SUSTAINABLE AGRICULTURE IN CARBON ARITHMETICS

LIFE+AGRICARBON

LAYMAN REPORT. LIFE08 ENV/E/000129

Life+AGRICARBON
AGRICULTURA SOSTENIBLE EN LA ARITMÉTICA DEL CARBONO
SUSTAINABLE AGRICULTURE IN CARBON ARITHMETICS

LIFE08/ENV/E/000129

AEAC.SV
Asociación Española Agricultura de Conservación Suelos Vivos

ECAF
European Conservation Agriculture Federation

Instituto de Investigación y Formación Agraria y Pesquera
CONSEJERÍA DE AGRICULTURA, PESCA Y DESARROLLO RURAL

UNIVERSIDAD Ð CÓRDOBA

LIFE PROGRAM

LIFE is a financial tool from the European Union (EU) to support environmental and climate action projects throughout the EU. Since 1992, LIFE has cofinanced almost 4,000 projects, contributing approximately €3.1 billion to the protection of environment.

http://ec.europa.eu/environment/life/

CLIMATE CHANGE AND AGRICULTURE

An analysis of the main gases contributing to the greenhouse effect demonstrates that carbon dioxide (CO_2) is the dominant component in terms of absolute weight, making up 80% of the total. Agriculture and climate change are closely linked, since agricultural activity can positively or negatively affect global warming. Agriculture is a source of greenhouse gas emissions, as are other sectors, but agriculture offers the advantage that farmland dedicated to crop cultivation can serve as a carbon sink.

However, the current model of European agriculture is based on labour-intensive systems, where soils are being depleted of carbon and CO_2 emissions are high. To reverse this trend, it is necessary to convert CO_2 from the atmosphere to carbon stored in the soil and to use energy efficiently.

LIFE+ AGRICARBON OBJECTIVES

Demonstration of the adaptability of arable crops introduced under conservation agriculture to the new climatic conditions caused by global warming.

Demonstration to the agricultural sector that these techniques, based on sustainability and the ability to reduce the atmospheric concentration of greenhouse gases are, at least, equally productive and more efficient in the use of inputs than conventional agricultural techniques.

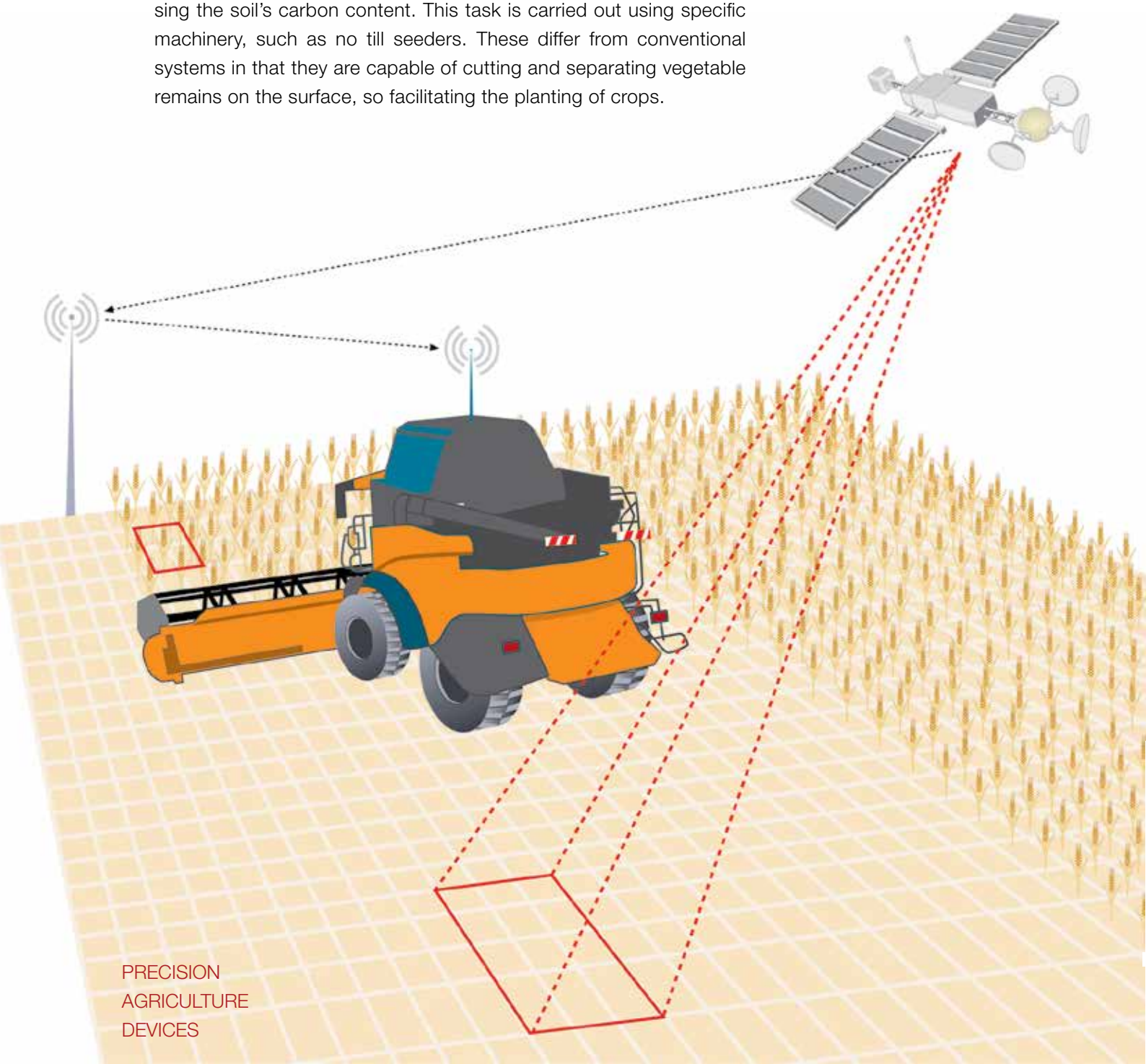
Setting up of a digital platform for the evaluation of CO_2 emissions and the energy consumption of agricultural holdings based on the climatic characteristics of the area, the crops introduced, and the agricultural practices employed.

Generation of a wide knowledge-base concerning the beneficial impact on climate change of the introduction of agricultural techniques such as conservation and precision agriculture regarding the reduction of greenhouse gases in the atmosphere.

Promotion and dissemination of conservation and precision agriculture in order to provide sufficient knowledge and tools for those working in the agricultural sector (public administrations, private companies, research organizations and farmers) to take the appropriate measures, and also to encourage the progressive introduction of sustainable agricultural techniques.

THE LIFE+AGRICARBON METHOD: CONSERVATION AND PRECISION AGRICULTURE

The project has applied sustainable techniques to address the above-mentioned problem. Conservation agriculture is based on cultivation with minimal alteration to the soil through no till, maintaining a permanent protective soil cover, and carrying out rotation of different types of crops. In practical terms, once harvesting is completed, the farmer leaves the non-economically exploitable vegetable debris in the soil. Once decomposed, this debris will form part of the soil, thus increasing the soil's carbon content. This task is carried out using specific machinery, such as no till seeders. These differ from conventional systems in that they are capable of cutting and separating vegetable remains on the surface, so facilitating the planting of crops.



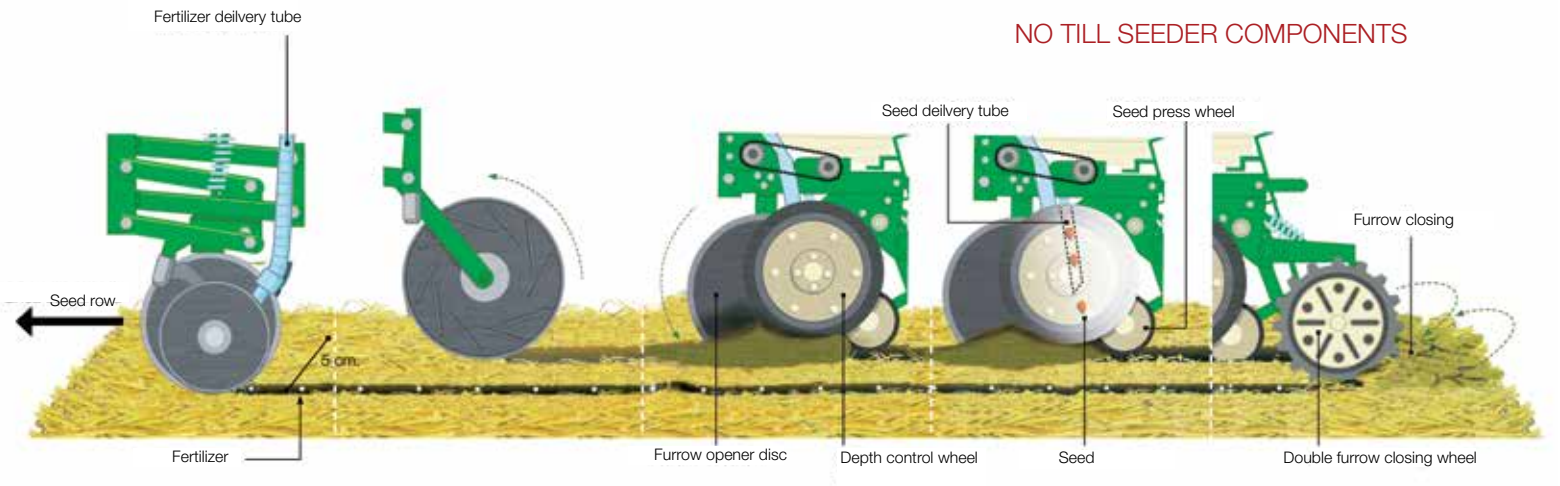
PRECISION AGRICULTURE DEVICES

Precision agriculture is based on equipping tractors and machines with GPS systems and other instruments. This technique promotes a more efficient use of agricultural inputs as it allows the reduction of overlaps between the paths taken by machinery and avoids empty areas, where work is not being done. In agricultural terms, overlap means the application of inputs twice at the same site, and thanks to GPS guidance, this waste can be prevented. Additionally, the precision system allows the application of equipment that agriculture employs in a differentiated manner. Sensors and systems for mapping tractors, fertilizers, or pesticide application bars can be used in a farm specific manner to optimize application doses according to the requirements of the crop and the expected harvest.

Both agricultural methods constitute a set of sustainable farming techniques, which, through energy savings and the carbon sink effect, contribute to a marked reduction in atmospheric greenhouse gas concentrations. The LIFE+ Agricarbon project has demonstrated synergistic effects produced by their joint use, using a network of test farms set up in the Guadalquivir Valley (Spain). In these farms, conservation and precision agriculture have been introduced to a typical rotation of crops suitable for dry/unirrigated land from the area (cereal, oil products, and leguminous plants). Greenhouse gas emissions, the carbon sink effect, the production, quality, and associated energy of crops, as well as water content and compaction of the soil have all been studied in the abovementioned farms.

In total, around 90 hectares (ha) of crops have been established, where conventional soil tillage techniques have been compared to the proposals from the LIFE+ Agricarbon project. Adjacent plots were used in all cases so that the results are comparable. Additionally, the plots were set up in accordance with trustworthy statistical criteria.

NO TILL SEEDER COMPONENTS



RESULTS

Climate change

Thanks to the employment of conservation agriculture in this project, the carbon sink effect of soil has been enhanced, increasing carbon content by up to 56% in comparison with conventional agriculture, and with an average improvement of around 30%. Additionally, the emission of CO_2 from the soil is 19% lower compared to conventional agriculture.

There have also been notable savings in respect to energy utilization, estimated at 12% for wheat, 26.3% for sunflowers, and 18.4% in leguminous plants. These savings mean lower CO_2 emissions, corresponding to 176 kg/ha for wheat, 73 kg/ha for sunflowers, and 86 kg/ha for leguminous plants. This means that the area dedicated to crops under conservation and precision agriculture has fixed 1,296 t more CO_2 and emitted 20 t less CO_2 into the atmosphere.

The project has brought about a genuine revolution in the countryside. According to official government data, since the launch of the LIFE+ Agricarbon project in Spain, the agricultural area under no till has increased by 115%, from an area of 274,869 ha to 590,473 ha.

Taking the total crop area using no till in Spain and applying the coefficients relating to the fixing potential from the conservation agriculture techniques collected in the scientific article developed within the framework of the project, *"Meta-analysis on atmospheric carbon capture in Spain through the use of conservation agriculture"*, reveals that 1.77 million tonnes of CO_2 would be fixed annually. Based on annual emissions per capita in the year 2011 for the EU-27 (7.4 t CO_2/inhabitant) (Eurostat), this would offset the emissions corresponding to a population of close to 240,000 inhabitants. In total, the project has succeeded in offsetting the emissions of some 1,200,000 European citizens.

So as to put this CO_2 sequestration potential into the context of the Kyoto Protocol, and in the commitments that Spain was taken regarding the GHG emissions in the period 2008-2012, these figures gain more relevance. Therefore, in the mentioned period, Spain issued an excess in emissions of 165.6 million tonnes of CO_2. This represents a 26.5% increase, exceeding the 15% permitted by Spain in the Kyoto Protocol. Spain has solved the excess emissions by buying other countries' emissions quotas at the international emissions trade with a cost of € 812 million. If we take into account the C sequestration addressed by conservation agriculture (González-Sánchez et al, 2012) and the 2014 year figures of conservation agriculture in the country, the greenhouse gas emissions estimated in that period would have been reduced in 9.2 million tonnes of CO_2. This fact supposes that the Spanish Government could have saved € 45 million in international emissions trade. Moreover, if conservation agriculture were to be fully implemented in the main arable crops, that figure could rise to € 598 million.

Harvest and Profitability

The global average production for the four agricultural seasons with a full rotation has been 5% greater with conservation agriculture than with conventional techniques. The biggest differences by crop have been for wheat, which has increased 7.3%, and in particular for leguminous crops with an improvement of 7.9%. However, for sunflowers, the difference has been less than 1%.

Conservation and precision agriculture have proven to be considerably more profitable, given that these production methods have also produced cost savings. In each season, savings are estimated at €59.6/ha for wheat, €72.7/ha for sunflowers, and €62.0/ha for leguminous plants. As a percentage, the cost savings were 9.5% for wheat, 21.6% for sunflowers, and 15.4% for leguminous plants.

More in-depth analysis also indicated that the techniques proposed by the LIFE+Agricarbon project have increased efficiency with regards to field work, with all the required tasks for each crop taking between 57% and 63% less time. Sustainable techniques also registered lower fuel consumption requirements, with diesel savings of 55.7% (28.5 l/ha) for leguminous plants, followed by 52.9% (24.9 l/ha) for sunflowers, and lastly with wheat requiring 51.6% (25.7 l/ha) less fuel.

Soil Water Content and Compaction

In general terms, efficiency in the use of this resource is a fundamental element in adapting to climate scenarios where less rain is expected. This is especially important in the areas where the project has been carried out, as it is rainfed land. In the project, the average humidity profile up to almost a metre in depth has been studied.

Thanks to the structural improvements facilitated by conservation agriculture throughout the project, the water content of the soil has increased by between 2.1 and 18%. However, in one case conventional tillage led to higher water content (13.5%), very probably due to the impossibility of maintaining effective soil coverage. Even so, the more efficient use of water in conservation agriculture meant that this difference will not be reflected in the harvest.

The lack of tillage causes slightly more surface soil compaction in conservation agriculture, but this does not hinder the sprouting and development of the plants, as the increased production for conservation agriculture has demonstrated. However, this slight difference is reversed at depth, where the soil is less compacted in the case of conservation agriculture, favouring the penetration of roots in search of water and nutrients.

Principal Benefits of Project Techniques

- Increased profitability for farmers.
- Lower production costs.
- Maintaining harvests.
- Better water use efficiency.
- Increased carbon sink effect of the soil.
- Lower CO_2 emissions.
- Better energy efficiency.
- Marked reduction in fuel consumption.
- Reduced field work times.

DIGITAL PLATFORM FOR VIRTUAL MANAGEMENT

Demonstrations and support for farmers and technicians is one of the objectives of LIFE+ Agricarbon. As a support tool for the sector, and with the objective of evaluating agricultural practices in the field, the project offers an informatics tool for calculating sustainability indicators in agricultural holdings, in the environmental, economic and social areas. The knowledge gained throughout the project has been fundamental in the development of indicators used at the environmental level, such as those for greenhouse gas emissions generated by crop management. This tool has been produced under the coordination of the Technological Platform for Sustainable Agriculture and endorsed by associations and companies in the agricultural and livestock sector. There has been additional support from the Biodiversity Foundation of the Ministry of Agriculture, Food and the Environment. This can be accessed through the project website

www.agricarbon.eu

DISSEMINATION ACTIONS

Just at the national level, communication actions have resulted in an estimated 1,000,000 impacts. At the international level, project members have met with experts from more than 30 countries, who have gained first-hand knowledge of the contributions brought by the LIFE+Agricarbon project. Around 3,000 people have participated in face-to-face training through various courses, field days, and congresses held within the framework of the project, and the number is greater still when taking into account third-party events attended by project staff reporting and explaining the results of the project.

Technical and Audio-visual Documentation

One of the pillars of the project has been the publication of practical up-to-date documentation to facilitate the adoption of sustainable techniques from the project. To this end, magazines, books, and leaflets have been published, and a full-length video produced. In total, 5 scientific articles in high impact journals in the Science Citation Index have been published; 15 technical articles in industry magazines, 29 oral communications and posters at congresses and conferences, and attendance at 24 different events.

As a summary of the project, an educational audio-visual has been produced regarding the benefits of sustainable agricultural techniques within the framework of the LIFE+ Agricarbon project, with practical information on how to apply them in the field. It is available at the website

www.agricarbon.eu

Actions with the Media and Sector Representatives

The partners of the LIFE+ Agricarbon project have worked intensively in this area. The project has appeared on TV a total of seven times, twice in the specialized prime-time TVE Agrosfera programme. It has also featured in interviews on national radio, print media, and online. Additionally, numerous meetings have been held with agricultural sector representatives to announce the technical foundations of the project, thus increasing its impact.

IMPACT ON AGRI-ENVIRONMENTAL POLICIES

The project partners have collaborated with several public administrations to develop policies and measures aimed at the promotion of conservation agriculture as best agricultural practice to limit and adapt to climate change.

The results and knowledge demonstrated in the framework of the LIFE+ Agricarbon project have helped reinforce the technical soundness of the Spanish Government's position when dealing with the UN team responsible for reviewing the Air Pollutant Emissions Inventory and Projections, and in particular when justifying conservation agriculture as a means to mitigate climate change, which has permitted the inclusion of around 400,000 ha of Spanish farms.

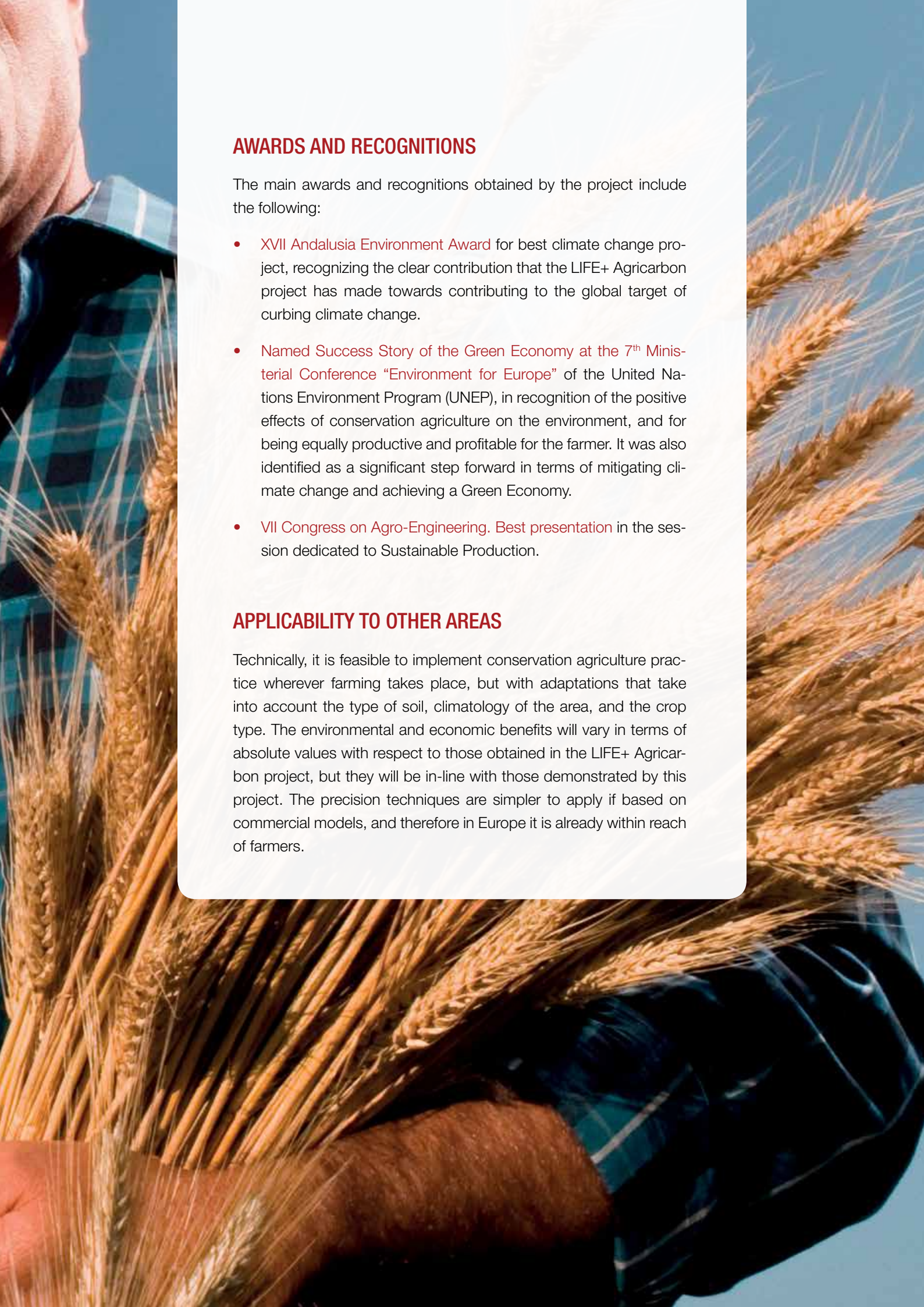
The Energy Saving and Efficiency Action Plan 2011-2020, managed by the Institute for Energy Diversification and Saving (IDAE) has included a measure of support for conservation agriculture as a tool to save energy in the agricultural sector with a grant of €17,600,000.

The project team collaborated actively in the EU Agriculture and Climate Change 2009/2157(INI) proposal, presented on the 27th January 2010 to the European Parliament session of the Committee on Agriculture and Rural Development. In said motion, conservation agriculture was identified as an effective measure to curb climatic change from an EU agricultural perspective.

The Spanish Office for Climate Change, part of the Ministry of Agriculture, Food and the Environment, has included the practice of conservation agriculture in the Road Map to reduce emissions in diffuse sectors, within the Low-carbon Climate-Resilient Development Strategy 2012-2020.

Appearance on 29th November 2010 in the Congress of Deputies of Spain (Congreso de los Diputados de España) before the Temporary Joint Congress-Senate Commission on the Study of Climate Change to report on the role of agriculture in climate change, making reference to the environmental and economic benefits of the LIFE+ Agricarbon project techniques.

Collaboration at the regional level, in the autonomous region where the farms are situated, with the Regional Ministry of Economy, Innovation, Science and Employment for the Andalusian Government. As part of the development of the Governance of the Rural Development Program of Andalusia 2014-2020, there is a measure entitled "Agri-environment and climate", in which conservation agriculture is promoted in Andalusia as a tool to improve natural soil, water and air resources. There have also been collaborations with other Spanish autonomous regions.



AWARDS AND RECOGNITIONS

The main awards and recognitions obtained by the project include the following:

- XVII Andalusia Environment Award for best climate change project, recognizing the clear contribution that the LIFE+ Agricarbon project has made towards contributing to the global target of curbing climate change.
- Named Success Story of the Green Economy at the 7th Ministerial Conference "Environment for Europe" of the United Nations Environment Program (UNEP), in recognition of the positive effects of conservation agriculture on the environment, and for being equally productive and profitable for the farmer. It was also identified as a significant step forward in terms of mitigating climate change and achieving a Green Economy.
- VII Congress on Agro-Engineering. Best presentation in the session dedicated to Sustainable Production.

APPLICABILITY TO OTHER AREAS

Technically, it is feasible to implement conservation agriculture practice wherever farming takes place, but with adaptations that take into account the type of soil, climatology of the area, and the crop type. The environmental and economic benefits will vary in terms of absolute values with respect to those obtained in the LIFE+ Agricarbon project, but they will be in-line with those demonstrated by this project. The precision techniques are simpler to apply if based on commercial models, and therefore in Europe it is already within reach of farmers.

LIFE+ AGRICARBON PROJECT

Reference: LIFE08 ENV/E/000129
Duration 01-01-2010 al 31-12-2014
Total Budget: 2.674.653 €
Contribution by the EU: 1.237.262 €
Web page: www.agricarbon.eu

Coordinating Beneficiary

Spanish Association for Conservation Agriculture / Living Soil (AECSV) *(Asociación Española Agricultura de Conservación / Suelos Vivos)*.
www.agriculturadeconservacion.org

The AEAC.SV is a non-profit organization whose objectives include training farmers, agricultural technicians, and society in conservation agriculture. The AEAC.SV also conducts research and training in this field. Founded in 1995, it has more than 1,500 members.

Associated Beneficiaries:

- Andalusian Institute of Agricultural and Fisheries Research and Training (IFAPA) *(Instituto Andaluz de Investigación y Formación Agraria, Pesquera, Alimentaria y de la Producción Ecológica)*.
  www.juntadeandalucia.es/agriculturaypesca/ifapa
- Universidad de Córdoba (UCO).
  www.uco.es
- European Conservation Agriculture Federation (ECAF).
  www.ecaf.org

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