions from different types of farming systems across the whole EU, and iii) the design/assessment of policy options for promoting low-carbon farming practices. The Carbon Calculator software was developed by a French consultancy company called Solagro. The testing of the Carbon Calculator and the surveys of data availability and policy options were carried out by Alterra, Wageningen University, including collaborators from the University of Copenhagen, the University of Reading, the University of Madrid and the Ecologic Institute in Germany. The project was managed by the Monitoring Agricultural Resources Unit of the European Commission's Joint Research Centre.

Task 1: Low-Carbon Certification Schemes Review The aim of the initial certification scheme review was to provide background information for the design of policy options based on an EU-wide farm-level carbon calculator. This review describes examples of national and regional certification and labelling schemes that explicitly aim to evaluate climate change mitigation practices in food production. A summary is given of the standards relating to the carbon footprint. The certification and labelling schemes included in the review were grouped into five different categories: (i) carbon footprint certification schemes, (ii) carbon-neutral product schemes, (iii) companies' carbon reporting schemes, (iv) criteria-based low-carbon farming certification schemes and (v) other certification schemes relevant to low-carbon farming.

It emerges from the review that there are multiple options for using a farm-level carbon calculator for certifying low-carbon farming practices. Farms can be certified upon a declaration of a third-party-verified carbon footprint, upon proven emission reductions, or upon lower emissions compared to the average in the product group. Alternatively, assessment of a carbon footprint can be a part of a wider environmental certification scheme. In addition to certification, carbon footprinting of farm products can be a means by which to justify and quantify the support given to farmers for carrying out voluntary rural development measures.

Task 2.1 Development of a farm level Carbon Calculator The project developed a user friendly open-source carbon calculator suitable for assessing the lifecycle GHG emissions from different types of farming systems across the whole EU. The Carbon Calculator tool is available for free download, together with its User Guidance Manual (Annex 2) from Solagro's website (https://carbone.solagro.org/). The Carbon Calculator quantifies direct and indirect GHG emissions according to international standards (e.g. ISO and PAS2050) and guidelines on lifecycle assessment and carbon footprinting (e.g. the Organisation Environmental Footprint and the Product Environmental Footprint methodologies). In addition to the quantification of GHG emissions, the tool proposes mitigation options and sequestration actions suitable for single farms. A prototype version of the Carbon Calculator was tested on farms around the EU. Furthermore, a peer-review meeting for experts was organised in order to receive feedback on the

methodology used in the tool. The feedback from the farm testing exercise and the peer-review meeting were used to improve the Carbon Calculator.

Task 2.2 Farm survey to check data availability to run the Carbon Calculator A survey of the availability of data to run the Carbon Calculator was conducted by interviewing farm advisors in six different Member States. Advisors were asked to assess whether the necessary data would be available from farm records or if such data could be estimated by farmers.

In general, advisors considered the Carbon Calculator tool to be a complex tool that requires significant data input by farmers (i.e. up to 80 data entries). The majority of the data (>60%) that is 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% of the total data requirements.

The analysis shows that substantial differences exist between countries across Europe. In general, farmers in the UK, Denmark and the Netherlands have more data available from farm records than do farmers in Slovenia and Spain, with Germany having an intermediate level of data availability.

Task 3: Testing of the assessment tool for low-carbon farming practices The practicality and acceptability of the Carbon Calculator were tested on approximately seventy farms across the EU. The first version of the Carbon Calculator was tested at farm level on a diversity of farm types across all environmental zones in the EU-27. The testing of the Carbon Calculator covered:

- the performance of the Carbon Calculator, assessing whether it can be applied to different farm types, in different geographical regions, and whether it can generate estimates of the total GHG emissions of the farms;
- the user friendliness of the Carbon Calculator (considering that farmers will be the main users) as well as the attitude of farmers towards using such a tool;
- the carbon mitigation options that are generated by the Carbon Calculator for the different types of farms in order to assess their feasibility and the willingness of the farmers to take them up.

The testing exercise provided valuable information for the development of the functionalities of the software and of the willingness of the farmers to use the tool. The overall conclusions were that farmers would be willing to use the tool only if they had financial incentives to do so. In order to reduce the amount of time required to enter data into the tool, farmers would prefer a Carbon Calculator that is linked with other databases that already include some of the necessary farm data.

Task 4: Assessment of certification systems for low carbon farming practices The policy option survey was carried out among farmers and other stakeholders in eight different Member States. The questions aimed to assess which of three different policy options would be the most appropriate for potential implementation of the Carbon Calculator. The three options examined were: *regulation* (use of the Carbon Calculator would be made compulsory, e.g. by incorporating it into Common Agricultural Policy (CAP) cross-compliance requirements), *publicly funded voluntary incentive schemes* (use of the calculator would be made a requirement for participation in voluntary schemes funded under rural development programmes), or *certification or quality assurance schemes* (use of the carbon calculator would be a requirement of one or more privately or state operated quality assurance and certification schemes).

The survey found a significant variation in attitudes towards, and perceptions of, different policy options in terms of their potential to promote the use of the Carbon Calculator and low-carbon farming practices. The

survey nonetheless identified a number of strengths and weaknesses of these options regarding their ability to encourage use of the Carbon Calculator, increase environmental awareness, and drive GHG mitigation. Given the diversity of opinions, a wider consultation may be needed to discern the preferred policy option. This would need to be based on the actual detailed design of each approach (for example, how the baseline is set within cross-compliance, and how the additional requirements of agri-environment measures are defined).

Task 5: Forward looking recommendations

Remaining improvement requirements on the Carbon Calculator

Although many improvements were implemented after the testing of the tool on farms, further improvements can still be made. Some of the main suggestions include:

- The current version of the Carbon Calculator only takes into account GHG emissions, direct energy and water use, and nitrogen balance. This could be improved by extending the tool to cover other environmental impact categories, such as biodiversity and water quality.
- Future versions of the Carbon Calculator could better align with the methods for life cycle -based environmental accountancy that were established by the 2003 Integrated Product Policy (IPP) Communication such as the International Reference Life Cycle Data System (ILCD) Handbook, and the recently published Organisation Environmental Footprint and Product Environmental Footprint -methodologies. Future alignment of the Carbon Calculator with the Food Sustainable Consumption and Production Round Table's Envi-Food Protocol would also be highly desirable.
- The European Reference Life Cycle Database (ELCD) and ILCD data network could be more widely used for lifecycle data in the Carbon Calculator wherever possible.
- The possibilities of linking the tool with existing farm-scale databases or other software should be investigated.
- The Carbon Calculator could take into account the whole crop rotation cycle rather than just yearly crops, so that changes to crop rotation patterns could form part of proposed mitigation options.
- More mitigation actions could be added within the tool, and cost-efficiencies of the proposed options could be calculated.

Recommendations on policy options

The main recommendations on policy options include:

- The Carbon Calculator could be used to raise awareness, which could then lead to behavioural change. An improved version of the current tool could also be used for benchmarking, so that farmers can compare their farm's carbon footprint with those of other similar farms.
- The adoption of GHG mitigation actions could also be encouraged by providing a tool that shows how emissions and costs can simultaneously be reduced.
- A combination of approaches, each with a different focus, could address the disadvantages while making the most of the strengths of different options.
- Regardless of the policy option chosen, the use of a carbon calculator should be EU-wide to maximise the benefits of the calculator and reduce any objections among farmers about potential discriminatory effects.

- The Carbon Calculator could also be used by Member State administrations to verify that the rural development measures they propose as being eligible subsidisation are efficient in terms of low-carbon farming.
- Farm advisory services could use the Carbon Calculator in assessing the environmental performance of farms.
- The carbon calculation needs to be part of a package of conscious improvement of environmental practices among farmers which also leads to added value that can be captured by the farmer. The promotion of the Carbon Calculator and low-carbon farming needs to consider potential trade-offs that could occur if GHG mitigation measures were the sole focus, so newly implemented measures must take into account existing obligations (e.g. preservation of biodiversity).
- Beyond the three policy options presented in the survey, expanded reporting of GHG emissions to account for all agriculture-related GHG emissions (including Land Use, Land-Use Change and Forestry (LULUCF) emissions) and clear policy mandates/targets in the form of binding national or EU reduction targets would provide a stimulus for mitigation action in agriculture and increase the relevance of the Carbon Calculator. LULUCF action plans, however, need to be developed at Member State level. The monitoring requirements might, in the short term, increase the relevance of the Carbon Calculator as a tool that can provide a fundamental basis for monitoring GHGs and reducing land-based emissions.

Conclusions

The study shows that there are multiple options for using a farm-level Carbon Calculator for promoting low-carbon farming practices in the EU. Although this study evaluates the pros and cons of different policy approaches, more detailed study would be needed to assess the costs and benefits of each approach. There is a clear need for future versions of the Carbon Calculator to be incorporated in wider environmental impact assessment tools rather than being concentrated on a single issue only. The Carbon Calculator should be better aligned with the methods for lifecycle-based environmental accountancy that were established by the 2003 IPP Communication ILCD Handbook as well as the recent Organisation Environmental Footprint and the Product Environmental Footprint Methodologies annex recommendations from the Single Market for Green Products communication. The time spent on entering data into the Carbon Calculator could be reduced by developing an automatic data transfer from already existing farm databases. It is possible to envisage a certification scheme based on a Carbon Calculator which would inform the granting of subsidies, or the use of the Carbon Calculator in helping to allocate support for rural development measures that address climate change issues. This would require additional investment in an EU-wide tool that would optimise the functionalities of the Carbon Calculator based on the specific requirements of the chosen policy option.

Contents

1 Description of the project

1.1 Overall description

In 2010, the European Parliament asked the European Commission to carry out a pilot project on the "certification of low-carbon farming practices in the European Union" to promote reductions of greenhouse gas (GHG) emissions from farming. Whilst explaining that "the scheme should target the whole farming sector and should aim to take into account all the main factors contributing to carbon emissions from farming", the European Parliament stressed that "in order to ensure its relevance throughout the territory of the EU, the certification scheme should be tested through practical trials on a number of farming regions appropriately situated in various parts of the Union".

The overall aim was to assess how efforts of European farmers to produce agricultural products with carbon-neutral or low-carbon-footprint farming practices might be incorporated into policy approaches (possibly via certification), so as to promote the reduction of GHG emissions from agriculture.

The project developed a user friendly open-source carbon calculator that is suitable for assessing the lifecycle GHG emissions from different types of farming systems across the whole EU. The Carbon Calculator quantifies direct and indirect GHG emissions according to international standards (e.g. ISO and PAS2050) and guidelines on lifecycle assessment and carbon footprinting (e.g. the Organisation Environmental Footprint and the Product Environmental Footprint). In addition to the quantification of GHG emissions, the tool proposes mitigation options and sequestration actions suitable for single farms. The practicality and acceptability of the Carbon Calculator were tested on around seventy farms across the EU. Finally, a range of options for making widespread use of the carbon calculator were outlined, including, for example, public or private certification schemes, payment incentives to farmers, and legal obligations for farmers to reduce their GHG emissions.

1.2 Duration and tasks

DG ENV was entrusted with the overall task, and the Institute for Environment and Sustainability of the Joint Research Centre (JRC) was entrusted with its execution. The pilot project entitled "Certification of low-carbon farming practices" was signed on 22 December 2010, with duration of 30 months. The tasks listed in the Terms of Reference are summarised below:

Task 1: Analysis of existing climate-related or low-carbon certification schemes with impact on farming in the EU

This study describes the existing use of national and regional certification schemes that explicitly aim to give value to climate change mitigation practices in food production in the EU. The strengths and weaknesses of these schemes were analysed.

Task 2: Assessment methods for low-carbon farming practices

Development of a farm-level carbon calculator (the title given to the task in the Terms of Reference was "Evaluation of existing carbon assessment methods for farms")

Instead of reviewing the existing carbon assessment methods and selecting the most advanced as the basis for the carbon calculator, it was agreed with DG ENV to develop a Carbon Calculator at the outset for the purposes of this project. Therefore, this task involves the development of an EU-wide farm-level Carbon Calculator.

Farm survey to check data availability to run a Carbon Calculator

This survey evaluates whether all the information needed to run the Carbon Calculator can be easily collected at farm level.

Task 3: Testing of the assessment tool for low-carbon farming practices

From June 2012, the initial version of the Carbon Calculator was tested on about 70 farms that represented a broad range of farming systems and bio-geographical situations in the EU. The testing exercise examined not only whether the Carbon Calculator was well designed for the farm in question, but also whether any difficulties were encountered in its use. Improvements were made to the tool during the testing phase and, as a result, several versions were used for testing as they became available. Therefore, the results of the testing exercise (presented in Section 3.4) are based on the 2012 versions, and most of the suggestions for technical improvements of the tool that were made during the testing phase have been implemented in the delivered version of the Carbon Calculator. The remaining suggestions for improvements are discussed in Section 3.6 of this report.

Task 4: Assessment of certification systems for low-carbon farming practices

This task identified what policy options could be supported by the carbon calculator, ranging from private certification options through policy models such as giving payment incentives to farmers to reduce GHG emissions to legal obligations to do so. The advantages and disadvantages of the various options were set out. The study examined what sort of administration and governance structure would be needed to implement an effective certification scheme. The administrative proposals were tested through a survey review of farm-level testing of the calculator.

Task 5: Forward-looking recommendations

This task addresses the remaining problems in the area and how they could be resolved via a certification system based on a Carbon Calculator at farm level. An assessment was made of the level of effort appropriate to invest into setting up such a system.

2 Project organisation

During 2011, the JRC published two calls for tender: i) development of a Carbon Calculator to promote low-carbon farming practices (Task 2.1) and ii) an EU-wide data availability survey and testing of the low-carbon farming practices assessment tool (Tasks 2.2, 3 and 4). The JRC received five offers for the first call, and a contract was signed with a French consultancy company, Solagro, on 15 December 2011. The JRC did not receive any eligible offers for the second call. Therefore, a specific contract implementing a framework contract was made between the JRC and the Fragaria consortium that was led by Alterra, Wageningen University, and included collaborators from the University of Copenhagen, the University of Reading, the University of Madrid and the Ecologic Institute in Germany.

3 Main results

3.1 Task 1: Low-Carbon Certification Schemes Review

Climate-related certification schemes and carbon labelling schemes have been developed in response to growing concern about climate change. These schemes aim to provide consumers and companies with information about the climate impacts of products and services. The aim of this review was to provide background information for the design of policy options that would utilise an EU-wide farm-level Carbon Calculator. This review describes examples of national and regional certification and labelling schemes that explicitly aim to give value to climate change mitigation practices in food production. The full review is given in Annex 1.

The standards related to carbon footprinting were summarised, including standards from the International Organization for Standardization (ISO), the British Standards Institution (BSI), the International Reference Life Cycle Data System (ILCD), the World Resources Institute (WRI), the World Business Council for Sustainable Development (WBCSD), the European Food Sustainable Consumption and Production (SCP) Round Table, the Product/Organisation Environmental Footprint and the French government.

The certification and labelling schemes included in the review were grouped into five different categories: (i) carbon footprint certification schemes, (ii) carbon-neutral product schemes, (iii) companies' carbon reporting schemes, (iv) criteria-based low-carbon farming certification schemes and (v) other certification schemes relevant to low-carbon farming. For each category only the most well-known examples were given; no attempt was made to give a comprehensive review of the many existing schemes in the EU.

It seems clear that there are multiple options for using a farm-level Carbon Calculator for certifying low-carbon farming practices. Farms can be certified on the basis of the declaration of a third-party verified carbon footprint, proven emission reductions, or evidence of lower emissions compared to the average in the product group. Alternatively, assessment of a carbon footprint can be a part of a wider environmental certification scheme. In addition to certification, carbon footprinting of farm products can be a way to justify and quantify the support given to farmers for voluntary actions in rural development schemes. While the carbon footprint of farm products is not directly considered in the current CAP, some farming practices with an effect on climate change have already been taken into account in the CAP, both in the first pillar (e.g. some practices are part of the minimum requirements defined in the Good Agriculture and Environmental Condition) and second pillar (e.g. practices taken up in agri-environmental schemes). It seems that this approach will be extended in the CAP after 2013. Therefore, instead of being used only in a certification scheme, the carbon footprint of farm products could be a means by which to justify and quantify the support given to farmers for voluntary actions in rural development schemes.

3.2 Task 2.1 Development of a farm-level Carbon Calculator

3.2.1 Characteristics of the Carbon Calculator

The aim of the task was to develop a comprehensive software model (i.e. "Carbon Calculator") for the calculation of GHG emissions from farming practices and for proposing mitigation actions at farm level. A simple and comprehensive user interface was developed by using Microsoft Excel with Visual Basics for Applications (VBA) for macros and user forms (Figure 1). Thus, users with basic computer and agronomic knowledge should be able to carry out an assessment. The Carbon Calculator tool is available for free download, together with its User Guidance Manual (Annex 2), from Solagro's website

(https://carbone.solagro.org/). The User Manual explains how to fill in the different modules, which are presented in detail. The document gives a step-by-step description of the process from data entry to the analysis of the results.

Another document, entitled "Methodological Guidelines for the Carbon Calculator" (Annex 3), presents the general principles of the tool and details the methodologies, formulae and sources used for the design and development of the Carbon Calculator.

An Administrator Guide (Annex 4) has also been developed. It contains explanations about the administrator web interface (to be managed by Solagro for one year starting on 15th June 2013) and the description of all the VBA formulae that are implemented in the Carbon Calculator.

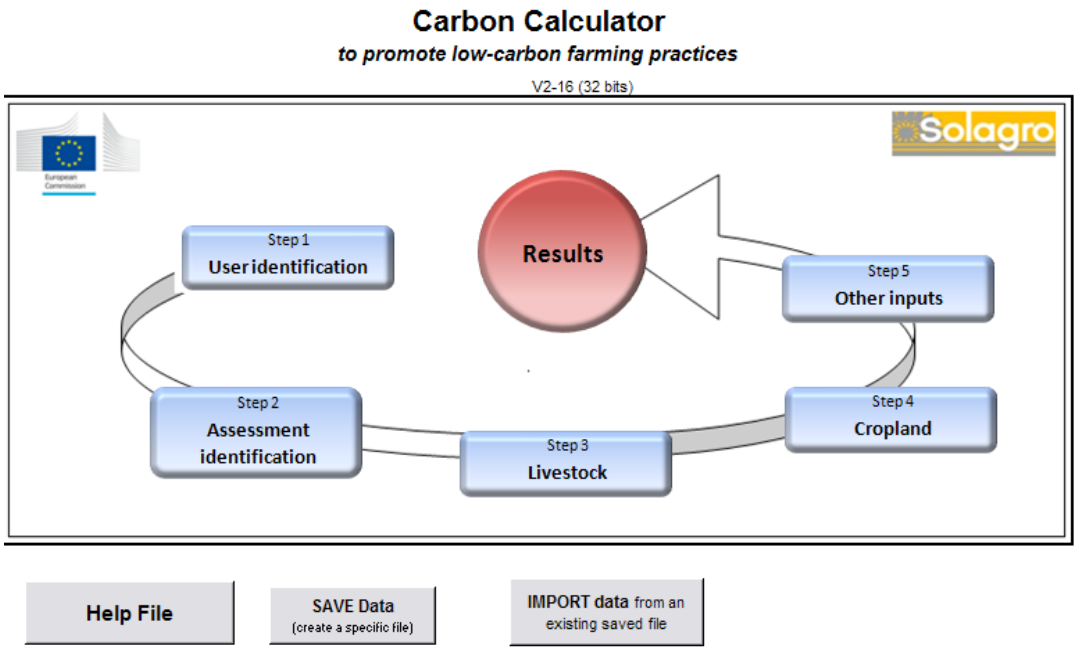

Figure 1. *Main menu of the Carbon Calculator*

3.2.2 Purpose and scope

Assessments conducted with the Carbon Calculator are carried out at farm scale, with a reporting period of one year. Methods of calculation and emission factors have been adapted to cover EU-27 specificities. The design of the Carbon Calculator is based on methodological choices informed by European and international literature. The first version of the Carbon Calculator was tested on farms (Task 3). A peer-review meeting (held in Ispra, July 2012) discussed and validated the general methodological choices and suggested some additional specifications (Annex 5). The second version of the Carbon Calculator was developed based on feedback from the farm tests and the peer-review meeting.

A life cycle 'cradle-to-gate' approach is fundamental to this tool's design, considering all emissions upstream of the farm (cradle) to the farm gate. Direct and indirect GHG emissions are considered, including emissions attributable to the production and distribution of farm inputs. Emissions related to activities upstream of the farm gate (i.e. distribution, storage, processing, retail, consumption, and end-of-life phases) are not included. Carbon stock changes in soils and vegetal landscape elements are also considered

in the analysis, but these are reported separately and are not included in the total GHG emissions of the farm. The tool is adapted to a wide range of farming systems (the main farming systems in the EU-27) but is not yet designed for less common farming systems (e.g. rice cultivation) or on-farm activities (e.g. agritourism and processing).

The tool offers 10 possible GHG mitigation and sequestration actions. For each established mitigation action, the Carbon Calculator evaluates the impact of a change in farming practices on the GHG profile (Figure 2).

Mitigation / sequestration actions at farm level

Rank	Actions	tCO_2e saving / ha / year	New level of GHG / ha / year	% saving	EUR savings / farm / year (if available)		Links to action forms
	Current situation		10,9				not activate for the moment
1	Biogas production	1,9	9,1	17,1%	0		*hypertexte to pdf*
2	Adjust N fertiliser balance	0,9	10,0	8,4%	18 971		*hypertexte to pdf*
3	Agroforestry	0,6	10,3	5,8%	0		*hypertexte to pdf*
4	Soils covered all the year	0,4	10,6	3,3%	6 278		*hypertexte to pdf*
5	No-tillage	0,4	10,6	3,3%	0		*hypertexte to pdf*
6	Reduce methane from enteric fermentation	0,3	10,6	2,7%	0		*hypertexte to pdf*
7	Introduction of legumes in the rotation	0,3	10,7	2,5%	0		*hypertexte to pdf*
8	Solar panel on suitable buildings	0,2	10,7	2,2%	0		*hypertexte to pdf*
9	Implementation of hedges and other landscape elements	0,1	10,9	0,8%	0		*hypertexte to pdf*
10	Reduce engines fuel consumption (test and eco driving)	0,1	10,9	0,5%	2 006		*hypertexte to pdf*

The total net gain is not the sum of each action.

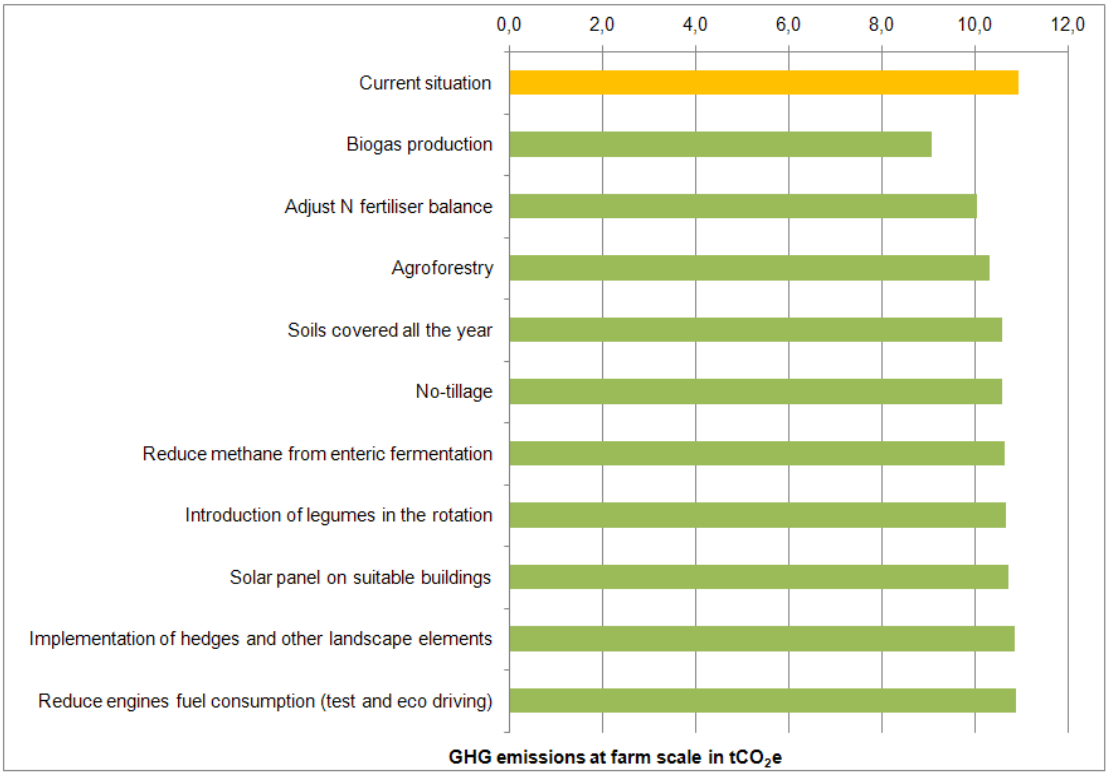

Figure 2. *Possible mitigation actions proposed by the Carbon Calculator*

3.2.3 Presentation of the results

The Carbon Calculator provides two levels of presentation of the results: at farm scale and for up to five main products of the farm. GHG emissions are expressed in tonnes of CO_2-equivalents/ha (farm scale) or per unit (product scale). The tool provides a possibility to graphically compare the results of similar farms once a sufficient database of carbon footprint results has been collected. The Carbon Calculator produces a table highlighting the five main sources of emissions (Figure 3).

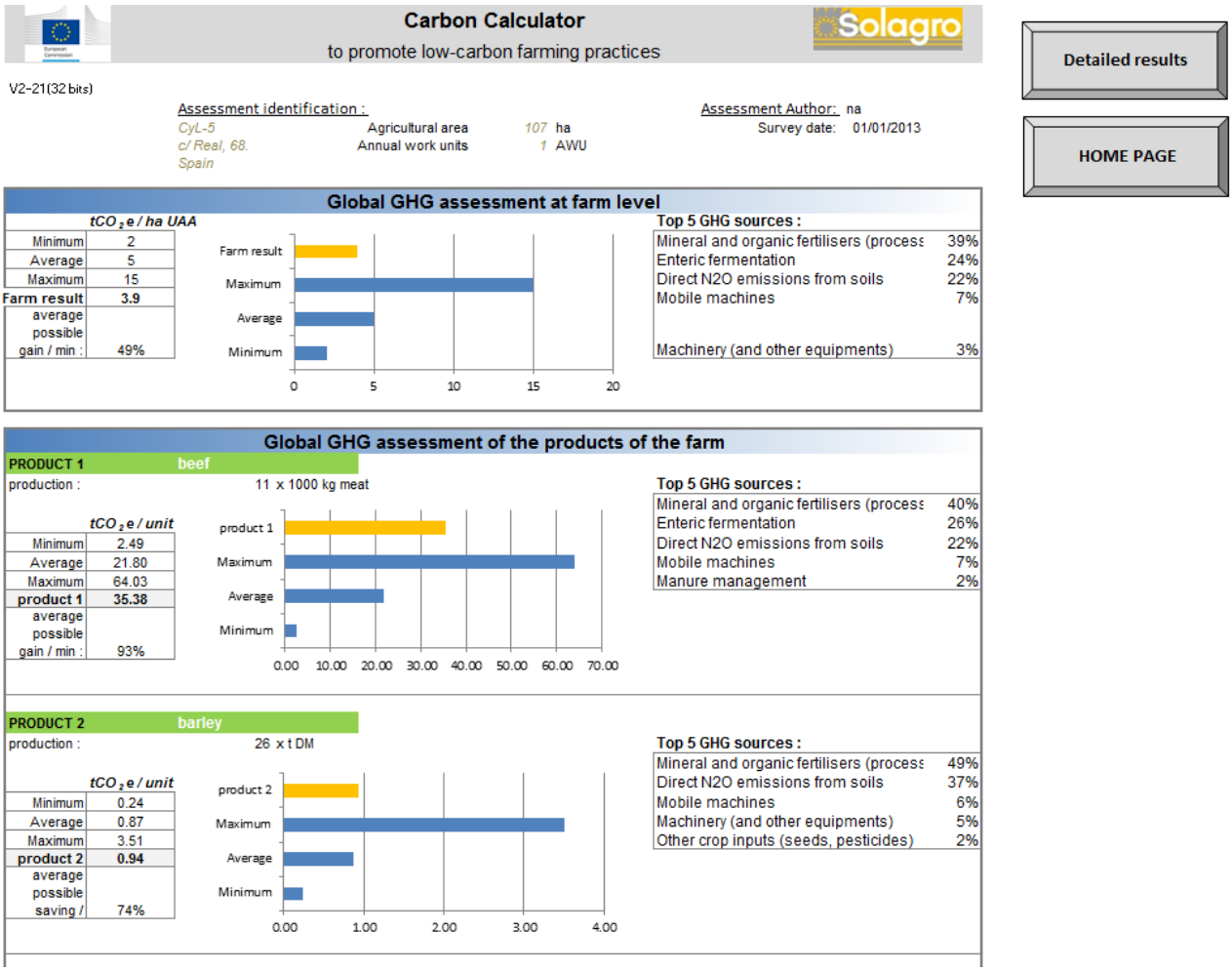

Figure 3. *An example of the result presentation in the Carbon Calculator*

The carbon stock changes (in soils and farmland features) and GHG emissions saved by renewable energy produced on farms are calculated separately from gross farm-scale GHG emissions. A "nitrogen balance" between inputs and outputs is calculated, and direct primary energy and water consumption levels are reported.

3.2.4 Key limitations

- The current version of the Carbon Calculator does not reliably allocate farm-level GHG emissions to the various products. Therefore, the allocation methods will have to be improved before the tool can be used for product carbon footprinting.

- The Carbon Calculator only provides results for GHG emissions, direct energy and water use, and nitrogen balance. More environmental impact categories should be added in order to assess the full environmental performance of the farms.
- The current version of the Carbon Calculator does not include any database against which to compare its results. It is planned to create a database for comparisons if sufficient farm data collected with the Carbon Calculators is forthcoming.
- The assessment only takes a single year into account, whereas higher emission reductions could be achieved by modifying crop rotations.

3.3 Task 2.2 Farm survey to check data availability to run the Carbon Calculator

A survey of the availability of data needed to run the Carbon Calculator (Annex 6) was conducted in six Member States that were chosen to represent the range of climate and farming systems found across the EU-27. In this phase of the project, farm advisors were surveyed and interviewed with the aim of generally benefiting from their wide experience gained through 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 farming community in Europe. Advisors were asked to assess whether the data needed would be available from farm records and, if not, whether farmers would be able to estimate it.

In general, advisors consider the Carbon Calculator tool to be a complex tool that requires significant data input by farmers (i.e. up to 80 entries) in order to be of use. The majority of the data (>60%) that are required to use 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%.

The analysis shows substantial differences between countries across Europe. In general, farmers in the UK, Denmark and the Netherlands have more data available from farm records than do those in Slovenia and Spain, with Germany having moderate data availability. Many farmers in Slovenia and Spain are confident that they can provide estimates for data missing from farm records.

The data required for completing the Carbon Calculator for cropland and livestock seems to be more readily available than data on energy use, organic matter, crop residue and manure management, soil carbon management and grassland management. While not many actual records exist, data on feed and fertilisers can be readily supplied based on estimates. In addition, the Carbon Calculator requires farmers to relate activities to the main products produced on farm, and this is relatively difficult for farmers to judge.

The extensive data requirements may make the tool relatively difficult to use and time consuming for individual farmers. Not all farmers will have necessary the computer skills, and some may have to rely on advisory services to use the tool. Farmers' interest in using the tool would certainly improve if the tool were as user friendly and self-explanatory as possible. It should include default values for, or instructions on how to estimate, data that is not readily available, and data already submitted should automatically be retrieved in order to complete other forms or questionnaires, e.g. CAP subsidy applications. Care should be taken to ensure that the results provided by the Carbon Calculator apply to the specific conditions of the farmer in question, and that the results are meaningful to and applicable by farmers.

3.4 Task 3: Testing of the assessment tool for low-carbon farming practices

3.4.1 Aims and methods

The first version of the Carbon Calculator was tested at farm level on a diversity of farm types across all environmental zones in the EU-27 (Annex 7). The testing of the Carbon Calculator covered:

- the performance of the Carbon Calculator, assessing whether it can be applied to different farm types, in different geographical regions, and whether it generates estimates of the total GHG emissions of the farms;
- the user friendliness of the Carbon Calculator (with farmers as the main users) as well as the attitude of farmers towards using such a tool;
- the feasibility of the carbon mitigation options that are generated by the Carbon Calculator for the different types of farms and the farmer's willingness to take these up.

In order to collect the information for testing the Carbon Calculator, a survey was performed of farmers in different regions across the EU (Figure 4). The regions were selected according to a sampling plan that ensured that the testing of the Carbon Calculator was carried out with a good distribution of farmers over the main farm types and environmental zones occurring in the EU-27. As a result, farmers were interviewed in Sweden (Småland), Denmark (Eastern Islands), the United Kingdom (England), the Netherlands, Slovenia, Germany (Brandenburg), Spain (Extremadura and Castilla y Leon) and Poland (Zachodnio-pomorskie and Wielkopolskie). In the selected regions, efforts were made to get a sample of "willing" farmers that cover different farming types and farm characteristics.

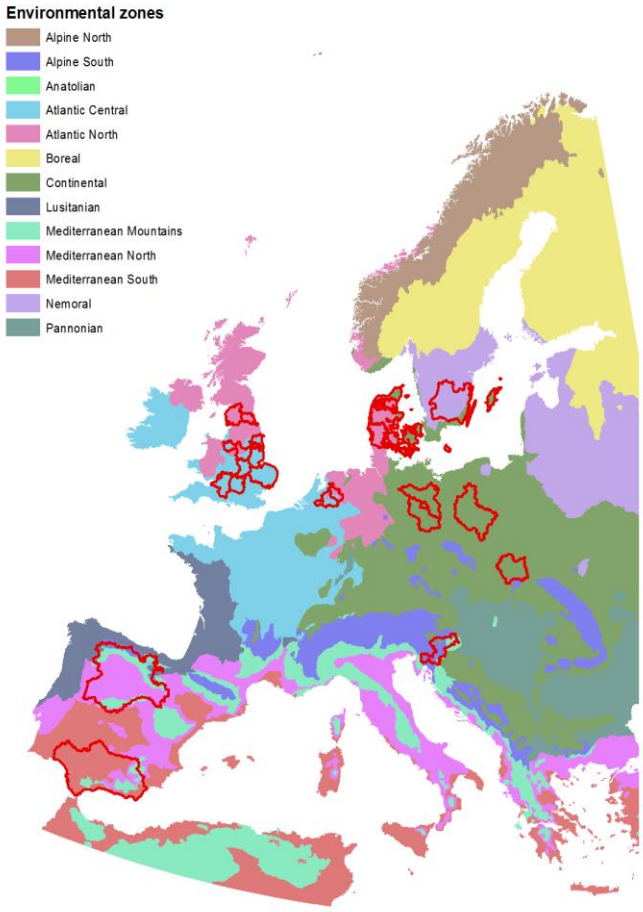

Figure 4. *Locations of the case study regions*

Although the questions asked were the same, the way in which the farmers were approached and interviewed differed by country. These different ways of approaching farmers were used in order to increase the response of the farmers and apply a survey method that would fit best with the culture of the local farming community. The survey was carried by out using a two-part questionnaire that was presented to the farmers in two steps.

1. The first part aimed to identify the farmers' willingness and preparedness to use the Carbon Calculator, as well as the ability to use and supply data to the Carbon Calculator. These questions were presented to the farmers prior to demonstration of the Carbon Calculator. The farmers were also asked to provide data to fill the Carbon Calculator.
2. The second part of the questionnaire was presented to the farmers after the demonstration of the Carbon Calculator. These questions addressed capability to use the calculator without support (other than translation) and what benefit farmers would derive in terms of income or management from using the Carbon Calculator. Farmers were also asked if they could see any barriers to using the Carbon Calculator and what changes (if any) would make the Carbon Calculator easier to use and increase their willingness to use it.

In total, 170 farmers were approached in all eight case-study countries. 71 farmers responded to part 1 of the questionnaire. 43 farmers also answered all questions in part 2 of the questionnaire, and 50 farmers provided datasets for testing the Carbon Calculator (Table 1).

Table 1. *Numbers of farmer questionnaires and farm datasets collected from each case study region*

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

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

3.4.2 Initial willingness to use the Carbon Calculator and perceived benefits

The views on perceived relevance of using the Carbon Calculator and willingness to use it after the final version is available differ strongly not only among Member States but also within the farming population within the same regions:

- The average perceived relevance of using the Carbon Calculator was the highest in the two Spanish cases and in the Dutch case.
- The willingness to use the Carbon Calculator once a final version is available was highest among Dutch and German farmers, while it was by far the lowest in Slovenia. Among the farmers interviewed in Slovenia, there is very little perceived relevance of using the Carbon Calculator due to the high time investment compared to perceived benefits.

The share of farmers interviewed that does not see any benefit of using the Carbon Calculator is quite high, at an estimated 31% of all case study regions, peaking in Slovenia, the Netherlands, Denmark and Sweden. Another 17% does not know the benefit, particularly in the Spanish regions. In Germany and Poland, some see the potential for marketing based on the environmental performance of the production process of a product to be an important potential benefit. In Poland, Spain, Denmark and Sweden, the perceived income and environmental gains are also mentioned as being important by several respondents. The fact that no benefit is seen in using the carbon calculator is not necessarily explained by the fact that the farmers are not open to undertaking additional mitigation measures. Rather, many of the farmers interviewed are already undertaking a variety of mitigation measures and do not see the usefulness of undertaking additional measures proposed by the Carbon Calculator. This sentiment was particularly evident in the Netherlands and Germany, where it was noted that many of the farmers interviewed question the utility of the Carbon Calculator as the best instrument to reduce emissions and improve the carbon cycle. They indicate that the interaction between soil carbon and fertilisers is very complex and that the full carbon cycle is very difficult to assess. According to them, the starting point for sustainable soil management should be the maintenance of soil fertility and the use of financial incentives to promote related measures, such as reduced tillage, improved water retention capacity, soil structure and improvement of soil organic matter rather than introducing the use of the Carbon Calculator.

In the United Kingdom, the Netherlands, Germany, Sweden and Denmark, farmers did not feel that they would face any insurmountable problems in using the spreadsheet-based Carbon Calculator, either alone or with support from an advisor, while this was less often the case in Slovenia, Poland and Spain. In spite of this, the confidence level of the Spanish farmers in using the Carbon Calculator themselves is higher than in the other countries. Farmers in the United Kingdom are the most familiar with working with computerised tools such as the Carbon Calculator, but given the many technical problems encountered during the testing of the Carbon Calculator, they were not necessarily more open to using it once the final version becomes available.

Farmers were generally reluctant to provide the data necessary to test the carbon calculator. By far the most important reason given in all case regions is the required time investment, which was generally perceived to be too long. This was the key reason given by all farmers in Slovenia, along with the difficulty of providing the type of data requested at farm level. As an exception among Member States, all UK farmers participating in the survey provided data to test the Carbon Calculator and did not generally perceive the data requirement as being complex. As a matter of fact, many farmers in the UK are already familiar with the use of farm-level carbon footprinting, and indeed many already supply data for use in carbon calculators, either through certification scheme membership or as a requirement of supplying to a

supermarket buyer. When asked about the level of difficulty associated with providing data for the Carbon Calculator it was universally agreed that the data requirements were relatively easy to understand and respond to. It was even reported that some of this type of data were already being generated for a carbon calculator operated by a supermarket buyer. This demonstrates that if they have the right incentives, farmers are willing to provide data for carbon calculators.

3.4.3 Evaluation of mitigation actions proposed by the Carbon Calculator

Farmers interviewed in the Netherlands and Poland found the mitigation actions proposed by the Carbon Calculator to be most helpful, while in England the evaluation of such proposals was less positive. Overall, the response to the mitigation options suggested by the Carbon Calculator was not very positive. It was observed that the majority of the farmers are already familiar with most of the mitigation options suggested by the Carbon Calculator, and many are already applying similar mitigation options. This is explained by the fact that, at the time of testing, only the most common mitigation options were implemented in the Carbon Calculator. These measures are often not very difficult to include in farm management and are often already part of legal obligations and/or Good Agricultural and Environmental Condition standards in the EU.

Cost was the most frequently given reason for not continuing with existing mitigation measures and/or lack of willingness to implement new mitigation measures in Germany, Poland, the United Kingdom and the Netherlands. Technical problems were the second most cited reason. These often related to problems encountered with the 'no-till' mitigation measure after several years of use, but also other to technical problems associated with not having the necessary know-how to implement it well. In Sweden and Denmark this has more to do with lack of training and technical support than with the financial aspects.

Different conclusions could be drawn with regard to the actions/incentives needed to make farmers continue with or implement new mitigation measures. In the Danish, Swedish and UK regions there was not much interest in and/or clear response to this question. Financial support, either through investments or compensation for higher costs, was mentioned most often and practically by all farmers interviewed in the other regions. Education, training and demonstration were also mentioned several times.

3.4.4 Evaluation of the performance of the Carbon Calculator prototype

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

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

Data identified as "difficult" in a large share of case regions were: the distribution of fuel use between on-farm activities; information on natural infrastructure; details on (extensive) grazing practices; and data on

other inputs. There was no indication of a difference in the ability of arable and livestock farmers to provide the data necessary for the operation of the Carbon Calculator. As a general rule, data were easiest to obtain when it was available from the farmer's memory, i.e. the sort of data that farmers use in everyday decision-making (although one can, indeed, question the accuracy of these types of answers). Beyond this, it was necessary for the farmers to consult farm records. This increased the amount of time needed to provide data, but resulted in a higher level of data accuracy and reliability. The requirement to consult farm records for some data items did not appear to diminish the interest of farmers in using the Carbon Calculator, at least for those that were also willing to test the Carbon Calculator in this study. The most difficult data to collect were those items with which the farmer was not familiar, i.e. those that were not used in normal farm accounting practices or everyday record-keeping. An example of this type of data would be the allocation of fuel usage to individual farm enterprises, where fuel usage is normally only accounted for at the farm level.

Overall, data entry in the Carbon Calculator proved to be challenging to farmers. This was particularly identified by the partners from England and Spain who collected most of the farm data for testing the Carbon Calculator and who had invested most effort in getting the Carbon Calculator to run using these data. The problems encountered were related to the completeness (level of development) of the user front-end that hampered the use of the Carbon Calculator during the testing phase. For example, there were issues related to the formatting conventions employed by the Carbon Calculator (they were not clearly described and/or were unfamiliar to the users, e.g. the use of the 'comma' in place of the decimal point). It was unclear in many places what units should be used to enter data, and there was sometimes a lack of clarity as to which data was essential for the proper functioning of the Carbon Calculator and which was optional. These technical issues were fixed after the testing phase.

As to the mitigation options suggested by the Carbon Calculator, the most commonly suggested options were the introduction of agro-forestry and the adjustment of the nitrogen (N) fertiliser balance, with both of these being suggested on all 14 UK farms for which mitigation options were generated. This was also the case in the Spanish, Slovenian, German, Dutch and Polish Carbon Calculator test results. Overall there was a broad level of dissatisfaction with the mitigation options generated by the Carbon Calculator, with these viewed as being very limited in number and unimaginative in scope, i.e. they are all familiar actions, of limited scope and simple in design. Many of the mitigation options suggested by the Carbon Calculator were already implemented on the farms surveyed. As a consequence, there was a sense that some of the more interesting and potentially significant (in terms of carbon footprint and economic implications) mitigation options listed by the Carbon Calculator were not yet functioning in the version provided for the test phase. More mitigation actions were added to the tool following the testing phase, and are functional in the delivered version of the tool.

3.4.5 Recommendations for improvement of the June 2012 version of the Carbon Calculator

Note that many of these recommendations for improvement have been taken into account in the development of the final version of the carbon calculator. The remaining areas for improvement are discussed in Section 3.6.

1. *Data requirements and input:*

- Greater use of prompts/warnings is necessary for identifying and correcting errors or missing data at the data input stage.
- Much of the data required by the Carbon Calculator are already provided by farmers for central registers (animals, land registers), CAP subsidy applications and the Farm Accountancy Data Natwork (FADN). Hydrological and soil data are available in national registers. Farmers find it unproductive and frustrating (as well as being time consuming) if data entry has to be duplicated or entered from scratch when it is already collected or available in other systems.
- The tool should be simplified by proposing more default values where the farmer is not able to provide all data, and automatically calculating certain values (e.g. automatic conversions to the required units, integration with software for manure management, etc.).

2. *Improving the functionalities:*

- The Carbon Calculator should generate mitigation options for all of those listed, including additional ones on increasing soil biodiversity and plant root biomass, and application of nitrogen-fixing bacteria (e.g. Azoarcus).
- Result pages need to be accompanied with explanations on how to interpret them from a perspective that is interesting to a farmer.
- Mitigation options should not be calculated if data sheets are not completely filled in, as this could lead to incorrect results. This is dangerous as it may influence farmers to change their management practices based on incorrect information.

3. *Implementation of the Carbon Calculator and enhancing its use:*

- To enhance and facilitate the use of the Carbon Calculator there is a need for good user guides in several languages, a clear help function and an on-line help desk that can be contacted by email or telephone.
- The definitions of the mitigation options suggested/recommended at the end should be clearly outlined and should be accompanied by good explanations. It is recommended that the current user manual include more practical descriptions, including examples of how day-to-day practices on the farm could be altered to avoid emissions and store carbon.
- As the farmers also need to adapt to climate change and contribute to climate policy, the Carbon Calculator should also provide support in directing farmers towards the most efficient adaptation actions that are also supported in the new post-2013 CAP. This also implies that the Carbon Calculator should cover farmland-use change actions that have large emission and mitigation impacts, such as conversion to perennial biomass cropping or permanent grassland, and also renewable on-farm energy production.

- An ideal option for Carbon Calculator implementation would be to provide a tool which suggests measures that help to reduce costs, while also benefiting soil carbon and the GHG balance.
- Inputting data into the Carbon Calculator is time consuming; hence many farmers may be unwilling to use the Carbon Calculator independently. As most of the data required by the Carbon Calculator is already available (via calculation/reporting tools; see below), the data requested should be linked to existing farm records and information systems. This would reduce the high data-entry burden and would enhance the use of the Carbon Calculator among farmers.
- Suggest a change of language from 'mitigation' to 'business / farm resilience planning'. The term 'mitigation' is generally not accessible for farmers (i.e. they find it meaningless). In contrast, 'resilience planning' suggests to farmers the notion of being 'prepared and acting positively' rather than being reactive, which may be more palatable.

3.4.6 Overview of the farm data collected during the testing phase

Further analysis of the farm data collected during the testing phase has been carried out by the JRC, and an overview of the data is given here. The JRC received 50 farm datasets either through the Carbon Calculator or as a Word file (in which case the data was entered into the Carbon Calculator by the JRC). The datasets were collected from six countries (20 from Spain, 19 from the United Kingdom, two from Germany, six from the Netherlands, two from Poland and one from Slovenia) (Table 2). The dataset included 41 conventional farms, eight organic farms and three integrated farms. It covers a wide range of products - of the farms included in the dataset, 36 had livestock, 23 grew cereals, 10 grew fruits and vegetables, and 9 grew industrial crops. The range of the farm-level GHG emissions per hectare was wide in each region (Table 3). This is due to the fact that livestock farms generally have higher emissions per unit of land area than do crop farms.

Table 2. *Overview of the 50 farms that provided data for the Carbon Calculator*

Country	Region	Type of practices	Number of farms	Products (number of farms)
Spain	Andalucia	Conventional	5	Livestock (4), Fruits and vegetables (1)
		Organic	4	Fruits and vegetables (3), Livestock (1), Cereals (1), Legumes (1)
		Integrated	1	Fruits and vegetables
	Castilla y Leon	Organic	1	Fruits and vegetables, Cereals, Industrial Crops
		Conventional	9	Livestock (4), Cereals (6), Industrial Crops (2), Fodder (1)
UK	Berkshire, Buckinghamshire and Oxfordshire	Conventional	5	Livestock (4), Cereals (2), Industrial Crops (1)
	East Anglia	Conventional	1	Livestock
	Leicestershire, Rutland and Northamptonshire	Conventional	1	Livestock
	East Yorkshire and Northern Lincolnshire	Conventional	1	Livestock, Cereals, Industrial crops
	Tees Valley and Durham	Conventional	1	Livestock, Cereals, Industrial crops
	Cumbria	Organic	1	Livestock
	Derbyshire and Nottinghamshire	Conventional	1	Livestock, Cereals, Industrial crops, Fruits and vegetables
	Gloucestershire, Wiltshire and Bristol/Bath area	Conventional	6	Livestock (6), Cereals (2), Industrial Crops (1)
	Cheshire	Conventional	1	Livestock
	Lincolnshire	Conventional	1	Livestock
Netherlands	Gelderland	Conventional	5	Livestock (5), Fodder (1)
	Overijssel	Integrated	1	Livestock, Cereals
Germany	Brandenburg	Organic	1	Livestock, Cereals, Fruits and vegetables, Legumes
		Conservation	1	Livestock, Cereals
Slovenia	Vzhodna Slovenija	Organic	1	Livestock
Poland	Wielkopolskie	Conventional	1	Livestock, Cereals, Industrial crops
	Malopolskie	Conventional	1	Livestock, Cereals, Industrial crops

Table 3. *Minimum and maximum values of the farm level carbon footprints in each region (note that the table include only a subset of the farms)*

Country	Region	Carbon footprint of the farms (t CO_2e / ha)	
		Min	**Max**
Spain	Andalusia	0.49	63.76
	Castilla y León	0.44	11.77
United Kingdom	Tees Valley and Durham	4.67	
	East Yorkshire and Northern Lincolnshire	6.82	
	Derbyshire and Nottinghamshire	5.12	
	Leicestershire, Rutland and Northamptonshire	1.76	
	Lincolnshire	1.58	
	East Anglia	9.06	
	Berkshire, Buckinghamshire and Oxfordshire	1.90	19.77
	Cumbria	4.41	
	Cheshire	32.19	
	Gloucestershire, Wiltshire and Bristol/Bath area	4.20	23.61
Germany	Brandenburg	1.83	3.85
Netherlands	Overijssel	8.89	150.27

At the time of the tests, 10 mitigation actions were functional in the tool and only nine mitigation actions were recommended for the farms (Table 4). The most frequently generated action was 'agroforestry' (41), followed by 'introduction of legumes in the rotation' (27) and 'reduce methane from enteric fermentation' (27). The least frequently suggested was 'reduction of electricity consumption of the milking system' (8) and 'change in slurry management system: cover/crust', which was not recommended for any of the farms (Table 4).

Table 4. *The number of each mitigation action was recommended by the Carbon Calculator in each region.*

	Spain		United Kingdom										Germany	Netherlands	
	Andalusia	Castilla y León	Tees Valley and Durham	East Yorkshire and Northern Lincolnshire	Derbyshire and Nottinghamshire	Leicestershire, Rutland and Northamptonshire	Lincolnshire	East Anglia	Berkshire, Buckinghamshire and Oxfordshire	Cumbria	Cheshire	Gloucestershire, Wiltshire and Bristol/Bath area	Brandenburg	Overijssel	**Total**
Number of farms	**10**	**10**	**1**	**1**	**1**	**1**	**1**	**3**	**3**	**1**	**1**	**6**	**2**	**6**	**47**
Adjust N fertiliser balance	5	5		1	1	1	1					1	1	2	**18**
Agroforestry	5	9	1	1	1	1	1	1	5	1	1	6	2	6	**41**
Introduction of legumes in grasslands		1		1	1						1	5			**9**
Introduction of legumes in the rotation	1	6	1	1	1		1		2		1	6	2	5	**27**
No-tillage	2	5	1		1				1			1	1	1	**13**
Reduce engines fuel consumption (test and eco driving)	9	10						1	1			1	1	6	**29**
Reduce methane from enteric fermentation	4	3	1	1	1	1	1	2	1	1	1	4	1	5	**27**
Reduction of electricity consumption of the milking system	3	3											1	1	**8**
Soils covered all the year	2	6					1						1	2	**12**
Total number of actions	**31**	**48**	**4**	**5**	**6**	**3**	**5**	**4**	**10**	**2**	**4**	**24**	**10**	**28**	**184**

Note: a blank cell indicates that the Carbon Calculator did not recommend the mitigation action to any farms in the region.

3.5 Task 4: Assessment of certification systems for low-carbon farming practices

Annex 8 presents the results of the survey on policy options for promoting the use of an EU-wide Carbon Calculator. Farmers and other stakeholders were consulted in the policy option survey, which was conducted in eight different countries in the EU. The questions aimed to assess which of three different policy options would be the most appropriate for the potential implementation of the Carbon Calculator. Three options were examined: *regulation* (use of the Carbon Calculator would be compulsory, e.g. by incorporating it into CAP cross-compliance requirements), *publicly-funded voluntary incentive schemes* (use of the Carbon Calculator would be a requirement for participation in voluntary schemes funded under rural development programmes), or *certification or assurance schemes* (use of the Carbon Calculator would be a requirement of one or more privately operated, or state operated, assurance and certification schemes).

The survey shows significant variation in the attitudes towards, and perceptions of, different policy options in terms of their potential to promote the use of the Carbon Calculator and low-carbon farming practices. It identified a number of strengths and weaknesses of these options according to their ability to encourage the use of the carbon calculator, increase environmental awareness, and drive GHG mitigation practices. Regulation would likely ensure the highest amount of participation and hold the most potential for GHG mitigation. However, this has significant weaknesses in terms of farmers viewing it as an imposed environmental constraint. If the targets for compliance were set low enough to gain political acceptance, real environmental improvements would not be achieved. Publicly-funded voluntary incentive schemes are likely to motivate participants to implement mitigation measures and lead to higher levels of environmental improvements. The weaknesses they suffer are that extra financial resources are needed to utilise this policy option and there is lower participation with “problem cases” not being addressed since participation is voluntary. The strength of certification schemes lies in their potential to increase consumer awareness of the contribution of farming to climate change, but the weaknesses identified are that they depend upon market demand and may fail due to an overabundance of certifications that are confusing to consumers.

Promoting the carbon calculator through cross-compliance, i.e. a mandatory requirement for receipt of CAP payments, is not a preferred option among farmers. Agri-environment schemes (supported through rural development programs) and voluntary low-carbon farming certification schemes, when supported by sufficient technical advice, are seen to offer greater benefits to the farmer. These two approaches are therefore perceived as being more effective in changing farmer management practices through demonstrated business benefits of improved environmental practice. Such practices can include increasing soil organic matter, water management, biodiversity, carbon storage, and prevention of nutrient losses. Nonetheless, it is accepted that many farmers may not adopt the Carbon Calculator under the voluntary approaches for a number of reasons. The additional cost burdens were seen to outweigh the benefits, mainly as a result of a high level of cynicism about the benefits of carbon footprinting and the perception that GHG accounting is generally incomplete, for example, due to the lack of knowledge of the carbon cycle of soils.

There is a strong opinion that the burden imposed by use of the Carbon Calculator and implementation of mitigation options is too great for smaller farms. Even if the mandatory approach is not preferred, it should be taken into account that a farm-size threshold could be applied in order to limit the compulsory use of a carbon calculator only to large farms (e.g. over 100 or 200 hectares).

Given the diversity of opinions, a wider consultation may be needed to discern the preferred policy option. Moreover, the responses to individual options may differ based on the actual detailed design of each approach (for example, how the baseline is set within cross-compliance, and how the additional requirements in agri-environment measures are defined). In this survey, respondents were not able to respond to such a detailed design and some stakeholders pointed out that a lot of critical issues depend strongly on the particular design of the different policy options.

Some possible suggestions emerged from the consultation, in particular from the side of stakeholders, which provide additional guiding principles for future policy design. Specifically, these are:

1. A combination of approaches, each with a different focus, may address the disadvantages while making the most of the strengths of the different options.
2. Regardless of which of the three proposed policy options is chosen, the coverage should be EU-wide to maximise the benefits of the Calculator and reduce any objections among farmers about potential discriminatory effects.
3. The carbon calculation needs to be part of a package of conscious improvement of environmental practices among farmers which also leads to added value that can be captured by the farmer. The approach to promote a Carbon Calculator and low-carbon farming needs to consider potential trade-offs that could occur if GHG mitigation measures were the sole focus, so newly implemented measures must take into account existing obligations (e.g. preservation of biodiversity).
4. A change in the language used to promote the Carbon Calculator towards emphasising resource efficiency and farm resilience planning as opposed to solely a GHG mitigation focus would be beneficial. The potential for cost savings resulting from mitigation actions and improvements in resource use efficiency can be further emphasised.

Beyond the three policy options presented in the survey, expanded reporting on GHG emissions to account for all agriculture-related GHG emissions and clear policy mandates/targets in the form of binding national or EU reduction targets would provide a stimulus for mitigation action in agriculture and increase the relevance of a Carbon Calculator.

3.6 Task 5: Forward-looking recommendations

3.6.1 Remaining possibilities for the improvement of the Carbon Calculator

- The current version of the Carbon Calculator can be used for estimating GHG emissions at the farm level and at the product level provided that the farm has a stable operation each year. It provides results at the product level that are very sensitive to the allocation method currently used. Comparison of the emissions of products between different farms and within the same farm between different years therefore has to be made with caution.
- The current version of the Carbon Calculator only takes into account the GHG emissions, direct energy and water use, and nitrogen balance. The tool could be improved by extending it to cover other environmental impact categories, such as biodiversity and water quality.
- Future versions of the Carbon Calculator could be better aligned with the methods for lifecycle-based environmental accountancy that were established by the 2003 Integrated Product Policy (IPP) Communication International Reference Life Cycle Data System (ILCD) Handbook as well as the recent Product Environmental Footprint (PEF) and Organisation Environmental Footprint (OEF)

Methodologies. Future alignment of the Carbon Calculator with the Food SCP Round Table Envi-Food Protocol is also highly desirable.

- The European reference Life Cycle Database ELCD and International Reference Life Cycle Data (ILCD) Network could be more widely used for lifecycle data in the Carbon Calculator wherever possible. The Platform on Life Cycle Assessment and its data sources were established in response to explicit EC commitments in the IPP COM in 2003 to address known issues. The ELCD focuses intentionally/strategically on only data that will be widely used across sectors (for example, energy carriers). However, the ILCD Data Network has the potential to have a much more important direct benefit. Equally, food-specific databases are now being established which include data for key farming materials as well as feeds, etc.
- Ideally, if the Carbon Calculator is widely adopted in the future, the possibilities of linking the tool with existing farm-scale databases or other software could be investigated. This function in the Carbon Calculator would include automatic transfer of farm data from existing databases. That would help to reduce the time requirement for inserting the data into the tool.
- The delivered version of the Carbon Calculator allows for the comparison of the results of one farm with other similar farms. However, this function can be activated only if a sufficient number of completed Carbon Calculators is received, in order to build the database for making the comparisons.
- The Carbon Calculator could take into account the whole crop rotation cycle instead of yearly crops, so that mitigation actions could recommend changes in crop rotation, and more accurate estimates of the changes in soil carbon levels could be made. This function would also allow multiannual evaluation of carbon emissions.
- The tool could take into account the use of anaerobic digesters at the farm, and anaerobic digesters could be included in the mitigation actions.
- In order to cover all farm activities, forestry could also be considered for inclusion in the tool.
- The tool could provide confidence intervals for the GHG emission results.
- More mitigation actions could be added within the tool, and the cost-efficiencies of the actions could be calculated.
- The Carbon Calculator and the user manual should be available in all European languages. The user manual should be accompanied with a leaflet that provides help with unit conversion. An online help office should be available, so that the user can ask for help when needed.

3.6.2 Recommendations on policy options

- Building policy options on the Carbon Calculator should not be considered unless the tool is robust and the quality of data can be controlled.
- It would be advisable to organise a large stakeholder consultation before implementing any policy options based on the Carbon Calculator. The discussion should include a detailed design of each approach.
- The Carbon Calculator could be used for awareness raising that could lead to behavioral change. An improved version of the current tool could also be used for benchmarking, so that farmers can compare their carbon footprint with those of other farms.
- The adoption of GHG mitigation actions could also be encouraged by providing a tool that shows how such actions can simultaneously reduce emissions and costs.

- Where the implementation of certification schemes is considered, the willingness of consumers to pay a premium for products with a low-carbon label should be investigated.
- A combination of approaches, each with a different focus, may address the disadvantages while making the most of strengths of the different options.
- Regardless of the policy option chosen, the use of a carbon calculator should be EU-wide to maximise the benefits of the calculator and reduce any objections among farmers about potential discriminatory effects.
- The Carbon Calculator could also be used by Member State administration to verify that the rural development measures that they propose for rural development payment allocation are efficient for low-carbon farming. Taking this further, the use of a carbon calculator could also become an eligibility criterion.
- Farm advisory services could use the Carbon Calculator when they are assessing the environmental performance of a farm.
- The carbon calculation needs to be part of a package of conscious improvement of environmental practices among farmers which also leads to added value that can be captured by the farmer. The approach to promote a Carbon Calculator and low-carbon farming needs to consider the potential trade-offs that could occur if GHG mitigation measures were the sole focus, so newly implemented measures must take into account existing obligations (e.g. preservation of biodiversity).
- A change in the language used to promote the Carbon Calculator to emphasise resource efficiency and farm resilience planning as opposed to solely a GHG mitigation focus would be beneficial. The potential for cost savings resulting from mitigation actions and improvements in resource use efficiency can be further emphasised.
- Beyond the three policy options presented in the survey, expanded reporting on GHG emissions to account for all agriculture-related GHG emissions (including Land use, land-use change and forestry (LULUCF) emissions) and clear policy mandates/targets in the form of binding national or EU reduction targets would provide a stimulus for mitigation action in agriculture and promote the relevance of a Carbon Calculator. LULUCF action plans, however, need to be developed at Member State level. The monitoring requirements might in the short-term increase the relevance of the Carbon Calculator as it can provide a fundamental basis for monitoring GHGs and reducing land-based emissions.

4 Conclusions

The study showed that there are multiple options for using a farm-level Carbon Calculator for promoting low-carbon farming practices in the EU. The farms can be certified upon a declaration of a third-party verified carbon footprint, upon proven emission reductions, or upon evidence of lower emissions compared to the average in the product group. Alternatively, assessment of a carbon footprint can be a part of a wider environmental certification scheme. In addition to certification, the carbon footprint of farm products can be a means by which to justify and quantify the support given to farmers for voluntary actions in rural development programmes. The Carbon Calculator could also be promoted as a tool that shows how farmers can simultaneously reduce both costs and emissions.

Although, this study provided an evaluation of the pros and cons of different policy approaches for promoting the use of low-carbon farming practices, a more detailed study would be needed to assess the costs and benefits of each approach. That would require a more detailed design of policy options (for example, how the baseline is set within cross-compliance, and how the additional requirements in agri-environment measures are defined).

Future versions of the Carbon Calculator could be incorporated in wider environmental impact assessment tools instead of concentrating on a single issue only. The Carbon Calculator could align better with the methods for lifecycle-based environmental accountancy that were established by the 2003 IPP Communication ILCD Handbook as well as the new Product and Organization Environmental Footprint Method. Future alignment of the Carbon Calculator with the Envi-Food Protocol is similarly desirable.

There is also room for improvement in the amount of time required to input data into the Carbon Calculator. This could be implemented by developing an automatic data transfer from databases in which the required data already exits (e.g. the FADN). The Carbon Calculator and the user manual should also be translated into all EU languages. Help should also be provided for the conversion of input values into the units that are required in the Carbon Calculator.

It is possible to envisage a certification scheme based on a Carbon Calculator which would benefit farmers through subsidised measures, or the use of the Carbon Calculator in holdings receiving support for rural development measures that address climate change issues. This would require additional investment in an EU-wide tool in order to optimise the functionalities of the Carbon Calculator based on the specific requirements of the chosen policy option.

Annexes

Annex 1: Tuomisto H.L., Pelletier N., De Camillis C., Angileri V., Haastrup P., 2011, *Analysis of existing climate-related or low-carbon certification and labelling schemes with impact on farming in the European Union*, EC-JRC. 46 pp.

Annex 2: Bochu J-L., Metayer N., 2013, *Development of Carbon Calculator to promote low carbon farming practices – User guidance manual for the Carbon Calculator*, Deliverable to EC-JRC-IES by Solagro. 67 pp.

Annex 3: Bochu J-L., Metayer N., Bordet C., Gimaret M., 2013, *Development of Carbon Calculator to promote low carbon farming practices – Methodological guidelines (methods and formula)*, Deliverable to EC-JRC-IES by Solagro. 145 pp.

Annex 4: Bochu J-L., Metayer N., Juanes X., 2013, *Development of Carbon Calculator to promote low carbon farming practices – Administrator Guide*; Deliverable to EC-JRC-IES by Solagro. 195 pp.

Annex 5: Tuomisto HL., Angileri, V., Haastrup P. *Minutes of the low-carbon farming peer-review workshop, 4th July 2012, JRC, Ispra*, EC-JRC. 10 pp.

Annex 6: Kuikman, P.J., E. Andersen, B.S. Elbersen, A. Frelih Larsen, P.J. Jones, S. Naumann, I. Staritsky, J. Onez (2013). *EU wide Farm-level Carbon Calculator: data availability at farm level for farms across EU-27*. A report on Deliverable 1 to the Institute of Environment and Sustainability (JRC/IES) by Alterra - WageningenUR, Wageningen, The Netherlands. 75 pp.

Annex 7: 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. 92 pp.

Annex 8: Frelih-Larsen, A., Jones, P. J., Dooley, E., Naumann, S. (2013). *Policy options for promoting the use of an EU-wide carbon calculator*. Deliverables 2.4.2 and 2.5: a report to the Institute of Environment and Sustainability (JRC/IES) by Ecologic Institute and University of Reading. 62 pp.

Some of the annexes are available at: http://mars.jrc.ec.europa.eu/mars/Projects/LC-Farming

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Abstract

In 2010, the European Parliament asked the European Commission to carry out a pilot project on the "certification of low-carbon farming practices in the European Union" to promote reductions of GHG emissions from farming. The overall aim of the project was to assess how efforts of European farmers to produce agricultural products with carbon-neutral or low-carbon-footprint farming practices might be incorporated into policy approaches (possibly via certification), so as to promote the reduction of GHG emissions from agriculture. The project included: i) a review of existing farm-level lifecycle-based climate-related certification and labelling schemes, ii) the development and testing of a user friendly open-source carbon calculator suitable for assessing the lifecycle GHG emissions from different types of farming systems across the whole EU, and iii) the design/assessment of policy options for promoting low-carbon farming practices.

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