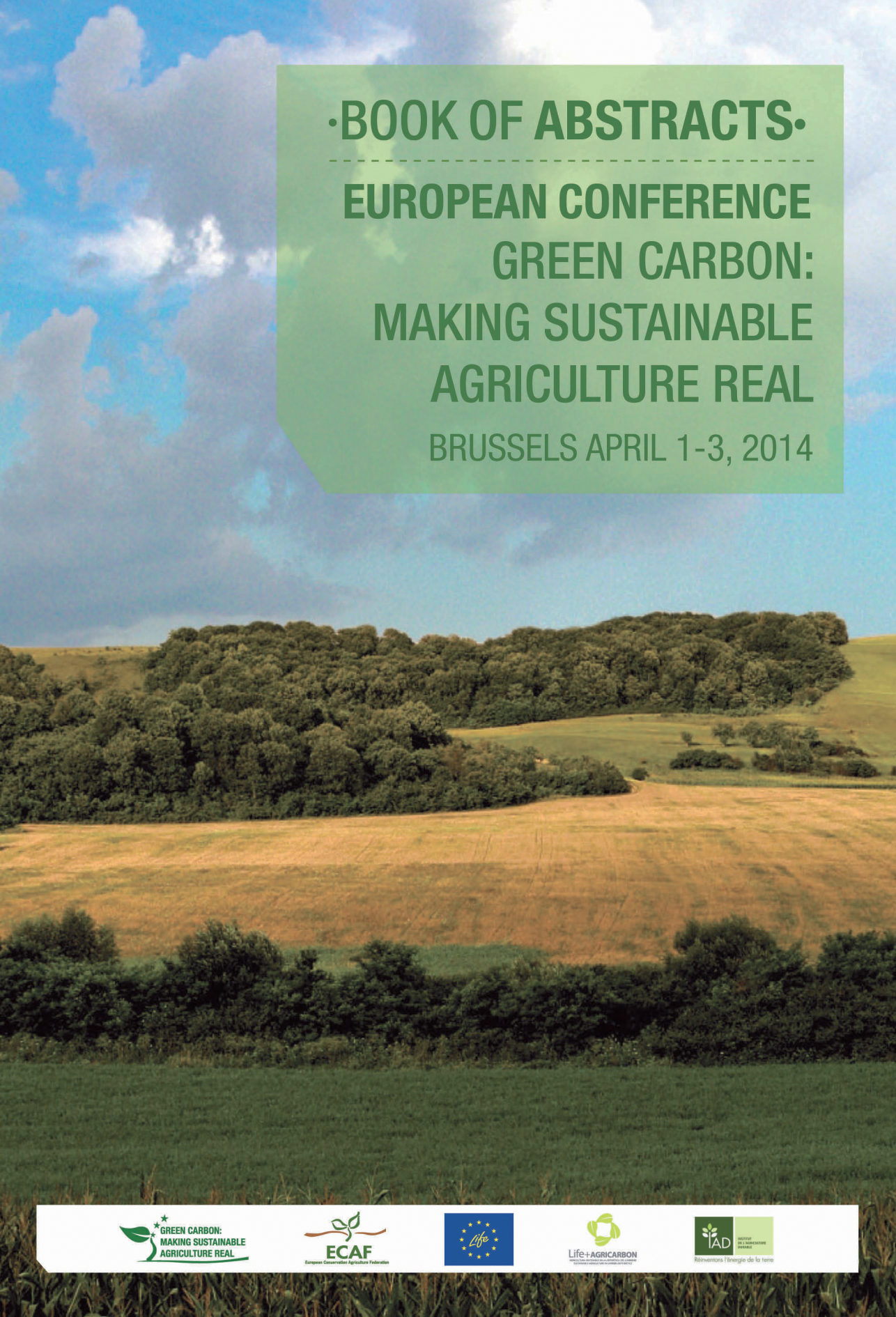

·BOOK OF **ABSTRACTS**·

EUROPEAN CONFERENCE GREEN CARBON: MAKING SUSTAINABLE AGRICULTURE REAL

BRUSSELS APRIL 1-3, 2014

GREEN CARBON: MAKING SUSTAINABLE AGRICULTURE REAL

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European Conservation Agriculture Federation

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GREEN CARBON:
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PREFACE

Green Carbon: Making sustainable agriculture real

The concept of sustainable development has evolved from a mere movement for the protection of the environment, to other multidimensional approaches. Indeed, today it calls for a holistic approach, seeking to preserve and improve not only the environment, but also to achieve social equity and economic sustainability. In Europe, society demands quality and safe products, not only in the industrial sector but also in agriculture.

According to FAO, sustainable agriculture development is a key element of the new global challenges to meet human food security needs at 2050. Unsustainable practices based on intensive soil tillage and excessive agro-chemical applications have increased agri-environmental risks. Whereas world's food needs are excessive to increase by 70% by 2050, agricultural land in Europe will also have to face environmental, economic and social challenges related to sustainable agriculture. As a result, in the EU 2020 Strategy, it is expressed that the new Common Agricultural Policy (CAP) is required to contribute to smart, sustainable and inclusive growth, enhancing social well-being, providing ecosystem services, managing resources sustainably while avoiding environmental degradation.

There is broad consensus within the scientific sector that human actions generate a large portion of the greenhouse gas (GHG) emissions, causing global warming. Certainly, Kyoto Protocol states it. According to the European Environmental Agency (EEA), there has been a decrease of 17% in GHG emissions between 1990 and 2009. However, EEA also stressed the importance of the agricultural contribution to total emissions (10.3%). The fossil fuel used in agricultural field operations, along with increasing CO_2 emissions from soil through tillage, are considered to be one of the main direct sources of GHG emissions from agriculture sector. Increased inputs required to sustain conventional agriculture also adds significantly to total GHG emissions. Therefore, intensification of production through tillage, inappropiate use of agro-chemicals and heavy machinery, which characterises conventional agriculture in Europe, strongly contributes inappropriate use of agro-chemicals to increased net GHG emissions instead of mitigating global warming.

Sustainable agricultural soil management is crucial for mitigating climate change, especially for the restoration of lost soil organic carbon. In fact, "Agricultural soils management" is recognized as one of the 15 most promising technology options for reducing GHG emissions in the COM (2005) 35 final "Winning the battle against global climate change".

The Green Carbon Conference aims to show sustainable management of agricultural soils can help agriculture to mitigate and adapt to climate change, being compatible with the objectives of environmental protection, enhancing biodiversity and supporting farmers' welfare along with many other environmental, economic and social benefits. Over the last decade, Conservation Agriculture has become known as a set of interlinked agricultural practices, of no or minimum mechanical soil disturbance, maintenance of soil mulch cover, and diversified cropping system, capable of: (a) overcoming several of the severe sustainability limitations of conventional agriculture; and (b) raising productivity, enhancing resilience, reducing degradation and increasing the flow of ecosystem services. The discussion around both the Soil Thematic Strategy initiated in 2002, and the JRC SoCo (Soil Conservation) project clearly recognized the potential of Conservation Agriculture in mitigating and even reversing the problems of soil erosion, soil organic matter decline, soil compaction, loss of biodiversity, climate change vulnerability, among others.

Whereas Conservation Agriculture is now practiced successfully on more than 125 million hectares worldwide, Europe has shown to be reluctant with regard to its adoption, despite many promising results confirming its suitability in Europe. Therefore, this European Conference on Green Carbon provides an opportunity to take a leap forward in terms of sharing farmers experiences on Conservation Agriculture across Europe, reviewing the recent progress made in knowledge generation regarding Conservation Agriculture, and to disseminate the outcomes of the currently running LIFE+ Agricarbon (LIFE08 ENV/E/000129).

The slogan of 'Green Carbon' chosen for this Conference attempts to clarify and highlight the indivisible yet vital link between soil organic carbon and the role that soil health plays in the sustainability of agricultural production and in the flow of ecosystem services.

Nevertheless, the topics addressed by the Green Carbon Conference are not only related to the importance of soil organic carbon for the overall soil quality and health, but also include other sustainability issues intimately related to the role of soil carbon such as landscape scale ecosystem functions and services, climate change mitigation and carbon offset, and economic aspects.

This Conference also seeks to alert and inform EU policy stakeholders and technical officers of the urgent need to adopt sustainable soil and production practices of Conservation Agriculture to contribute to the objectives of Europe 2020, the EU's growth strategy for the coming decades.

Dr. Gottlieb Basch
President
European Conservation Agriculture Federation

OPENING SESSION

GREEN CARBON AND POLICY ISSUES

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ABSTRACT

Carbon in its various forms has been useful to humanity for centuries. More recently we have come to an understanding and appreciation of carbon flows within various cycles and ecosystems. Monitoring of these flows has raised concerns of deforestation, land degradation and climate change. Economic sectors that utilize land (agriculture and forestry) and impact ecosystems have become an area of interest for scientists, policy makers and society as a whole. Often the focus is on issues within the sector at the peril of missing the opportunities. Carbon can become 'green' with Conservation Agriculture practises to benefit agriculture and society as a whole. Policy makers need to appreciate the opportunities that green carbon can offer.

The world, its citizens and economic sectors are all undergoing rapid change. World population is projected to grow by another 2 billion people (+28%) in the next 30 years. Demographic changes and societal preferences will apply greater and newer demands for food. Globalization will become more ingrained into trade and supply chains for food products. Society will seek assurances of sustainable practises through transparency, accountability and documentation or labelling. New technologies will transform farming practises and other economic sectors. Internet has already changed how we do business and personal commerce; imagine what the next decade or two will bring. Environmental consciousness and concerns are at an all-time high. Climate change is listed as one of the top global issues. Monitoring environmental status and trends across landscapes and economic sector footprints are undertaken by various organizations and governments. Governments are expected to underwrite the assurances of sustainable food production and environmental responsibility of economic sectors in order to meet public interests (demands).

It is clear from the changing demographics, technology developments, environmental concerns, supply chain interest in sustainability and, societal expectations, that business as usual (BAU) is not an option for the future. Policy should also not be expected to be developed in the future in the same fashion as it was done in the past. Society and industry is more 'connected' than ever before. Social media can create issues and solve them before informed conversations can even commence. Consultations for policy development can be done through more venues and media than ever before. In the current era, more players of society and industry can influence policy development and adaptation.

Policy development within governments can be influenced by many ways. Policy diffuses through a variety of mechanisms such 'first mover advantage', interest group influencers (special interest groups) and needs-response mechanisms. The greenhouse gas offset system in Alberta and recognition of No-Till practises to sequester carbon will be used to illustrate some of the policy diffusion mechanisms. How these mechanisms can be used to influence green carbon policies elsewhere will also be presented.

Keywords: policy, environment, conservation agriculture, green carbon.

LIFE+ AGRICARBON. SUSTAINABLE AGRICULTURE IN CARBON ARITHMETICS

González-Sánchez, E.J.[1,2,3,*], Ordóñez-Fernández, R.[4], Gil-Ribes, J.A.[1,2], Agüera-Vega, J.[1], Gómez-Ariza, M.[1,2], Veroz-González, O.[2], Márquez-García, F.[1,2] Carbonell-Bojollo, R.[4], Triviño-Tarradas, P.[3], Holgado-Cabrera, A.[3], Blanco-Roldán, G.L.[1], Castro-García, S.[1]

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ABSTRACT

LIFE+ Agricarbon is an EU funded project in partnership with AEAC SV, ECAF, IFAPA and UCO (www.agricarbon.eu). This project aims to encourage the progressive establishment of sustainable agriculture, such as Conservation Agriculture and Precision Agriculture (CA&PA), contributing to GHG emission decreases and the adaptation of the agricultural system to the new climate conditionants found in global warming. Also, making available to European and National authorities sufficient knowledge about these practices could serve to set up environment policies in the agricultural domain, with the two-fold mitigating and adapting to climate change. The Green Carbon Conference is an action included in LIFE+ Agricarbon.

The project has two main strands. One has been the fieldwork, managing 90 hectares in 3 demo farms in the South of Spain, which have served to obtain data that have supported many publications. Additionally, the technology transfer activities are at heart of the project. Through field days and courses, partners expect to train in sustainable agriculture over 2,500 farmers and technicians.

Main results follow. The joint use of CA&PA, captured up to 35% more Carbon compared to conventional tillage. Moreover, the absence of tillage made CA&PA reduce soil's emissions between 56% -218%. Regarding energy use, CA&PA, resulted in cuts by 13.8% in wheat, 21.6% in sunflower and 24.4% in the legume when compared to tillage. These savings caused lower CO_2 emissions, corresponding to 199.1 kg ha^{-1} for wheat, 63.6 kg ha^{-1} for sunflower and 107.1 kg ha^{-1} for legume. In terms of yield, the seasons have been very erratic, but results show that in the rotation wheat-sunflower-legume, there are no major differences between conservation agriculture and tillage systems. Due to lower costs, economic results per hectare have always been better for CA&PA compared to conventional tillage: +€77 in chickpea, +€59 in wheat, +€48 in sunflower and +€25 in beans.

LIFE+ Agricarbon has also been prolific in publications. To date, 3 papers in peer reviewed journals, 3 more being reviewed currently; 18 communications at international conferences; 10 communications at national conferences; 16 numbers of the Agricultura de Conservación journal; 5 technical reports and one booklet. Available in the website, an internet platform has been created to help farmers and technicians choose agricultural Carbon-friendly management.

Institutions and organisms have recognized the effort made by the project partners. The United Nations Environment Programme highlighted this LIFE project as good example of Green Economy in 2011. In 2012, the Government of Andalucía awarded Agricarbon as Best Project on Climate Change in the XVII Environmental Award. The project was also granted for the Best Communication at the VII Iberian Conference of the Agro-Engineering Spanish Society, 2013.

Keywords: conservation agriculture, precision agriculture, climate change, energy, yield

A DECADE OF CONSERVATION AGRICULTURE IN ENGLAND

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ABSTRACT

We are a family farming business, farming 1,250 ha across the East Midlands and Lincolnshire. The farm is 90% arable growing combinable crops and 10% grass on which we run 150 beef cattle and 16,000 free range, egg laying hens.

The presentation will show why we started Conservation Agriculture (CA) in 2002, faced with the problem of wind and water erosion, soil compaction and low levels of soil organic carbon. We have experimented with deep till, min till and no till systems of husbandry before committing to CA on all the land. The soils vary from high organic, black fen to 80% clay content and in fact most soil variations between the two extremes which are all now farmed in the CA system. The entire farm is soil mapped every four years in order to monitor P, K, Mg and pH levels. The farm is being mapped again in March 2014, the results of which will be presented as well as 2006 and 2010 results.

The rotation is generally 40% first wheat, 20% second wheat, 20% oilseed rape and 20% spring cropping. The spring cropping contributes to the environmental benefit of over-wintered stubble for the wildlife and farmland birds. We also utilise cover crops in some areas to boost soil fertility.

We have tried a variety of seed planters and other equipment which will be shown in action by video.

The effect of CA on the soil has been dramatic. The soil mapping results have shown increases in soil organic carbon and pH levels across the farm, as well as P and K levels remaining consistent. This has meant we have not applied P, K or lime in the past 10 years. We have also seen vast improvements in soil drainage which was the main subject of a research project in 2013. Furthermore, we have seen a reduction of 50% in fuel usage which has had a positive impact on the costs involved as well as the environment. The environmental benefits are also obvious with an increase in key species such as Brown Hare and Lapwings.

We still have much to learn about the practical application of CA but with our day to day findings combined with academic research we will continue to improve the system to make is more accessible to other farmers.

Keywords: conservation agriculture, farming, practical application.

THEME 1

EVIDENCE OF CARBON SEQUESTRATION IN EUROPE AND CARBON OFFSET POTENTIAL

CONSERVATION AGRICULTURE, CARBON MANAGEMENT, SEQUESTRATION AND OFFSETS IN EUROPE

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ABSTRACT

Soil carbon (C) management, including sequestration, is critical to our economy and our existence for maintaining sustainable production and ecosystem services for our quality of life. The increasing pressure to provide food, enhance environmental quality, and address societal problems creates challenges for agriculture and requires we consider how to change our current systems. The soil is the fundamental foundation of our economy and our existence. Carbon management is required to address a complex list of issues including soil, water and air quality, biofuels, and climate change. The world's farmers must broaden their perspective and shift conservation concepts and programs to manage for only yield and erosion control and move to managing soil C for crop production sustainability and maintaining environmental quality. This presentation will discuss the agricultural production systems and ecosystem services associated with enhanced C management. The benefits and challenges of No-Tillage systems for C sequestration, C offsets and ecosystem services will be addressed. Social economic and policy aspects of enhanced C management for environmental quality are an important part addressing agriculture production sustainability and landscape issues as recent extreme climate events provide even more challenges. Management emphasis on diverse rotations must be combined with maximum biomass and yield production and the use of cover crops to maximize the C input into the soil system. The smaller CO_2 loss following conservation tillage tools is significant and suggests progress in reducing soil C losses. Conservation agriculture (CA) reduces the extent, frequency and magnitude of mechanical disturbance caused by the moldboard plow and reduces the air-filled macropores and slows the rate of C oxidation. Any effort to decrease tillage intensity and maximize crop residue return should result in surface C sequestration for enhanced environmental quality. Understanding these environmental benefits directly related to soil C and getting the conservation practices implemented on the land will hasten the harmony between man and nature while increasing production of food, fiber and biofuels. The value of ecosystem services should reflect its full economic, environmental and social cost. The cost of soil loss and/or degradation is not included in the full cost accounting of our food security. Even if C sequestration is questionable in continuous No-Tillage systems on some soils of the world, forms of CA are an important new technology that improves soil processes, controls soil erosion and degradation, reduces production cost, maintains environmental quality, and provides food security in a sustainable manner.

Keywords: sustainability, ecosystem services, environmental quality, no-tillage, cover crops.

KEYNOTE

SYSTEMATIC REVIEW OF THE IMPACTS OF LAND MANAGEMENT ON CARBON SEQUESTRATION IN UK RELEVANT SOILS

Buckingham, S.[1,*], Cloy, J.M.[1], Webb, J.[2], Evans, C.[3], Kuhnert, M.[4], Moxley, J.[5], Smith, P.[4], Topp, C.F.E.[1], Rees, R.M.[1]

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ABSTRACT

This international literature review gathers agricultural-soil carbon data derived from UK and UK-comparable experimental programmes from peer-reviewed published reports. The review identifies and compiles the activity data of key management practices that are crucial in the development of an operational framework for reporting soil carbon changes from cropland and grassland management in the LULUCF inventory. The principles of a systematic literature review were utilized to search for and gather publications. This involved the formulation and utilization of a search strategy throughout the data gathering process. Publications were then screened using a set of inclusion and exclusion criteria defined in the review strategy to ascertain viable publications while eliminating bias throughout the process.

Literature searches were focused on two themes (residue returns and soil disturbance) and two land uses (cropland and grassland). A range of management scenarios were identified in the literature as key UK-relevant agricultural operations influencing soil carbon stocks. These include organic and inorganic nitrogen applications, reduced tillage, tillage direction, grazing and mowing and the comparison of land uses such as cultivated versus fallow. The applicability of land management that may be viable for adoption as a mitigation practice to increase carbon sequestration is considered.

The literature review highlighted limitations in data availability for soil carbon concentrations and/or stocks and key auxiliary parameters (for example soil depth and bulk density). With respect to carbon dynamics we summarise existing knowledge on the distribution and redistribution of carbon in the soil profile and evaluate processes that control this.

Keywords: LULUCF, soil carbon, systematic review, land management, agriculture.

ORAL PRESENTATION

OPTIONS FOR SOIL ORGANIC CARBON SEQUESTRATION IN MEDITERRANEAN AGROECOSYTEMS

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ABSTRACT

Over the last decades it has been observed that the reduction in tillage intensity contributes to mitigate the increment of anthropogenic atmospheric CO_2 throughout soil organic carbon (SOC) sequestration. However, different response of the carbon sequestration from tillage systems can be obtained depending on the local factors acting.

At the beginning of the last decade, several studies at three different levels (i.e., field, laboratory and modelling) were set out to quantify the impact of different soil management systems on soil organic carbon dynamics. These studies were performed across the Ebro river valley area located in NE Spain using both long-term field experiments (i.e., >20 years old) and commercial farm plots. In particular, we selected 5 long-term experiments and 350 commercial plots, with different fertilization and soil management strategies, generating a yield potential gradient. In this study we present an integrated analysis of the effects of soil-climate and cropping management practices on SOC sequestration. The results show that the adoption of an integrated management approach considering soil management and fertilization can result in significant gains in the stock of SOC in Mediterranean rain fed areas.

Keywords: global warming mitigation, greenhouse gases, cropping technology, soil organic matter.

ORAL PRESENTATION

CARBON SEQUESTRATION POTENTIAL IN EU AGRICULTURAL SOILS: SCENARIO ANALYSIS WITH A NEW PLATFORM OF SIMULATION

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ABSTRACT

Despite the EU climate and energy package aiming at consistently reducing GHG emissions by 2020, known as the "20-20-20" targets, the adoption of carbon sequestration measures in the agricultural sector has been excluded. Major constrains are related to the lack of soil organic carbon (SOC) stock estimates at EU level and of tools for orienting the future policymaker decisions. In this context, a comprehensive model platform was established at pan-European scale (EU + Serbia, Bosnia and Herzegovina, Croatia, Montenegro, Albania, Former Yugoslav Republic of Macedonia and Norway) using the agro-ecosystem SOC model CENTURY. Almost 164,000 combinations of soil-climate-land use were computed, including the main arable crops, orchards and pasture (Lugato et al., 2013 GCB). The model was implemented with the main management practices (e.g. irrigation, mineral and organic fertilization, tillage, residues management, etc.) derived from official statistics and validated against independent datasets.

The simulation platform was then run to explore the potential effect of different management practices on SOC change, encompassing crop residues management, tillage techniques, crop rotations and land use change options. The simulations were projected until 2100 by some IPCC climatic scenarios.

The results indicated a biogeochemical sequestration potential in the order of 0.3-0.5 Gt of C within the next 50 years combining several practices which effect, however, was strongly dependent to the spatial and temporal extent considered. Land use change scenario had the greatest impact in term of SOC change compared to alternative managements under the same land use, as the cropland to grassland conversion. Within the arable land use some promising managements such as cover crop, complex rotation, residues management and reduced tillage adoption showed a SOC accumulation trend, lasting for half of the century at least. Considering the importance of SOC in future EU policies, this platform of simulation appears to be a very flexible tool to make scenario analysis, hence orienting future policymaker decisions.

Keywords: modelling, SOC stock, scenarios, agricultural management.

ORAL PRESENTATION

CO_2 SEQUESTRATION FROM ITALIAN CULTIVATED LAND: OPPORTUNITIES, CHALLENGES AND RISKS

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ABSTRACT

Management of agricultural soils may determine soil carbon emission to the atmosphere (source) or soil carbon sequestration (sink). Conventional agriculture is tillage-based (TA) in industrialised as well as developing countries and relies, as a key operation for seed-bed preparation, on mechanical soil tillage with no organic mulch cover. It is generally considered to speed up the loss of Soil Organic Matter (SOM), by increasing its mineralization and through soil loss by erosion. In addition, tillage is a high energy-consuming operation that uses large amounts of fossil fuel per hectare in mechanised systems. As opposed to tillage-based systems, Conservation Agriculture (CA) is an agro-ecological approach to resource-conserving agricultural production that requires compliance with three linked practical principles, namely: i) minimum mechanical soil disturbance (with no-till and direct seeding); ii) maintenance of permanent organic soil cover (with crops, cover crops and/or crop residues); and iii) species diversification through crop rotations and associations (involving annual and/or perennial crops including tree and pasture crops) Corsi et al. (2012). CA facilitates good agronomy, such as timely operations, and improves overall land husbandry for rainfed and irrigated production and is complemented by other good practices, such as the use of quality seeds and integrated pest management (Pisante et al., 2012).There is evidence that in the medium term the most effective way for adaptation to climate change is represented by a rational management of the biosphere and particularly of the agricultural sector: by the adoption of specific agricultural practices, agriculture is potentially in grade to reduce its emission with the minor costs with respect to other activities, to increase carbon sequestration and reduce greenhouse gases emission. In fact, agricultural activities play a fundamental role in carbon sequestration and reduction of emissions, mainly because the high stock capacity of this element associated with the retention time into the soil. The cultivated land (arable and tree crops) occupy 28% of the Italian territory, for a total of 10.9 million ha can stock massive reserves of carbon by putting in place agronomic measures and/or agro-ecological infrastructure that help reduce the amount of CO_2 in the atmosphere. The net balance of the two processes on an annual basis can result in positive net flows (emissions) or negative (sequestration). However, the aggregated balance sheet of carbon from soils cultivated is subject to significant uncertainties with estimates vary greatly depending on the method and data sources. The average European values, for example, range from losses of -0.17 ± 0.33 Mg C ha^{-1} y^{-1} (emissions), when calculated from data in the inventory of agricultural soils (available for 33% of the European cultivated land) to values of accumulation of 0.15 ± 0.15, or loss of -0.08 Mg C ha^{-1} y^{-1} when calculated with simulation models. It is estimated that in Italy over the past 70 years, the intensification of agricultural activities has caused a net loss of soil organic carbon by 39% compared to the initial content. The extent of actual SOC sequestration achieved on Italian cultivated land will depend crucially on future policies. These could be inclusion of agriculture in an emissions trading scheme, either as a covered sector, or as an offset provider. It is important to resolve outstanding research questions as a matter of urgency, to remove this barrier to inclusion of soil carbon in emissions trading. Complementary measures, such as research, development and technology transfer to improve the extension to improve adoption of existing techniques or direct financing to accelerate the adoption of conservation farming systems, should be contemplated.

Keywords: climate change, Kyoto protocol, CO_2, soil organic carbon, conservation agriculture.

ORAL PRESENTATION

CARBON CAPTURE AND SOIL BIOLOGICAL ACTIVITY IN FRUIT TREE ORCHARDS

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ABSTRACT

Climate changes (mainly increased temperature and precipitation changes) will have agricultural consequences due to the interrelations between climate and soil degradation, land and water use, landscape changes. At the same time, conservation agriculture offers new chances to adapting and mitigating climate change.

In sustainable agro-forestry systems, management practices are able to increase carbon inputs into soil and possibly reduce GHGs emissions due to some revised field operations (e.g. irrigation, pest and disease, fertilization, soil and plant management). Carbon enrichment increases biological activities by changing (improving) soil structure as well as the soil moisture and nutrient contents which are beneficial to plant growth and production.

This paper reports results on the effects of changed soil management practices from conventional (soil tillage, mineral fertilisers, burning of pruning residues) to sustainable (no-tillage, pruning residues and cover crop retention, compost application) on soil microbial biomass and organic carbon (SOC).

Results show that a 7-year period of changed practices significantly (including carbon input at a mean rate of 8-9 t C ha^{-1} y^{-1}) increased SOC concentration (from 1.3% up to 1.8%) proving the potential role of that orchards for carbon capture. In addition, and soil microbial biomass was significantly increased. The paper shows the beneficial effects of sustainable practices on yield which was improved by 30-50% as compared with conventional managed orchards. The effects of carbon addition on reserves of soil nutrients (N, P, K, Ca, Mg) and on CO_2 soil emission are discussed.

Keywords: orchard management, CO_2 emissions, biomass, soil bacteria.

ORAL PRESENTATION

SOIL CARBON BALANCE IN A BIO-ENERGY PLANTATION (POPFULL)

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ABSTRACT

The substitution of fossil fuels by bio-energy from woody crops is one strategy to reduce CO_2 emissions to the atmosphere. Afforestation with fast-growing woody crops is also relevant for soil organic carbon (SOC) sequestration. Both measures are part of the policies to mitigate climate change. In short-rotation coppice (SRC) cultures part of the above-ground biomass is periodically harvested and processed for bio-energy production, where the fixed carbon is released again to the atmosphere. However, the harvest of the biomass implies less carbon input to the soil as compared to a natural forest. The potential of SRC to store carbon into the soil and to mitigate the rising atmospheric CO_2 concentration is still not well understood. The primary objectives of this contribution are to monitor the impact of SRC on SOC of a particular SRC with fast-growing poplar (Populus) trees. The studied SRC culture has been established on land that was previously used as cropland and as pasture. The large-scale SRC plantation (18.4 ha) in East-Flanders (Belgium, 51°06'N, 03°51'E) is managed in two-year rotation cyles. The most important soil carbon fluxes were measured during the entire rotation of the SRC. Data of all carbon fluxes into and out of the soil are presented. The main carbon inputs to the soil resulted from the leaf-fall, annual weeds and harvesting losses. The main carbon flux coming upt from the soil was from soil respiration, being the leaching of dissolved organic carbon only a minor proportion. To detect significant changes in SOC after a changed land management (from agriculture to SRC for bio-energy), long-term records are required. But by assessing the fluxes we can model and simulate the SOC balance and predict future changes. Our results highlight the importance of measure all carbon fluxes into and out of the soil. This and other relevant data allow us to assess the potential of SRC for bio-energy production and for SOC sequestration.

Keywords: soil organic carbon, poplar, short-rotation woody crop.
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POSTER

CONSERVATION AGRICULTURE AS A DRIVER FOR CARBON CREDIT MARKET

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ABSTRACT

Reducing CO_2 emission is an unavoidable target by now. Nevertheless the implementation of new technologies will produce effects only in the medium-long term. In the meantime the compensation of CO_2 emissions through "carbon credits" generated by agriculture could achieve a double goal, mitigating the impact of climate change and stimulating agriculture itself to become more efficient in the use of energy and more sustainable. Carbon credits representing reductions in greenhouse gases in the atmosphere can indeed arise increasing the amount of carbon stored in soils and trees and reducing or avoiding emissions during the productive processes. Scientific literature demonstrated in particular soil management according to the "Conservation Agriculture" principles could significantly increase the soil organic carbon content. Those data were confirmed by the results recently achieved in north Italy (project "AgriCO_2ltura", ERSAF- Regional Agency for Agriculture and Forests of Lombardy, Italy). In fact, in the Po plain the organic carbon stock currently stored in soils varies from 34 to 60 t/ha and a potential for further uptake in the presence of appropriate soil management has been estimated at least 12.8 t/ha of CO_2 equivalent. Therefore, opportunities to develop a carbon market, where the CO_2 emissions are compensated by "agriculture credits", potentially occur. Examples of carbon markets are already running in Canada (province of Alberta) and Australia. In Lombardy the intention is now to test a prototype of a carbon offset system adapted to the specific local situation. The aim is to verify which are the conditions for the development of a voluntary carbon credits market based on offset protocols of interest to agriculture, allowing to provide new economic opportunities for farmers and keep at local level the funds collected through the offset credit trading. The project is expected to address the development of "green marketing" strategies by private companies or public institutions as well as a more precise accounting for the agricultural carbon deposits (in Lombardy almost 10% of total greenhouse gases emissions are ascribed to agriculture). As a first step the development of farm protocols concerning the Tillage management and the Milk Life Cycle is planned. At the same time extension efforts to grow awareness and provide tools and information to support the offset system are needed. In this way, the Life project "HelpSoil" (LIFE12 ENV/IT/578) is expected to give an important contribution with respect to soil tillage improvement. In fact, the "HelpSoil" project is aimed at verifying on different pedoclimatic conditions and cropping systems of the Po plain how Conservation Agriculture management practices allow to a reduction of fuel consumption for soil works and lead to the sequestration of carbon into the soil.

Keywords: soil, carbon market ,offset, credits, agriculture.

POSTER

EFFECT OF AGRONOMIC AND ENVIRONMENTAL FACTORS ON CO_2 EMISSIONS ON A DRYLAND ROTATION

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ABSTRACT

Agriculture is a substantial source of greenhouse gas emissions (GHG) in many countries.
Conservation agriculture includes soil management systems that help to reduce CO_2 emission levels.
However, there are many factors involved in the production of these emissions such as soil management type and time at which the agriculture operations are performed, crop phenological state, the weather, and handling of the residue amongst others. In the long term, the relationships that exist between these factors seem to determine the balance of these emissions.
In this study, we analyzed the influence of the soil management system as well as the climatology of the different seasons studied and the phenological state of the different crops implanted.
For this purpose a field trial was conducted in Las Cabezas de San Juán (Seville). This pilot farm consisted of six experimental plots with an approximate area of 5 ha; conservation agriculture practices were employed in three of the six plots while traditional tillage management was used in the other three. Within these plots the three crops of the wheat-sunflower-legume rotation were tested simultaneously.
The study was conducted over four agricultural seasons - 2009/10, 2010/11, 2011/12 and 2012/13. Each of these cropping seasons were characterised by very different rainfall amounts, registering a total of 814.4, 721.6, 268.2 and 676.4 l/m^2, respectively.
When we studied the evolution of emissions over four seasons, an increase could be observed for both management systems during the time in which the crops were established due to the roots respiration processes. These increases were heavily influenced by the rainfall recorded during the time in which the crop was in place.
In the case of wheat, higher emissions were produced during the cultivation time of the first and fourth season during which 84% and 60% of the total rainfall of each season was recorded. These emissions were 9 and 5 kg CO_2/ha for conventional tillage and no tillage, respectively for the 2009/10 season and 11.7 and 6.8 kg CO_2/ha, respectively in the 2012/13 season. Conversely during the 2011/12 season, a season in which lower precipitation was registered, the higher emissions were comparatively minor with respect to the previous values, specifically 3.7 and 1.9 kg CO_2/ha for non-tillage and conventional tillage.

Keywords: CO_2 emissions, no tillage.

POSTER

INCREASING SOIL ORGANIC CARBON FIXATION BY USING COVER CROPS IN OLIVE ORCHARDS

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ABSTRACT

Andalusia, located in the south of Spain, is the main olive producer in this country, with the 60.2% of its total agricultural area cultivated with this tree. This region produces the 39% of the world olive oil and 24% of the table olive. However, this kind of production based on the tillage of the soil produces many environmental problems. Especially related to the soil and organic carbon (OC) lost. Not only because of the sediment dragged, but also due to the combustion of fuel and oxidation of the OC of the ground. Conservation agriculture systems in woody crops, cover crops (CC), significantly reduce soil losses. Also decrease the emission of CO_2 to the atmosphere by two ways: less fuel consumption, due to the suppression of the tillage, and increase of the soil organic carbon (SOC) sink, by enhancing its structure and providing a large amount of plant debris.

The objective of this work is to quantify the efficiency of the CC as a method to improve the SOC sink capacity in olive groves in semiarid climates. The study was carried out during four seasons in five experimental fields distributed in different olive-growing regions of Andalusia, South of Spain. In two different soils management systems, conventional tillage (CT) and CC, were measured diverse parameters as: OC adsorbed in sediments, temporal evolution of the amount of OC in the ground, and biomass production.

After four year of experimentation, was observed that the CC promoted an average reduction of the losses of OC adsorbed in sediment of 67.7%, respect to the CT. The OC sink in the soil was increasing by both management systems. However, these values were significantly higher in CC, 15.9 Mg $ha^{-1}y^{-1}$, respect 3.6 Mg $ha^{-1}y^{-1}$ of the CT. Significant variations in the increase of SOC were also observed based on textural characteristics of the experimental fields and the type of weeds that constituted the CC.

According to the results, and extrapolating them to the total olive area of Andalusia (1.55 Mha), an amount of 19.1 Mt of equivalent CO_2 could be fixed each season during the first years of implementation of the CC systems.

Keywords: olive, cover crops, climate change, fixation, organic carbon.

POSTER

MONITORING SOIL ORGANIC CARBON VARIATIONS IN ORGANIC FARMING BY PROXIMAL SENSING

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ABSTRACT

It has been widely It has been widely recognized the crucial role of soil monitoring in assessing the effectiveness of the soil measures and agro-environment schemes passed by Regional and local administration in complying the EU's Common Agricultural Policy to soil protection. The costs of soil monitoring however are substantial and the reliability of the results often questionable. A reason is that the monitoring activity commonly consists of a network of sampling points which are then spatialized through different inference models. This methodology does not often enable a reliable estimation at the field scale, that is the scale where the measures are foreseen and financed. The organic carbon content of the ploughed layer is an important soil feature, which regulates many soil functions. It is therefore considered in Organic Farming (OF) and contemplated in many agro-environment schemes. The adoption of OF is expected to improve soil organic carbon content (SOC) of the fields as a whole. Nevertheless, the improvement might show local variations, because of the interaction between crop management and other factors, for instance, soil erosion. Aim of this work was to check the variations in SOC and stock between and within fields where CA was or not applied, using combined soil proximal sensors, namely γ-ray and Vis-NIR spectroscopy.

The research work was carried out in four areas in western Sicily (Italy). Two adjacent arable fields were surveyed for each area, comparing OF (green and organic manure, 20-30 cm rotary tilling, chiselling, or ploughing, crop rotation) lasting from 3-10 years, with continuous traditional farming (TF, no rotation, mineral fertilization, 40-50 cm ploughing). The lithology was either clayey and calcareous-clayey flysch, or clays, silty-clays and marls, but the soils were similar and characterized by toposequences of Calcisols, Regosols, Cambisols, and Vertisols. The γ-radiometric survey was performed by "The Mole" sensor, made by "Medusa Systems", while the Vis-NIR spectroscopy used Fieldspec 3Hi-res with the ASD Contact probe for Vis-NIR region (0.350-2.5 μm).

The soils had similar texture, common vertic properties, presence of secondary carbonates, and low organic matter, but gravel content was very variable. The carbon stock (upper 30 cm) of the whole fields under OF resulted significantly higher than in TF (on average of 36.0 versus 33.2 Mg. ha^{-1}). In addition, TF fields showed very heterogeneous SOC, with very high and very low values, as a consequence of soil erosion, while in OF SOC was much more homogeneous, thus reflecting both higher organic matter accumulation and lower soil loss from water erosion in similar morphological positions.

Keywords: cross compliance, carbon stock, Vis-NIR, Y-Ray, Sicily.

POSTER

SHORT, MEDIUM AND LONG-TERM INFLUENCE OF TILLAGE AND ENVIRONMENTAL VARIABLES ON CO_2 FLUXES FROM IRRIGATED CROPS ROTATION IN CASTILLA Y LEÓN, SPAIN

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ABSTRACT

In recent years numerous studies have emerged to quantify the carbon and water vapour exchange between the atmosphere and our terrestrial ecosystems, with the aim of characterizing the potential feedbacks that global warming may be producing on Earth's surface. Crops capture CO_2 from the atmosphere during photosynthesis, converting carbon into forms associated with organic matter in the soil during microbial decomposition processes. Changes in soil use, land transformations and disturbances all lead to modifications of the carbon balance because an important part of the resulting CO_2 fluxes goes to the atmosphere. Conservation agriculture has introduced important changes in the dynamics of C in the soil and favours its sequestration. The combination of leaving crops residues on the soil surface and not disturbing it with the tillage results in a reduction in the decomposition rate of the crop remains. That is the reason why an experiment with different tillage system and their influence on CO_2 emission was carried on in Zamadueñas, Castilla y León, Spain, within the period of 2011-2013. The compared tillage systems were the conventional tillage (CT) and the no-tillage system (NT) in irrigated conditions.

The experimental design was a split-plot with four replications where the main factor was the tillage system, CT: mouldboard plough, cultivator and sowing and NT: herbicide and sowing, and the second factor is the crop rotation (Maize-Maize-Maize, Maize-Soy Bean-Wheat, and Maize-Sorghum-Wheat).

The short term influence of tillage on soil CO_2 evolution was assessed by recording varies series of successive measurements during the soil´s preparation and sowing. Measurements were made before these operations took place, immediately after them and 2, 4, 24 and 48h after carrying them out in CT and NT. Specific measurements took place along different seasons due to determine the importance of climate conditions of CO_2 emissions.

Soil CO_2 fluxes, measured from November 2011 to November 2013, were similar at successive points along each plot before tillage. By 2 minutes after tillage, fluxes along the tilled plots increased 4 to 5 fold over the no tilled plots, thereby fluxes along the undisturbed soil remained nearly unchanged. About 4 hours after tillage, differences between CO_2 fluxes along till and no till plots were not significant.

Keywords: soil CO_2 flux, tillage, soil respiration, soil carbon sequestration.

POSTER

DEGRADATION AND RECALCITRANCE OF DIFFERENT BIO- AND HYDROCHARS RELATIVE TO THEIR CARBONIZATION DEGREE IN TWO CONTRASTING SOILS

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ABSTRACT

Biochar is recognized as a climate change mitigation option by carbon sequestration and soil storage with environmental co-benefits (IPCC 2007, WG III). We investigated the carbon sequestration potential of four carbon amendments (Miscanthus x giganteus feedstock, vapo-or hydrothermally carbonized or pyrolyzed) in two different soils (agricultural sandy soil and loamy soil from permanent grassland) by means of greenhouse gas (GHG) emissions, stable isotope measurements (bulk13C/15N and $13CO_2$) and qualification/quantification of soil biota in an incubation experiment over a period of 13 months. To force weathering and break-down of the carbon substrates, we included fertilization, and simulated extreme events such as frost-thaw and dry-wet cycles, soil disturbance by ploughing, and degradation by co-metabolization after the addition of glucose (priming).

We found significant interactions between soil type, carbon amendment and CO_2 emissions. CO_2 fluxes followed the carbonization degree of the amendments in the order feedstock>vapochar>hydrochar>pyrochar with slightly higher total emissions from sandy soil vs loamy soil (CO_2 efflux means: 15.78 vs 14.39 g*kg soil mix). Both carbon loss and remains correlated with the structural properties of the amendments, i.e. cellulose was a predictor for carbon loss, and aromatic compounds indicated recalcitrance against biotic and abiotic decay.

Isotope measurements and the short-term priming experiment gave evidence that there is neither the danger of native soil organic carbon (SOC) loss by biochar amendment, not even after glucose amendment. We even observed a negative priming of SOC by biochar amendment in both soils (49-59% SOC emissions reduction). The less carbonized materials led to SOC loss (CO_2 emission increases of 15-307 % compared to the unamended control soil) especially at the beginning of the experiment and more pronounced in the sandy compared to the loamy soil, respectively.

Degradation of the total carbon (SOC + added substrates) in the mixtures was highest in the beginning of the experiment, indicating the mineralization of labile carbon fractions from the amendments. The degradation was triggered by all purposely reinforced abiotic factors (extreme events and soil disturbance), but the patterns were similar throughout the experiment.

Our results offer possibilities for humus buildup and humus protection by soil amendment of biochar. Supported by effective carbon offset policies, farmers could get the opportunity to implement climate friendly, especially GHG reduced land management.

Keywords: biochar, carbon sequestration, GHG emissions, soil improvement, hydrochar.

POSTER

IMPACT OF TILLAGE AND CROP ROTATION SYSTEMS ON CARBON SEQUESTRATION IN A RAINFED MEDITERRANEAN XEROFLUVENT SOIL

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ABSTRACT

Tillage systems and increased cropping intensity have a very important influence on soil properties, but these changes depend on soil type, climatology, used crops and tillage management systems. This paper reports the impact of different tillage practices, no-tillage (NT), minimum tillage with chisel plow (MT) and conventional tillage with mouldboard plow (CT), and crop rotation systems (wheat – barley – fallow – wheat – barley - pea (WBFWBP), wheat – barley – pea – wheat – barley - fallow (WBPWBF), fallow - wheat – barley – pea – wheat- barley (FWBPWB), pea – wheat – barley –fallow – wheat - barley (PWBFWB), barley – fallow – wheat – barley – pea - wheat (BFWBPW), barley – pea – wheat – barley – fallow - wheat (BPWBFWB), on soil organic and particulate organic carbon (SOC and POC) at the end of a eight-year experimental period at a depth of 0 to 60 cm in a semi-arid soil in Castile-Leon, Spain. The study was conducted between 2004 and 2012 at Zamadueñas farm, Valladolid on a Typic Xerofluvent soil with a 1.0 % soil organic matter content. A split-plot experimental design was used, in which the main factor was tillage system and sub-factor crop rotations. The measurements showed that SOC stocks were significantly greater for conservation tillage (NT and MT) than for CT at a depth of 0 to 10 cm. However, the mean SOC stocks were similar for all tillage systems at a depth of 0 to 60 cm. At a depth of 0 to 30 cm, POC stock was significantly greater for NT and MT than for CT. The effects of crop rotation on these parameters were less pronounced than those of tillage systems. However, SOC stock was significantly greater at 0 to 60 cm in plots with legume crop than in fallow plots. The short-term tillage effects showed that NT, MT and the avoidance of fallow practice increased the soil quality by improving the C content compared to CT in soils in semi-arid areas of Spain.

Keywords: conservation tillage, crop rotation, soil organic and particulate carbon stocks and Xerofluvent soil.

POSTER

LIFE CARBONFARM: TECHNOLOGIES TO STABILIZE SOIL ORGANIC CARBON AND FARM PRODUCTIVITY, PROMOTE WASTE VALUE AND CLIMATE CHANGE MITIGATION (LIFE12 ENV IT 000719)

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ABSTRACT

The LIFE+ CarbOnFarm project (http//agricoltura.regione.campania.it/CARBONFARM/index.html) represents an application of both demonstrative and innovative practices aimed to promote the sustainable Soil Organic Matter (SOM) managements in the agro-ecosystems. The project strategies approach the environmental problems related to the decrease of SOC content and to soil degradation, in agricultural areas of Mediterranean countries, which are among the chiefly target objectives advised by EU Soil Thematic Strategy. The objective is the restoration of SOM functions in agricultural soils, attained through the valorization of local recycled agricultural biomasses and with soil application of green chemistry products; these practices will be applied at farm scale in four project sites, reproducing the local farming systems, located in Piemonte and in Campania regions in Italy. The improvement of SOC, the enhancement of the economic and environmental role of soil resources in the agro-ecosystems and the valorization of agricultural biomasses recycling are the main area of concern. The proposal is tailored on the non-livestock farms of agricultural areas of Southern Europe characterized by limited access to renewable OM sources, the progressive decline of SOM content and soil fertility, with a potential increase of soil erosion and a steady requirement of high energy inputs.

An important target of the project is to promote the productive and economical valorization of residual biomasses from the local agricultural activities to reach a high quality compost. In farm sites of Campania, which territory is characterized by the scarcity of suitable organic sources, the compost will be obtained by on-farm composting facilities. In farm sites of Piemonte the compost will be produced in external composting plan by using the available organic biomasses represented by solid fraction from anaerobic digestion of cattle slurry. The innovative activities based on soil addition with eco-friendly biomimetic catalyst, will strengthen the in situ stabilization of SOM. These activities will meet the main goal of the project which is to promote the SOC sequestration and the restoration of SOM functions thereby involving a decrease of GHG emissions and combining the maintenance of crop productivity with lower energetic inputs. The adoption of specific monitoring actions has been conceived to make available the application of suitable approaches for the acquisition of a useful array of data concerning the SOC quantity and quality, GHG emission from cultivated soils, soil stability, crop productivity as well as the environmental, energetic and economical sustainability of the applied methodologies.

Keywords: LIFE project, SOM management, SOC sequestration, on farm composting, biomimetic catalyst.

POSTER

ORGANIC CARBON SEQUESTRATION IN CULTIVATED SOILS BY IN SITU CATALYZED POLYMERIZATION OF SOIL ORGANIC MATTER

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ABSTRACT

Soil organic matter (SOM) is the key compartment for the maintenance of soil fertility, acting as driving force for the overall sustainability of agro-ecosystems. The acknowledged progressive decrease of SOM in European agricultural lands, accelerate the decline of soil fertility, thus also contributing to global CO_2 emissions. In fact, the decrease of SOC in agricultural lands is believed to account for a global loss of 5.1-6.1 Gt CO_2-eq/year^{-1}, two-thirds of which is attributed to OM mineralization. These effects are even more emphasized in marginal areas of Mediterranean regions, which are characterized by low OM inputs, extensive erosion, and increased GHG emissions.

The appraisal of forecasting analyses indicate that European agricultural soils could potentially store up to 19 Mt C year^{-1} .Therefore, a growing attention is devoted to SOM managements aimed to enhance OC sequestration and limit both soil degradation processes and GHG emissions.

An important role in SOC sequestration is assigned to humified organic matter which is the most abundant and persistent pool of SOM, and represents the principal potential sink of OC in the biosphere. A novel understanding of humus chemistry has shown that the stable soil humified pools are build up by relatively small heterogeneous biomolecules, self-assembled by weak interactions in supramolecular associations. An important implication of the supramolecular nature of SOM resides in the opportunity to further stabilize the humic components by coupling them into larger molecular-weight materials, thereby strengthening the intermolecular interactions and enhance the energy threshold required in SOM mineralization process.

Specific technologies based on biomimetic catalysts, such as biocompatible metal-porphyrins, that mimic the activity of oxidative enzymes, can be successfully employed in the catalysis of photo-oxidative formation of covalent bonds among phenolic molecules, which is expected to stabilize the SOM, providing the in situ SOC sequestration.

Previous results obtained in a laboratory incubations have revealed an effective oligo-poly-merization of aromatic components in humic substances. Soil addition with iron-porphyrin could stabilize the SOC, under photo-oxidative natural conditions, thereby significantly reducing SOC mineralization and CO_2 emissions.

Here we reports the results of an Italian national project in which the innovative methods for SOC sequestration based on the mechanisms of in situ SOM photo-polymerization was extended at real field level within common agricultural practices of crop production. We aimed to verify on three cultivated soils whether the new approach based on a catalyst-assisted photo-polymerization reaction may promote the SOC sequestration through in situ SOM stabilization.

Keywords: SOC sequestration, CO_2 emission, humic molecules, supramolecular, biomimetic catalyst.

POSTER

THEME 2

SOIL ORGANIC CARBON, SOIL HEALTH AND PRODUCTIVITY

SOIL ORGANIC CARBON, SOIL HEALTH AND PRODUCTIVITY

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ABSTRACT

Land use change is a major factor that affects soil organic carbon (SOC) and global C balance. It is widely recognized that conventional plow-based tillage (CT) disrupts soil structure and aggregates, induces drastic changes in soil environment, decreases the overall biological activity, exacerbates CO_2 emissions and other GHGs, and depletes SOC. The concern about global warming has motivated the scientific community to identify efficient soil management and cropping systems which can sequester atmospheric CO_2 into SOC. Several reports have demonstrated C sequestration soils managed by a no-till (NT) system in conjunction with complex crop rotation. Important factors in increasing CO_2 mitigation and the SOC stock are the amount, quality and frequency of the crop residues added to soil under a wide range of climate-driven decomposition rates, soil mineralogy and profile characteristics. Cropping systems with a high biomass input to maintain a permanent soil cover mimic the environment under undisturbed ecosystems (e.g., forest, savanna, prairies). These cropping systems support a continuous flow of mass and energy which release organic compounds, accentuate soil biodiversity and enhance soil organic matter. These processes are driven by the multifunctionality of each species in the cropping system and its interaction with soil attributes stimulating a systemic interdependence of the soil structure and SOM pools. Continuous input of large amounts of biomass to the soil surface creates a positive C budget, enhances the stable C based on the hypothesis that the intensification of cropping systems by increasing C-input and biodiversity under NT restores SOC pool, increases resilience of degraded agro-ecosystems, and enhances crop yield. The continuous CT decreased the SOC stock by 0.58 and 0.67 Mg C ha^{-1} yr^{-1} in 0-20 cm depth at a subtropical and tropical site, respectively, and the rate of SOC sequestration was 0.59 for the subtropical site, and ranged from 0.48 to 1.30 Mg C ha^{-1} yr^{-1} at the tropical site. The fraction of C input by crop residues converted into SOC stock was ~14.2% at the subtropical and ~ 20.5 % at the tropical site. The SOC resilience index (RI) ranged from 0.29 to 0.79, and it increased with increase in C input among NT systems and the SOC sequestration rates at the tropical site. Every 1 Mg increase in SOC stock to 1-m depth increased soybean yield by 28 kg ha^{-1}, and every 0.1 unit increase in RI increased soybean yield by 600 kg ha^{-1}.

Keywords: C depletion, C restoration, C sequestration, soil resiliency, agronomic productivity.

KEYNOTE

OPTITILL – A DANISH PROJECT ON REDUCED TILLAGE AND DIRECT SEEDING

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ABSTRACT

In Denmark less than 10 percent of the agricultural areal is cultivated with reduced tillage and less than 1 percent is cultivated with direct seeding.
The major physical challenges are cold wet conditions and soil compaction. There is, however, also a mental barrier – the farmers have a desire to perform a visually nice work. To most Danish farmers straight rows of green sprouts on a uniform brown soil is the norm, and it (therefore) appears more appealing to the eye than sprouts in mixture of soil, crop residues and wilted weeds and volunteers.
The aim of the OptiTill project is to make recommendations on where and how to succeed with reduced tillage. We would also like to challenge the perception of our farmers by raising the question: do I as a farmer till the soil to benefit my crop or is it a visual mind trick?
The OptiTill-project runs for 4 years, is funded with 1 Mio € from the Danish GUDP-program and involves 5 partners.
Aarhus University achieves scientific data on soil structure, decomposition rates, nutrient leaching and emission of nitrous oxide.
The Knowledge Centre for Agriculture is conduction on farm studies and trials.The focus in the presentation is on the dissemination activities of the project. FRDK, CTF Europe.dk and LMO are contributing to these activities. LMO is the largest company within the Danish agricultural advisory service, and the manager of the OptiTill project.
As a platform for the dissemination activities we have established three demonstration fields on varying soil types. The demonstration fields are cultivated for the four year project period with a variety of tillage types. In 2013 11 different sowing machines were operation in the fields. We also conduct tests with catch crops and cover crops. We make registrations of germination of the crop, germination of weeds, sowing depth, yield etc.
Based on the demonstration fields and the registrations we arrange field days, make videos, obtain photo-documentation, write articles and a practical manual for farmers.
We have so far made 75 videoes with presentation of machinery, results, recommendations and other farmers with extensive knowledge on reduced tillage. For the sowing demonstration in 2013 more than 400 farmers participated and on a rainy follow–up-day 6 weeks later 100 farmers participated.
The different project partners are already invited to present the results of the project at meetings by our colleagues within the Danish agricultural advisory service.

Keywords: reduced tillage, direct seeding, dissemination, demonstration.

ORAL PRESENTATION

SOIL FERTILITY AND PRODUCTIVITY UNDER DIFFERENT CROP ROTATIONS AND SYSTEMS OF FERTILIZATION IN THE BALTI STEPPE OF MOLDOVA

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ABSTRACT

Research on typical chernozem soil from Balti steppe is aimed at evaluation different crop rotations and systems of fertilization on soil fertility and crop productivity. The aim of the research is to reduce the dependence of agriculture on industrial agro-chemicalinputs to maintain soil fertility and simultaneously to prevent soil degradation and pollution of the environment. Investigations are conducted in the long-term field experiment. Four systems of fertilization are being investigated in each crop rotation: without fertlization; composted manure; composted manure +PK; composted manure +NPK. Suplementary amount of crop residues are used in one of the two crop rotations with mixture of perennial leguminous crops and grasses. The sequence of crops in crop rotation with and without perennial leguminous crops and grasses is as follows: corn for green mass+mixture of alfalfa and grasses-mixture of alfalfa and grasses-mixture of alfalfa and grasses-winter wheat-sugar beet-corn for grain-winter barley andvetch and oats for green mass-winter wheat-sugar beet-corn for grain-winter barley-corn for grain-sunflower. The data in tables for three full rotations of crops are reported in the article. A combination of inversion and non-inversion soil tillage is used in all crop rotations. No chemicals are used in the experiment for insect pest, disease and weed control.

Soil organic matter content is considered to be the integral index of soil fertility. No differences in time have been detected detected in the content of soil organic matter for different crop rotations (with and without mixture of perennial leguminous crops and grasses) on unfertilized plots. Composted farmyard manure alone and together with mineral fertilizers have significantly increased the content of soil organic matter in the 0-20 cm soil layer. The content of total soil nitrogen has decreased significantly in all crop rotations but especially in the crop rotation without mixture of perennial leguminous crops and grassesand on unfertlized plots. Composted manure alone and together with mineral fertilizershave reduced the decrease but could not compensate the deficit of total nitrogen.

The influence of suplementary amount of crop residues in crop rotation was lower than the influence of different crop rotations and organic fertilizers.

The soil organic carbon content increased in time under the influence of organic and organo-mineral systems of fertilization in both crop rotations.

The total nitrogen content decreased significantly in all crop rotations, especially in crop rotation without mixture of perennial leguminous crops and grasses. Organic and organo-mineral systems of fertilization in crop rotations significantly reduced the deficit of total nitrogen, but losses have remained uncompensated.

By respecting crop rotation with higher diversity of crops and proper management of organic fertilizers, it is possible to reduce the dependence on mineral fertilizers and pesticides.

Future work will include the role of no-till and mulch cover.

Keywords: soil organic carbon,soil fertility,crop rotations,crop productivity.

ORAL PRESENTATION

IMPACT OF TILLAGE AND CROP ROTATION IN SOIL ORGANIC MATTER OF A 17 YEAR EXPERIMENT IN CENTRAL GREECE

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ABSTRACT

Maintenance and improvement of soil quality in continuous cropping systems is critical to sustaining agricultural productivity and environmental quality for future generations. In recent years great effort is made to produce energy from biomass. The second-generation biofuels are expected to remove all produced materials from fields. This will reduce soil organic matter, increase soil erosion risk . To aleviate these effects reduced or no tillage, appropriate crop rotations and use of cover crops were proposed. The addition of organic fertilisers could work to the same direction.

A long term experement was established in the University of Thessaly farm comparing five tillage methods under different crop rotations. The experiment was established in 1996. In 2012 it was used with the same tillage treatments to produce biomass for second generation biofuels. A split block experimental design with four replications was used with rotations as the main plots and tillage as sub-plots. Two seperate fields were used: one for irrigated crops and one for rainfed. Five tillage treatments were tested as follows:

1. Conventional tillage (CT) with ploughing at 25-30 cm and 2-3 passes of a disk harrow at 7-9 cm or a light cultivator at 6-8 cm for seedbed preparation.
2. Reduced tillage (HC) using a heavy cultivator at a depth of 20-25 cm and 2 passes of a disk harrow or a light cultivator for seedbed preparation.
3. Reduced tillage (RC) with only one pass of a rotary cultivator at 10-15 cm for primary tillage, and sometimes one pass of a light cultivator before planting.
4. Reduced tillage (DH). Two tillage treatments were used. For winter crops primary and secondary tillage with a Disk harrow at 6-8 cm. For summer crops a strip tillage machine was used.
5. No-tillage (NT). Direct planting using two no-till planting machines

From 1996 till 2012 different crop rotations were applied with crop residues remaining always in the soil. In many cases even the whole crop was left in the field. In 2012 two energy crop rotations were initiated in the irrigated field. Each rotation included two crops every year, a winter (rain fed) and a summer (irrigated) one.

The objective of the present study was to investigate: 1. The effects of the treatments applied to soil organic matter and 2. the true mechanisms of SOM as affected by different crop rotations, management of crop residues and tillage methods.

Soil samples were taken from the two experimental fields at two soil depths at the begining of the new experiment. The soil analysis referred to organic matter, humic and fulvic acids, Disolved Organic Carbon, Microbial Activity, electrical conductivity etc. The first results, depicting the tillage and crop residues management effect of the previous 17 years, indicated that there is a significant difference in the percentage of organic matter among the two depths, with topsoil having the highest o.m. content . Statistically significant differences were observed between tillage treatments.

Keywords: soil organic matter, crop rotation, tillage treatments, soil analysis, biomass, soil fertility.

ORAL PRESENTATION

ROLE OF THE COVER CROPS IN THE SOIL ORGANIC CARBON OUTPUT REDUCTION IN OLIVE ORCHARDS

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ABSTRACT

The woody crops in the Mediterranean basin have suffered a great development, being the olive tree which has a higher distribution. Spain is the main world producer, being this crop a social and economic backbone of many regions. Andalusia has more than the 60% of the total area cultivated with olive in Spain, representing a 25% of his agrarian production. Most of the plantations are rainfed (74.5%), located in poor soils and on steep slopes. This make the crop particularly sensitive to soil degradation process, due to the loss of incomes that it produces. However, the management system of the crop, with high frequency of plow operations, promotes the erosion. Being the soil loss the bigger environmental problem in the olive production. Although, erosion is the main problem, is not the only one, because a huge amount of organic carbon (OC) is dragged adsorbed in the sediment, with a big pollutant potential. It is estimated, that the amount of world CO_2 emissions associated to erosion are around 0.8-1.2 Gt y^{-1}. These facts represent a very negative consequence not only for the farmers, due to the loss of fertility, but also for the society in general.

The objective of this work is to quantify the efficiency of the permanent cover crops (CC) as a method to reduce the OC output in olive groves in semiarid climates. The study was carried out during four seasons in eight experimental fields distributed in different olive-growing regions of Andalusia, South of Spain. In two different soils management systems, conventional tillage (CT) and CC, were measured diverse parameters as: characteristics of the rain events, runoff and erosion, OC adsorbed in sediments and temporal evolution of the amount of OC in the ground.

After the study period, was observed that the CC promoted an average reduction of the OC losses of 76.4% respect to the CT. Owing to a diminution of the runoff and erosion, 36.4% and 85.6% respectively, because of an increasing of the average soil cover: 65.7% for CC, respect 22.4% of CT. Furthermore, the OC output in the CC was not so influenced by the characteristics of the rainfall events, versus the CT that was highly influenced.

According to the results, and extrapolating them to the total olive area of Andalusia (1.55 Mha), the average erosion rate in our region (60-80 t ha^{-1}) and the average OC concentration in sediment measured during the study period (approximately 1,5%), around 4.6 Mt of equivalent CO_2 could be saved each year by applying CC systems.

Keywords: olive, cover crops, climate change, organic carbon output.

ORAL PRESENTATION

DOES SOIL ORGANIC MATTER INFLUENCE FUNCTIONAL SOIL PROPERTIES? – A REVIEW OF PUBLISHED INFORMATION

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ABSTRACT

A review has been undertaken into how soil organic matter affects a range of soil properties. The effect of varying the amount of soil organic matter on a range of individual soil properties was investigated using a literature search of published information largely from Australia, but also included relevant information from overseas. The soil properties considered included aggregate stability, bulk density, water holding capacity, soil erodibility, soil thermal properties, soil colour, soil strength, compaction characteristics, friability, nutrient cycling, cation exchange capacity, soil acidity and buffering capacity, capacity to form ligands and complexes, salinity and the interaction of soil organic matter with soil biology. Soil organic matter had clear effects on water holding capacity, cation exchange capacity, aggregate stability and buffering capacity to acidification. Soil organic matter also had a definite effect on the compaction and strength characteristics of soils which in combination with friability can determine how the soil responds to traffic and tillage. Soil organic matter was an important factor in providing a nutrient supply and in nutrient cycling, especially of nitrogen, but also of significant proportions of phosphorus and sulphur and other micronutrients. The relative effects of soil organic matter varied with texture, with soil organic matter generally being more critical in soils with lower clay contents. Given the broad effects of soil organic matter on soil properties, there is the capacity of soil organic matter to have a measurable effect on soil productivity and economic returns. This was confirmed in one study on Red Luvisols in the cropping zone of south eastern Australia.

Keywords: soil organic matter, soil properties, water holding capacity, nutrient cycling, soil productivity.

ORAL PRESENTATION

NINE YEARS OF CONSERVATION AGRICULTURE-BASED CROPPING SYSTEMS RESEARCH IN EASTERN AFRICA TO SOIL DEGRADATION AND MITIGATE EFFECTS OF CLIMATE CHANGE

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ABSTRACT

In Ethiopia, repeated plowing, complete removal of crop residues at harvest and aftermath grazing of crop fields have reduced the biomass return to the soil and aggravated cropland degradation. Conservation Agriculture (CA)-based cropping systems may reduce runoff and soil erosion, and improve soil quality and crop productivity. Thus, a long-term tillage experiment has been carried out (2005 to 20123) on a Vertisol to quantify - among others - changes in runoff and soil loss for two local tillage practices, modified to integrate CA principles in semi-arid northern Ethiopia. The experimental layout was a randomized complete block design with three replications on permanent plots of 5 m by 19 m. The tillage treatments were (i) derdero+ (DER+) with a furrow and permanent raised bed planting system, ploughed only once at planting by refreshing the furrow from 2005 to 2013 and 30% standing crop residue retention, (ii) terwah+ (TER+) with furrows made at 1.5 m interval, plowed once at planting, 30% standing crop residue retention and fresh broad beds, and (iii) conventional tillage (CT) with a minimum of three plain tillage operations and complete removal of crop residues. Wheat, teff, barley and grass pea were grown in rotation. Runoff and soil loss were measured daily. Significantly different ($p<0.05$) runoff coefficients averaged over 9 years were 14, 22 and 30% for DER+, TER+ and CT, respectively. Mean soil losses were 3 t ha^{-1} y^{-1} in DER+, 11 in TER+ and 178 in CT. A period of at least three years of cropping was required before improvements in crop yield became significant. Further, modeling of the sediment budgets shows that total soil loss due to sheet and rill erosion in cropland, when CA would be practiced at large scale in a 180 ha catchment, would reduce to 581 t y^{-1}, instead of 1109 t y^{-1} under the current farmer practice. Using NASA/GISS Model II precipitation projections of IPCC scenario A1FI, CA is estimated to reduce soil loss and runoff and mitigate the effect of increased rainfall due to climate change. For smallholder farmers in semi-arid agro-ecosystems, CA-based systems constitute a field rainwater and soil conservation improvement strategy that enhances crop and economic productivity and reduces siltation of reservoirs, especially under changing climate. Adoption of CA-based systems in the study area requires further work to improve smallholder farmers' awareness on benefits, to guarantee high standards during implementation and to design appropriate weed management strategies.

Keywords: conservation agriculture, runoff, soil conservation, permanent raised beds.

POSTER

THE INFLUENCE OF CONSERVATION FARMING PRACTICES ON SOIL MICROBIAL COMMUNITIES AND SOILBORNE DISEASES OF POTATO

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ABSTRACT

Soilborne diseases of potato including common scab, powdery scab and black scurf and plant-parasitic nematodes pose a severe threat to potato production as chemical control is either ineffective or non-existent. For this reason, potato production is increasingly reliant on soil fumigation. The use of synthetic fumigants not only increases production costs, but also has a treadmill effect in that it severely disrupts the soil ecosystem and repeated application in increased dosage is needed to achieve desired pest control. Such practices are highly non-sustainable and the resulting ecological disturbances to the production system have devastating effects in the long run. Through fumigation the soil is sterilised and beneficial micro-organisms are in so doing, destroyed. Pathogenic organisms that are introduced by planting material proliferate under these sterile conditions where no competition is offered by beneficial micro-organisms. This is especially problematic for the potato industry as potatoes are clonally propagated by planting whole seed tubers, which promotes the spreading of pathogens from one area to another. A more sustainable approach needs to be investigated.

To address these and other concerns, a long-term conservation farming project was initiated in February 2013 in the Sandveld, the second-largest potato producing region in South Africa. Treatments consist of three tillage regimes namely mouldboard plough (maximum disturbance), rip plough (intermediate disturbance) and para plough (minimum disturbance). The aim is to evaluate the effect on potato yield, the physical, biological and chemical status of the soil, and water use efficiency in the potato production system. The biological part of this study investigates the influence of conservation tillage on indigenous soil microbial communities and the incidence of soilborne diseases of potato and if a correlation exists between these. Conservation tillage is known to suppress soilborne diseases by increasing organic carbon and indirectly influencing indigenous microbial communities. These changes in the microbial community may lead to suppression of pathogen and plant-parasitic nematode populations. Culture-dependent and -independent methods were used to assess the changes in microbial populations. Microbial activity was measured by measuring enzyme activities, microbial diversity by measuring soil carbon substrate utilisation using the BIOLOG® system and microbial density by soil dilution plating.

Results from the first season indicate a positive correlation between conservation tillage and active carbon, soil respiration, potato yield, free-living nematodes as well as microbial diversity and a negative correlation with plant parasitic nematodes and common scab incidence.

Keywords: conservation tillage, potato production, organic carbon, microbial diversity, common scab.

POSTER

EFFECT OF TILLAGE SYSTEM AND CROP RESIDUE MANAGEMENT ON SOIL CARBON CONTENT OF A LUVISOL AND ITS EFFECT ON WHEAT RESPONSE TO NITROGEN UNDER RAINFED MEDITERRANEAN CONDITIONS

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ABSTRACT

Under Mediterranean conditions, soils under conventional tillage farming usually have very low contents of organic matter. This situation is due to intensive soil tillage, low biomass production under rainfed conditions, and removal of cereal straw for alternative use off the field. In order to study strategies to improve soil organic matter content (SOM), a long term experiment (11 years) was established in 1995 to evaluate the effect of four different tillage systems (conventional tillage (CT) based on moldboard plough (25 cm) + disc harrow with removal of cereal straw; reduced tillage (RT) based on non-inversion tine cultivation with removal of cereal straw; no-till (NT) with removal of cereal straw; and no-till with cereal straw retained (NT+S). The crop rotation was lupine – wheat – forage oat – barley. Soil organic carbon (SOC) (0-30 cm) and crop yields (grain and straw) were measured every year. In addition, yield response of the wheat crop to nitrogen fertilization was studied, in order to evaluate the interactions with SOC accumulation.

Under CT and RT, SOC remained almost unchanged over the experimental period. NT improved SOC by 18% in relation to CT and NT+S increased SOC by 62%. There were no significant differences between CT and NT in the amount of residues left in the field over the experimental period, but NT+S significantly increased the amount of residues retained in relation to the other treatments. The results indicate that NT reduced SOM mineralization, but that maximum increase of SOC can only be achieved if crop residues are retained on the field. Nitrogen use efficiency was significantly improved with greater SOC contents, i.e. from 19.1 kg of wheat per kg of applied N at 0.58% SOC to 104 kg of wheat per kg of applied N at 1.74% SOC.

Keywords: soil tillage, residue management, soil organic matter, nitrogen use efficiency.

POSTER

SIMPLE SOIL STRUCTURE ASSESSMENT FOR THE FARMER ANALYSIS OF SOIL STRUCTURE CONDITIONS AND PLANNING FOR APPROPRIATE SOIL MANAGEMENT

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ABSTRACT

The interest of farmers is large, considering the profile pits on the field days, which enjoy great popularity. Unfortunately, only the enthusiasm and the good feeling for the soil often remain after a professional soil analysis by a soil scientist.

Structure identification was always a key interest of soil scientists, agricultural consultants and farmers. Thus a range of sophisticated methods for soil structure identification and for spade diagnosis have been developed.

Missing up to now has been a soil structure assessment for the farmer with only few parameters to evaluate the structural condition of the soil. Use it after short instruction in order to plan the soil management and to document and fulfilled prevention requirements. The preventive soil protection should be realized site-adapted out in the field. Therefore it is necessary for the farmer to evaluate the current state of the soil. If the management should be profitable, the technical parameters should adapt to critical soil conditions. This is achieved only locally through a structure assessment and not on the computer in the office.

These guidelines for a simple assessment of soil structure should help to draw conclusions on the current status of the soil structure for the implementation of conservation tillage and adapted field traffic. Each site (sandy, loam, clay) must be considered holistically in terms of its specific properties and can achieve the highest rating for optimal structural conditions. The ranking is not intended for the comparison of soil types.

The soil pit is a compromise between a simple soil cube taken with the spade diagnosis and a walk-in pit created with a mini-excavator (size of the pit: 80 cm length / 45 cm width / 45 cm depth). The colour changes in the soil profile help to identify the different soil layers, for example surface, tilled topsoil, topsoil base and adjacent subsoil.

At this depth the most important parameters and characteristics can be considered (1) Surface structure (2) Root penetration (3) Macropores and biopores (4) Soil structure and compaction (5) Organic residues and (6) Colour and smell of the soil.

The Evaluation of the analysis is the comprehensive assessment of these six parameters.

Keywords: soil structure assessment, structure conditions, soil management, prevention requirements.

POSTER

SUSTAINING SOIL CARBON RESERVES OF BIOENERGY CROPPING SYSTEMS IN TEMPERATE REGIONS

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ABSTRACT

Soil organic carbon (SOC) has an essential role in controlling ecosystem functions associated with physical, chemical and biological properties of soil. Maintenance of SOC amount is important regarding environmental safety and food security. The mineralization of SOC into CO_2 and its humification into stable C fraction depends on its amount in soil. Biofuel production from lignocellulosic feedstock has environmental concerns regarding amount of OC of soil as it involves the removal of plant residues from field. In temperate region, management practices such as application of biochar, other organic and inorganic fertilizers, crop rotation of biofuel versus high biomass producing non-biofuel crops, annual versus perennial biofuel crops and tree-base intercropping and water management is suggested. Moreover, new technologies such as introduction of genetically modified biofuel crops, which have cellulase/ligninase enzyme production system is highly recommended to enhance higher biofuel production per unit energy and crop residue consumption. However: in future, the influence of those GM crops on residual SOC amount merits further research in order to assess their usefulness regarding soil health.

Keywords: bioenergy crops, temperate region, crop rotation, tree-based intercropping, humification.

POSTER

LIGNIN CONTROLS ON SOIL ECOSYSTEM SERVICES: IMPLICATIONS FOR BIOTECHNOLOGICAL ADVANCES IN BIOFUEL CROPS

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ABSTRACT

Lignin is a complex phenolic polymer, mainly derived from the three monolignols: p-coumaryl, coniferyl, and sinapyl alcohols. As an important component of secondary cell walls in vascular plants, lignin is the second most abundant plant derived organic substance after cellulose. Relative to most other plant derived organic substances (i.e. structural and non-structural carbohydrates), lignin is recalcitrant to mineralization by soil microorganisms. The recalcitrance of lignin is due to the fact that only few microorganisms (i.e. white rot fungi and few bacterial species) can completely degrade polyphenols, and catabolism is often required to fully break down plant lignin. Consequently, lignin directly and/or indirectly influences soil microbial community structure, which in turn controls soil quality through the provision of several key ecosystem services: i) reducing the emissions of greenhouse gases from soil, ii) retaining soluble nutrients, iii) promoting soil aggregate formation and stabilization, which reduces soil erosion, and iv) bioremediation and detoxification of natural and man-made organic pollutants. As lignin is a heterogeneous polymer composed of phenylpropanoid units, the guaiacyl:syringyl ratio of lignin is considered as a indicators for its effect on ecosystem services. The influence of global warming on accelerating lignin degradation and the consequence of reduced lignin concentration and soil organic matter levels in the soil ecosystem are discussed.

Keywords: lignin, ecosystem functioning, ecosystem services, humus, soil aggregation, soil organic matter, soil carbon.

POSTER

LEGUME-WHEAT ROTATION IN MEDITERRANEAN ENVIRONMENTS DURING TRANSITION TO CONSERVATION AGRICULTURE

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ABSTRACT

The influence of the rotational system has a strong influence on soil fertility, crop yield and quality. With the present work durum wheat in monocropping and in rotation with faba bean were compared during the first three transitional years (from 2009 to 2012) to conservation agriculture in a typical Mediterranean environment. On a randomised block design with three replicates, two thesis were compared: durum wheat in monocropping and the rotation durum wheat-faba bean. The effects on soil biodiversity, organic matter and organic carbon content as well as on durum wheat yield and quality were investigated.

The overall microbial concentration increased in the third year of AC. The rotation wheat-faba bean induced an higher concentration of mesophilic and actinomycetes microorganisms. Conversely, the nitrogen-fixing bacteria were not affected neither by year and rotational system.

The % of both organic carbon and organic matter did not increas after three years of CA.

The presence of faba bean induced higher durum wheat yields thanks to an higher number of spikes per unit area and to higher spike length; while grain quality resulted not significantly affected by the rotational systems.

Keywords: Conservation Agriculture, legume-wheat, monocropping, nitrogen-fixing bacteria, organic carbon.

POSTER

GOVERNANCE OF ECOSYSTEM SERVICES IN CARBON AGRICULTURE THROUGH SHARED INDICATORS

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ABSTRACT

In Europe, agriculture is the subject of polemics between producing community including farmers, and citizens and NGO's.
Policy makers need to serve common good, made of apparently contradictory needs : production, profit, environment on diverse parameters…
Some cases exist of farmers who have systems bringing results on all parameters, able to satisfy all contradictory needs at the same time.
There is a need to incorporate into policies the knowledge of best farmers, despite they are an innovating minority operating inside of a democratic system, i.e. driven by the conservative majority.
The authors describe a process of governance able to solve these contradiction, and produce common goods for all citizens, including all farmers.
This process includes: definition of common good through establishment of agreed multi parameters objectives of sustainability, using stakeholders dialog, periodic evaluation of results obtained on farms, using standard agreed criteria and indexes.
Farmers can use the system to evaluate the implementation of their progresses towards their objectives of sustainability, but also to dialog with society and public representatives.
Public operators could eventually accelerate transformation of agriculture by contracting to farmers specific ecosystem services the community needs, as service of water, of biodiversity, or of climate mitigation.

Keywords: governance, ecosystem services, stakeholders dialog, common objectives, agreed indicators.

POSTER

INFLUENCE OF DIFFERENT CARBON AMENDMENTS ON THE MICROBIAL BIOMASS IN GRASSLAND

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ABSTRACT

Soil carbon amendment is now recognized as climate change mitigation strategy with co-benefits such as improved biomass growth, increased water storage capacity and soil health. We investigated the influence of three different carbon amendments on quality and quantity of the microbial biomass in a temperate grassland soil. All carbon amendments were made from 10 mm ground Miscanthus x giganteus material and were applied 1. uncarbonized, 2. hydrothermally treated (200°C, 1,6 MPa) and 3. pyrolyzed (550°C). For our experiment, we incubated soil taken from a field experiment where the carbon amendments had been applied in spring 2011 in jars in a climate chamber at 20°C (n=4 per treatment). Total microbial biomass was determined using the substrate induced respiration method; differentiation into bacterial and fungal biomass was achieved using the two inhibitors streptomycin and cycloheximid.

Generally, in all treatments, fungi were more prominent than bacteria. The carbon amendments promoted microbial biomass throughout with significant treatments effects. Especially pyrolyzed material led to a significantly higher respiration activity quotient, indicating an alteration of the microbial population. We will discuss mechanisms of changes in microbial population such as soil carbon content, structural properties of the carbon amendments and pH.

Keywords: microorganisms, carbon amendment, hydrochar, biochar, substrate induced respiration.

POSTER

TOTAL AND RESIDUAL SOIL ORGANIC CARBON IN DIFFERENT CROP ROTATIONS, IN BRAZIL

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ABSTRACT

The great Brazilian challenge is to practice an efficient, profitable and sustainable agriculture, with rationally using of natural resources and sequestering carbon to minimize emissions of greenhouse gases. Brazil, at the 15th UN Conference on Climate Change, COP 15 held in Copenhagen, Denmark, in 2009, voluntarily committed to reduce emissions of greenhouse gases by 36.1% and 38.9% of projected emissions by the year 2020 and part of this commitment lies with the agricultural sector. The carbon cycle shows that the soil is a major carbon sink and the roots plays an important role in that. One long-term experiment was initiated in 2010, in Universidade Estadual de Londrina, with the goal to quantify the stocks and total and residual organic carbon in soil of different combinations of soybean cultivation in summer and 8 different crops in the winter crop. The study is being conducted at the Farm School of Universidade Estadual de Londrina (23° 20' 23" S and 51° 12' 50" W) at an altitude of 572 m in an Oxisol under Cfa climate, in Londrina city, Paraná State, Brazil. The experiment consists of 8 treatments and 6 replications in a randomized block design. Each plot has 160m² (20m x 8m) , each block has 1280m² (160m² x 8) for a total area of 7680m² (1289m² x 6). Treatments are sequences of soybean (*Glycine max*) in the summer to the following winter crops: corn (*Zea mays*), wheat (*Triticum aestivum*), canola (*Brassica napus*) consortium of maize (*Zea mays*) with Brachiaria ruziziensis as cultures with commercial value. Black oat (*Avena strigosa*), wild radish (*Raphanus sativus*), Braquiaria ruziziensis and fallow as cover crops. In each experiment soil samples was collected at depths of 0.00-0.05 m, 0.05-0.10 m, 0.10-0.20 m and 0.20-0.40 m for analyzing levels of total and residual organic carbon. Sample analysis will be performed at the Laboratory of Soil Science, Universidade Estadual de Londrina. This paper aims to present the results of the first 3 years of the experiment but analyzes are ongoing and will be included in the final text if approved. The experiment will need constant monitoring. The results will determine the succession of crops more efficient in carbon sequestration.

Keywords: crop rotation, soil organic matter, carbon sequestration.

POSTER

THEME 3

CONTRIBUTION OF SOIL ORGANIC CARBON TO ECOSYSTEM FUNCTIONS AND LANDSCAPE MANAGEMENT

CONTRIBUTION OF SOIL ORGANIC CARBON TO ECOSYSTEM FUNCTIONS AND LANDSCAPE MANAGEMENT

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ABSTRACT

In 'natural' ecosystems, many of the ecosystems functions and the related ecosystem services are soil and landscape mediated, and depend on the established biodiversity and how well the supporting services are functioning and enabling the delivery of regulatory and provisioning services. The carbon, nutrient and water cycles as well as the primary production processes are the key supporting services and they dictate the performance of the regulating and provisioning ecosystem services. The key ecosystem functions that are linked to agricultural productivity, ecosystem services, resilience and self-recuperation are also soil mediated and depend on the soil health which in turn depends on soil organic matter and the associated biological processes that influence the soil quality parameters of soil structure; water infiltration, storage and drainage; soil aeration; and soil biodiversity. Thus, when ecosystems are transformed into agro-ecosystems, the productivity performance and ecosystem services depend on the extent to which soil, land and biodiversity management remain close to nature to deliver ecosystem services.

Landscapes comprise mosaics of ecosystems and land uses in altered states. The purpose of agro-ecosystems is to provide biological products. However if adequate attention is not paid to ensuring that other linked provisioning services as well as linked regulating and supporting services remain functional, then over time the whole ecosystem becomes sub-optimal in performance, and degradation sets in, resulting in a partial or total loss and destruction of ecosystem functions and services.

In the past three decades, ecosystem approaches to sustainable production intensification have led to the emergence of alternative approaches to sustainable farming and land management across all continents. In agricultural landscapes, provisioning ecosystem services can be delivered efficiently only when the related regulatory and supporting services are also allowed to operate efficiently which is not so in tilled landscapes. Land managers around the world are being called upon to mobilise the delivery of ecosystem services, including from agricultural landscapes. The presentation will highlight some examples of large-scale landscape level ecosystem service benefits that are being harnessed from sustainable soil and land management systems based on Conservation Agriculture. These ecosystem services include: carbon sequestration in Canada, watershed services in Brazil, control of soil degradation in Australia, improvement of air quality in China, and control of soil erosion in Spain. The presentation offers some concluding remarks regarding what policy can do to support the trend.

Keywords: agro-ecosystems, soil health, ecosystem services, carbon sequestration, watershed.

KEYNOTE

HARNESSING ECOSYSTEM SERVICES FROM AGRICULTURE IN BRAZIL AND CANADA

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ABSTRACT

Societies benefit from the many resources and processes of a public goods supplied by nature. Collectively these are known as ecosystem services (ES) and include the provision of clean drinking water; edible and non-edible biological products; processes that decompose and transform organic matter; and regulatory processes that maintain air quality. They also include services such as carbon, water and nutrient cycling and primary production that support the provisioning and regulatory services. Land managers around the world are seeking new opportunities for markets in ecosystem services, including from agricultural land.

Soil organic carbon is a provisioning service, a product of the carbon cycle. It exists as a constituent part of soil organic matter (SOM) derived from biomass produced from photosynthesis. SOM performs several ecosystem functions including serving as substrate for soil life and carbon sequestration, and building soil structure, enhancing cation exchange capacity, increasing water infiltration and soil moisture holding capacity, conserving nutrients and improving soil fertility.

On agricultural land, the nature of the production system deployed has a profound influence on the SOM and the quality of ES that can be harnessed. In tillage agriculture, ES are disrupted and degraded because of the loss in SOM and soil structure, leading to compaction, surface sealing, run-off and erosion, and decrease in land's agronomic potential and productivity.

With Conservation Agriculture (CA), a farming practice involving minimum mechanical soil disturbance (no-till), organic mulch cover and crop diversification, it is possible to simultaneously realize enhanced productivity as well as a range of desired ES. When CA practices that deliver ES on agricultural land at the farm level are reproduced across farms in the same catchment/landscape, the ES provided become more apparent and cumulative. CA-based ES covering large areas and populations are emerging in different parts of the world, benefiting farmers, society and environment. These include: the greenhouse gas offset system in Alberta and the hydrological services from Paraná 3 Basin in Brazil.

Alberta was the first jurisdiction in North America, if not the world, to develop a greenhouse gas offset system in which any sector could submit protocols for review and approval by the regulator to participate within the rules of the system. Agriculture offsets from CA practices comprise about one third of all offsets supplied to date. The Itaipu dam in Brazil saw the investment in CA in the Paraná watershed provides enhanced ES in the form of better water quality and less sedimentation behind the hydroelectric dam. Early successes have encouraged further program development and investments. These initiatives show that such services can be harnessed from agricultural landscapes and taken successfully to the market. The poster will elaborate on experiences and learning from Brazil and Canada, and on how learning from these experiences can make subsequent efforts elsewhere better and easier.

Keywords: Conservation Agriculture, no-till, soil organic carbon, greenhouse gas, Itaipu dam.

ORAL PRESENTATION

FUNCTIONS OF BIODIVERSITY IN CARBON CYCLE AND FARM MANAGEMENT OF NATURE

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ABSTRACT

The authors describe a pedagogic concept by which farmers can practically understand the key mechanisms of their ecosystem, the principles on which they can eco-conceive their farming system, and capture the keys of actions to improve their performances, as well on economics as on environment, without opposing them, but in synergy.

A farm may be described as a living ecosystem where carbon, nitrogen and nutrients cycles, as well as vegetal and animal communities and trophic chains interact. This system follows the rules of biology and scientific ecology.

The engine of the system is the photosynthesis, its source from energy is the sun.

Organic matter production, transformation and recycling, carbon/nitrogen cycles are the key mechanisms nature manages to produce high level of biomass.

The better farmers know and understand these mechanisms the more and better they can produce, the higher profit they get, and the higher performance ecosystem services they produce.

The tools they need to master are the ones enabling them beneficial management of biodiversity: foster and boost beneficial functions of biodiversity, monitor and limit damaging biodiversity elements.

Precise knowledge about diversity description, role, functions and mechanisms is essential to enable production of positive results, as well as in production as in ecosystem services and management of biodiversity itself.

Keywords: farming ecosystem, carbon cycle, photosynthesis, functional biodiversity, natural mechanisms.

ORAL PRESENTATION

FUNCTIONAL SOIL BIODIVERSITY; THE CONTRIBUTION OF REDUCED TILLAGE SYSTEMS TO ECOSYSTEM SERVICES AND SUSTAINABLE FARMING

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ABSTRACT

Implementation of reduced tillage (including no-till) systems is targeted at increased soil organic matter contents and soil biodiversity, reduced soil erosion and enhanced climate resilience of agroecosystems. Enhanced soil biodiversity has been related to a range of soil functions and ecosystem services, e.g. nutrient delivery, soil structure and water storage, disease control and crop yields. However, development of reduced tillage approaches and optimization of overall system performance requires adaptation of basic principles to the agroecological and social context, as well as farming objectives (e.g. conventional vs. organic). Therefore we aimed to 1) document reduced tillage practices within different agroecological contexts in NW Europe; 2) evaluate the effects of the reduced tillage systems on soil biodiversity and soil functions; 3) develop approaches to integrate data, extract proxies for ecosystem services and evaluate overall agroecosystem sustainability, and 4) increase understanding of agroecological factors that determine potential benefits and trade-offs.

Earthworm and nematode taxa were selected as indicator organisms to be studied for their known response to soil management and effects on soil functions. Additionally soil organic matter, physical soil parameters and processes, and crop yields have been measured across a range of sites. Data have been collected over multiple cropping seasons in long term field experiments and farmers field sites in France (Brittanny) and the Netherlands (Flevopolder, Hoeksche Waard and Southern Limburg). Through international and interdisciplinary collaboration the observed diversity in earthworm communities in terms of species, abundance, and trait diversity could be related to soil quality and soil functioning. Data integration further allows for the evaluation of the impact of reduced tillage systems on the provision of ecosystem services via proxies such as crop biomass yields, soil organic matter, aggregate stability and water infiltration rate.

The paper will present forthcoming results of this collaborative work, thereby shedding light on the benefits and trade-offs related to reduced tillage systems in NW Europe, and the role of soil organism groups for improved soil functioning and crop performance. Recommendations are provided for soil sustainable management aiming at ecological intensification of agricultural land.

Keywords: reduced tillage systems, arable cropping systems, organic farming, France, The Netherlands, soil biological and physical quality, ecosystem services.

ORAL PRESENTATION

CROPPING INTENSIFICATION IN DRYLAND SYSTEMS AND SOIL PHYSICAL AND SOIL FERTILITY PROPERTIES

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ABSTRACT

Northern Kazakhstan dryland Agriculture is a risky zone because of low limited amount of annual precipitation (260-340mm), large annual fluctuation in precipitation during vegetation period of crops, high evaporation potentials, risky zone of wind and water erosion, and short frost free vegetation period.

Research showed, that the use of No-Till practices resulted in better soil cover by crop residues and higher soil organic matter content compared to conventional tillage practices. Soil cover protected the soil against wind erosion and soil runoff, prevented the loss of water from the soil through evaporation in spring, presowing time.

No-Till provides available water on the surface for plants to have early and fast emergence and access of plants to soil moisture. No-tillage practice maintaining stubble and crop residues on the soil surface has been designed to protect the soil from soil runoff. Research has showed, that the efficiency of absorption of spring melt water by summer fallow field is only 19-22%, and 78-81% is lost to evaporation and runoff of melt water in early spring time and leads soil to wind and water erosion.

The soil temperature monitoring showed that in the field after summer fallow, higher moisture content in frozen subsurface soil layer was a reason of slow melting of the soil, resulting in slower water penetration from the snow melt water and water loss through enhanced evaporation. Replaced summer fallow by cover crops in soil cover crop rotations increased water use efficiency by 60%, prevented wind and water erosion, increased crop biomass and crop residues on the surface of the soil, decreased soil compaction and helped control decomposition of soil organic matter.

One of the purposes of this study was to determine the influence of land use management on the dynamics of soil organic matter depending on cropping intensification (fallow –cereal rotation, soil-cover crop rotation and grassland under No-till and conventional tillage). We hypothesized that including in rotation cover crops and grasses instead of fallow can save the soil fertility. For example, the carbon budget of summer fallow fields ranged approximately from -0,10 to -1,2 mg C ha^{-1}. Therefore, to save soil fertility and to improve soil physical properties and prevent depletion of soil organic matter in dryland farming system of Northern Kazakhstan we recommend that soil-resource saving cropping system should be introduced as part of the Conservation Agriculture in rainfed conditions.

Keywords: Northern Kazakhstan, water balance, carbon budget, soil erosion.

POSTER

CARBON BALANCE OF A RAINFED OLIVE GROVE UNDER DRY MEDITERRANEAN CLIMATE: A REVISIT WITH GREEN MANURE INCORPORATION

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ABSTRACT

The conversion from native to agricultural ecosystems has increased carbon losses to the atmosphere without enhancing carbon inputs into soil, and therefore the global carbon (C) cycle has been drastically altered. These C losses, given by previous native vegetation and subsequent annual crop removal, tillage and enhancement of soil erosion rates, may be compensated with sustainable land management (SLM) practices such as green manure incorporation into the soil of a given cropping system.

The aim of this study was to estimate the contribution of green manure incorporation to the soil C balance of a rainfed olive grove under dry Mediterranean climate in Southeast Spain. We hypothesize that green manure incorporation accounts for a significant C gain within the soil C balance of this rainfed olive grove, increasing its belowground C sequestration capacity. Based on the conservation mass approach proposed by Giardina and Ryan (2002), data of carbon fluxes and pools previously reported for this field site (Martínez-Mena et al., 2008; Almagro et al., 2010) will be combined with estimates of carbon gains and losses derived from green manure incorporation in order to revisit the belowground C sink capacity of this rainfed olive grove.

Annual C losses by land use change (that is, conversion from forest to agricultural ecosystem) for this rainfed Mediterranean olive grove were estimated to be around 7 g C m^{-2} yr^{-1}, from which 5 g C m^{-2} yr^{-1} were mainly derived from soil water erosion. Annual aboveground biomass C from green manure was estimated to be 53 g C m^{-2} yr^{-1}. According to estimated average decay rate for the whole agricultural field (kC= 0.29 yr^{-1}), annual carbon inputs into soil derived from cover crops were estimated to be 38 g C m^{-2} yr^{-1}, while 15 g C m^{-2} yr^{-1} were released to the atmosphere. This means that annual C inputs into soil derived from green manure incorporation are more than five-times higher than annual C losses by land use change, which highlights its potential for increasing the annual belowground carbon sink capacity of this dry Mediterranean agroecosystem. According to our estimations, land use change-driven C losses can be compensated after 20 years of green manure incorporation in this rainfed Mediterranean olive grove.

Keywords: soil C balance, soil erosion, green manure, litter decomposition, sustainable land management.

POSTER

EFFECT OF DIFFERENT TILLAGE SYSTEMS ON YIELD OF SELECTED FIELD CROPS

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ABSTRACT

The aim of this study was to compare the effect of four tillage systems in stationary crop rotation on productivity, efficiency and environmental sustainability. Field experiment was established in 2006-2009 on experimental base of Plant Production Research Center Piešťany Research Station Borovce (PPRC Piešťany– RS Borovce). Experimental site is characterised by annual average air temperature 9.2 °C, annual average rainfall 625 mm. Altitude is 167 m.

Field experiment was conducted in 3 repetitions. Size of single plot was 35 × 9 m. Four crops were involved into crop rotation: winter wheat (cultivar Astella, since 2007 Bardotka), maize (hybrid DKC 3511), spring barley (cultivar Ezer), and soybean (cultivar Quito, since 2008 London). Machines and seeders used for conventional tillage were Amazone and Kinze, for minimization Great Plains and Kinze, for Mulch till Horsch Concord and Kinze, for No-till Great Plains and Kinze. Sowing of maize was realized by seeder Kinze in all tillage systems.

Following operations in conventional technology were included: conventional sowing by seeder Amazone, tillage with plow and mouldboard and interline cultivation. Minimization technology (reduced) with loosening (plate tools) of the soil surface after the harvest of foregoing crop, so that soil was covered for 15 to 30 % by plant residues, soil preparation before sowing (or without preparation), sowing by seeder Great Plains. Mulch till characterised by stubble undercutting by cultivator Amazone; the soil surface was only disrupted (lifted), crop residues remained on the soil surface. Seeder Concord Horsch was used for sowing. Seeder Great Plains was used in no-till technology.

The results showed the observed field crops responded differently to the growing technologies, when the limiting factor for the use of specific technology is the optimal amount of rainfall. The highest grain yield was achieved by maize and spring barley in 2006–2009, in the minimization technology. Winter wheat was the most productive in no-till technology. The highest seed yield of soybean was obtained in conventional technology. In this context, minimization and conservation tillage seemed to be “friendly technologies” for cereals.

Crop, growing year and tillage were statistically highly significant for yields. The most important were the interactions of crop × cultivation, year × cultivation.

Keywords: conventional tillage, conservation tillage, cereals, soybean, yield.

POSTER

REDUCED TILLAGE PLUS GREEN MANURE AS AN EFFICIENT MANAGEMENT TOOL FOR SOIL CARBON SEQUESTRATION IN THE SHORT-TERM IN RAIN-FED MEDITERRANEAN AGRO-ECOSYSTEMS

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ABSTRACT

According to several authors the modifications introduced by conservation agriculture on the carbon dynamics in the soil directly result in an increase of the carbon in the soil fraction (Gonzalez-Sánchez et al., 2012).The distribution of different organic carbon (OC) pools within aggregates is key to the capacity of a soil for sequestering carbon. In particular, the micro-aggregates within the macro-aggregates OC fraction have been used as a diagnostic fraction for determining changes in total SOC in response to changes in tillage management practices (Denef et al., 2007). In this study, we report the changes observed in soil aggregate size distribution and different OC pools under several conservation management practices (reduced tillage (RT); reduced tillage plus green manure (RTG) and no tillage (NT)) in order to investigate which one should be more appropriate to use for sequestering carbon in semiarid soils and under organic, rain-fed almond orchards which represent a substantial area in Spain. The green manure consisted of *Avena sativa* L. and *Vicia sativa* L. (1:3) at 150 kg ha^{-1}, manually sown during early autumn and cut in May. After cutting the green manure was incorporated into the soil by ploughing with a cultivator. Under the no tillage (NT) treatment, the weeds were manually cut in May and left on the soil surface and with no addition of organic matter or manure was done. The following aspects have been studied: i) Distribution of stable aggregates and their associated OC (Elliot 1986; Six et al., 1998), and ii) SOM fractionation into four pools meaningfully related to OC protection mechanisms: free POM-C (unprotected) and coarse iPOM-C, fine iPOM-C, and mineral-associated OC occluded within macro and microaggregates (physico-chemical protection). The incorporation of green manure lead to an increase in bulk soil OC of about 15% with respect to that under RT. 50% of this increment was as OC in microaggregates occluded within macroaggregates, while the other 50% was as fine iPOM-C occluded within free microagregates. Contrary to other studies (Plaza- Bonilla et al., 2013), no tillage did not increase bulk soil organic carbon with respect to reduced tillage. However, enhancements of the fine iPOM-C within free micro-aggregates, and the mineral OC of micro-aggregates within macro-aggregates were observed compared to RT. Thus RTG and NT treatments favour macro and micro-aggregate formation and OC physico-chemical stabilization compared to RT alone. However, while under RTG the gain of OC is in the short-term, no tillage alone might need more time in order to raise the OC content in these semiarid soils.

Keywords: particulate organic matter, soil aggregation, semiarid areas, carbon associated with aggregates, no tillage.

POSTER

GRAMINEOUS, CRUCIFEROUS AND LEGUMINOUS AS COVER CROP IN OLIVE GROVE TO REDUCE EROSION AND SOIL ORGANIC CARBON LOSS

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ABSTRACT

Olive is one of the main crops in the Mediterranean area. In order to make better use of land resources, the olive trees usually have been placed in planting frames which leave unprotected the area between them. This favours the erosion which is the principal environmental problem in olive groves, mainly affecting those which are located on slopes. The steeper the slope, the greater the generation of runoff and fine particle transport, which decreases the fertility.

The existence of a soil covered, as a conservation method, reduces the flow of water compared to a tilled soil. The soil management plays an important role in the sediments production, pollutants and fertility loss. Using of cover crops in woody crops, spontaneous or sown, has spread in recent years as a tool of environmental sustainability to control erosion, improve soil structure and preserve its water content.

In order to compare runoff, erosion and soil organic carbon (SOC) loss in sediment, several trials were developed in plots located in the south of Spain during two years. The plot area was: 5 m in wide and 10 m in length. A gramineous (*Brachypodium distachyon*), a cruciferous (*Sinapis alba*) and two leguminous species: *Vicia sativa* and *Vicia ervilia*; were sown as cover crops. They were compared with conventional tillage and a cover crop of spontaneous weeds, cover employed by most farmers. A sprinkler rainfall simulator was used with rate rain of 15 mm/h and 40 mm/h at two moments of the year: with the cover in its development and after mechanical mowing.

The powerful root system of crucifers and their fast growth, which favours the infiltration, reduced runoff in S. alba plot over 95% respect to conventional tillage and spontaneous weeds. As regard as the erosion, all systems with cover crop were significantly lower than tillage system.

The loss of SOC, as well as the erosion, was greater in the tilled plot; *S. alba* reduced over 99% respect to it, followed by *V. ervillia* 96.9%, *B. distachyon* 94.9%, spontaneous weeds 93.7% and *V. sativa* 92.9%. With respect to spontaneous weeds, the most employed cover, *S. alba* obtained the best result with a 91.1% of reduction.

The low percentage of cover of tillage system significantly increases water, soil and SOC losses. The high rate of losses observed indicates the convenience to protect the soil in order to conserve its fertility.

Keywords: rain simulator, runoff, erosion, cover crops, olive.

POSTER

BEST SOIL MANAGEMENT PRACTICES TO REDUCE RUNOFF AND SOIL CARBON LOSSES. TOPPS-PROWADIS

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ABSTRACT

TOPPS PROWADIS is a European stewardship project in partnership between 14 participants from Universities, Research Centers and Consulting companies, and the European Crop Protection Association (ECPA). TOPPS PROWADIS is in Belgium, Denmark, France, Germany, Italy, Spain and Poland.
The project focuses on promoting Best Management Practices (BMPs) for the use and application of plant protection products (PPPs) in a sustainable way, in order to protect natural water resources. TOPPS PROWADIS comprises a toolbox to prevent water contamination by PPPs by diffuse sources, drift and runoff. In this abstract, we focus on runoff measures, as are the closest to a proper soil conservation and soil Carbon management.
Runoff BMP's are divided into six categories: soil management; cropping practices; vegetative buffers; correct use of PPP; and irrigation. In the soil management and cropping practice chapters, BMPs are very close to conservation agriculture. Minimum soil disturbance practices are recommended, together with crop rotations, among many other BMPs. Several factors influence the risk of erosion, i.e., type of soil, climate, and land morphology, among others. Farmers cannot control those inherent parameters, as are intrinsic to the area or place where the farm is located. However, any farmer can shift soil management practices. BMPs helps maintain a good soil structure and, therefore contributing to soil conservation and reduction of runoff. Soil management systems directly influence the infiltration of water in the soil profile, and consequently the release or not of runoff and erosion. Definitely, good practices for soil conservation, such as conservation agriculture, are linked to the reduction of runoff. As a collateral benefit, and according to the literature, TOPPS PROWADIS soil management BMPs would increase Carbon stocks in soil.

Effective training activities help disseminate BMPs. The formats chosen are field days and seminars, combining both theoretical and practical sessions. The aim is to transfer the technology to farmers and advisers for properly carry out the diagnosis of farms, including runoff risk assessment. To date, within the project over 4,000 persons have been trained. Comprehensible publications for a better assimilation of the concepts support all the training events. In project's website, www.topps-life.org, visitors can find a complete set of publications in English and other official languages of the EU.

Keywords: Runoff, Erosion, Best Management Practices, soil conservation, TOPPS-PROWADIS

POSTER

THE INFLUENCE OF TREE SPECIES AND LAND USE TYPE ON FOREST SOIL CARBON AND NITROGEN STOCKS IN NORTHWEST OF TURKEY

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ABSTRACT

The need for an accurate inventory of carbon stocks and the capacity of forest to accumulate carbon was strongly emphasized at the Helsinki (1993) and Kyoto (1997) conferences. Forest ecosystems cover 30% of the land areas, but contain 81% of the terrestrial carbon biomass. In addition, forests accumulate 20 to 100 times as much carbon per unit area as agricultural land and are 20 times more productive than grassland. However, in Turkey, this subject has received little attention. We therefore aimed at investigating the effects of tree species and land use types on soil carbon and also nitrogen pools in the northwest of Turkey. We studied mineral soil carbon and nitrogen stock rates at two soil depths (0-10 cm and 10-20 cm) under four tree species; black pine (*Pinus nigra Arnold*.), beech (*Fagus orientalis Lipsky*), Scots pine (*Pinus sylvestris L*.) and Uludag fir (*Abies nordmanniana Spach*.) and also under adjacent grassland. The results showed that there were significant differences in soil C and N contents, C/N ratios and stock rates between four three tree species and grassland. Carbon content at 0-10 cm depth increased in the order grassland < beech <fir = Scots pine <black pine, whereas N content increased in the order grassland = black pine < Scots pine =fir <beech. Similar trends were noted at 10-20 cm soil depth for soil C and N contents. Mean soil carbon stock rates (0-20 cm depth) was the highest under black pine (79 Mg C ha^{-1}) followed by Scots pine (73 Mg C ha^{-1}), fir (71 Mg C ha^{-1}), beech (67 Mg C ha^{-1}) and grassland (65 Mg C ha^{-1}), whereas mean soil nitrogen stock rates was the highest under beech (9,57 Mg C ha^{-1}), fir (5,93 Mg C ha^{-1}), grassland (5,81 Mg C ha^{-1}), Scots pine (5,77 Mg C ha^{-1}) and black pine (4,20 Mg C ha^{-1}). In general, the results suggest that C and N stocks are significantly influenced by tree species. These initial data on carbon and nitrogen stocks influenced by tree species combined with spatial information on tree species distribution can improve insight into the spatial distribution of forest carbon and nitrogen pools in the northwest of Turkey.

Keywords: carbon and nitrogen stocks, forest floor, mineral soil, tree species, management.

POSTER

INSPIA EUROPE: "EUROPEAN INDEX FOR SUSTAINABLE PRODUCTIVE AGRICULTURE"

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ABSTRACT

The concept of sustainable development has evolved from a mere movement for the protection of the environment, to a holistic approach, seeking to preserve not only the environment, but also to achieve sustainability in economics and social wellbeing. According to FAO and EU position papers, the challenge faced by society is to produce 70% more food for an additional 2.3 billion people by 2050. The challenge is to produce more but in a sustainable way. As recognised by many papers, a proper soil management is a key part of sustainable agriculture. The InSPiA Europe (European Index for Sustainable Productive Agriculture) project aims to demonstrate that the implementation of best management practices (BMPs) by farmers can deliver economic performance as well as ecosystem services, whilst recognizing the importance of the values of natural capital, biodiversity, water and soil quality, as well as the welfare of farmers. Implementing BMPs would increase the soil organic carbon content in European farmland as well as progress on other key indicators.

The European Conservation Agriculture (ECAF), the French Institute for Sustainable Agriculture (IAD) and the European Crop Protection Association (ECPA) jointly conduct the project. InSPiA will provide an index on farm sustainability based on a set of verifiable indicators based on data provided by a 50-farm network. That network will enable the validation, demonstration and communication of BMPs to promote the uptake of sustainable agricultural practices throughout Europe and to raise awareness among EU policy stakeholders, technicians and farmers in favour of sustainable agriculture.

InSPiA main objectives are to:

1. Demonstrate that sustainable agriculture based on BMPs, helps to achieve sustainability in agriculture.
2. Provide an index of sustainability based on a set of verifiable indicators.
3. Create a farm network to enable the validation, demonstration and communication of BMPs.
4. Promote the uptake of sustainable agricultural practices throughout Europe.
5. Raise stakeholder awareness in favor of sustainable agriculture.

Keywords: index on farm sustainability, best management practices, sustainability indicators, soil management.

POSTER

THEME 4

ECONOMIC AND POLITICAL ASPECTS OF "CARBON FARMING"

INCENTIVISING THE MANAGEMENT OF SOIL CARBON

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ABSTRACT

This paper will address the economic and political aspects of encouraging the use of agricultural soils as a carbon sink through incentivising changes in production practices. The debate about carbon sequestration in agricultural soils has technical, economic and political dimensions. The policy framework both at international and EU levels on accounting rules and action plans on greenhouse gas emissions and removals resulting from activities related to land use, land use change and forestry will first be discussed. The paper will then review the advantages and disadvantages of different kinds of incentive mechanisms, including mechanisms to preserve existing carbon stocks. Possible mechanisms include the use of instruments under the Common Agricultural Policy (GAEC cross-compliance standards, the new green payment, and agri-environment schemes), voluntary project-based carbon offset schemes, and in the longer-term, linking carbon sinks in agriculture to the EU's carbon Emissions Trading Scheme. Developments in other countries will be briefly discussed. The paper will also review literature estimates on the size of incentives that might be necessary to encourage carbon sequestration in the agriculture and forestry sectors.

Keywords: LULUCF rules, carbon offsets, carbon trading.

KEYNOTE

REDUCTION OF CARBON DIOXIDE EMISSIONS AND AGRICULTURAL COSTS BY APPLYING NO TILL & GUIDE ASSISTANCE IN ARABLE CROPS IN SOUTHERN SPAIN

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ABSTRACT

Carbon dioxide (CO_2) plays a very important role in the climate change. Agriculture is the third human activity in the amount of CO_2 emissions. Therefore actions reducing energy consumption in this sector are very interesting, not only for the mitigation of climate change, but also for upgrading the farmers economy. No Till (NT), based in the suppression of the tillage, and Guide Assistance (GA) that allows a more efficient and homogeneous work, reduce fuel and inputs consumption. So, the aim of this work is to quantify the reduction in the CO_2 emissions and agricultural costs that NT&GA can provide respect conventional tillage (CT) in order to promote these techniques in politics of "carbon farming". This work belongs to a European project, Life+Agricarbon, and it shows the results of four seasons carried out in three rainfed farms in Southern Spain. On each farm, 30 hectares of arable crops, with two soil management systems (CT vs NT&GA) were studied. Trials in each system followed a typical crop rotation in the Andalusian countryside: winter wheat, sunflower and legume. Different parameters on mechanized operations made in each crop and management system were logged using a remotely data acquisition system. To this end, one tractor in each farm was instrumented with different technology: GPS; fuel flow sensor, and a guide assistant bar. As data acquisition system a Datataker (DT 85) was used. The stored information about the operation was transmitted via GPRS modem to a PC. Moreover, the crop production was monitored with a crop yield monitor Ceres 8000i RDS.

Results showed how the NT&GA, not only reduced the CO_2 emissions in 12.0% (176 kg CO_2 ha^{-1}) for wheat, 26.3% (73 kg CO_2 ha^{-1}) for sunflower and 18.4% (86 kg CO_2 ha^{-1}) for legume, respect to the CT, but also reduced the agricultural costs in 9.3% for wheat (59 € ha^{-1}), 14.6% (48 € ha^{-1})for sunflower and 11.9% (51 € ha^{-1}) for legume. Contribution of each system (NT&GA) in the saving varied in function of the crops. So, in wheat the higher save was obtained by applying GA, which decreased the overlaps and consequently reduced the consumption of fertilizers. In contrast, fertilizer consumption for sunflower and legume was very low. Therefore, the reduction of fuel consumption provided by NT, more than a 50% respect to CT, was the main parameter of the total saving.

So, according to the results, only in Andalusia the application of these techniques (NT&GA) in arable crops could save 0.14 Mt y^{-1} of equivalent CO_2 and also reduce the agricultural costs in 49.1 million of euros.

Keywords: remote monitoring, conservation-precision agriculture, climate change, CO_2 save.

ORAL PRESENTATION

SOIL ORGANIC MATTER – NOT AN ENVIRONMENTAL ISSUE IN DENMARK

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ABSTRACT

Since 1998 Danish farmers, as the only farmers I EU, have not been allowed to fertilize their crops with nitrogen according to the Economic optimum level. For example The National Advisory Centre has calculated that Danish farmers are obliged to fertilize 13-27% below the economic optimum nitrogen level according to the price of protein.

These nitrogen quotas mean that the content of inorganic Nitrogen in the soil in autumm has declined a lot. It is very difficult to produce organic matter in cover crops because of this lack of Nitrogen.

It has been measured in November that the content of kg $N\text{-}NO_3$/ha in 0-100 cm has declined from 74 kg/ in 1990-1992 to 38 kg N in nitrate/ha in 2009-2011.

Results from Danish trials show that on loamy soils farmers will lose yield in spring barley the first year following cover crops without legumes. The reason for this is that the cover crop takes up nitrogen that the commercial crop would need.

It has been measured that the content of soil organic matter has declined on the best soils for plant production in the range of about minus 1000 kg C/ha in 0-100 cm pr. year between 1986 and 2009. The best soils for plant production are situated in the Eastern part of Denmark and it is also here we have the highest Dexter Ratios. Possible explanations for this decline will be discussed.

In Denmark soil organic matter is not an environmental issue. Some official environmental people even think it is better to take organic nitrogen out of the soil. They have not seen the connection that Nitrogen is needed in order to build up the content of organic matter in the soil. Obviously the living soil is not very much in focus at this level.

FRDK makes a lot of efforts trying to make it legal to use cover crops including legumes in a mixture of species. Today it is not legal to do this when we speak about the area with cover crops that the Danish farmer is obliged to have. Only if he has cover crops on a bigger area than he is obliged to have, he can use legumes in the cover crop mixture on the surplus area.

Keywords: soil organicmatter, N quotas cover crops.

ORAL PRESENTATION

CONSERVATION AGRICULTURE: IT CHANGES FARM PRACTICES, TRACTOR AND IMPLEMENT DESIGNS, FOR IMPROVED EFFICIENCY, REDUCED FUEL-CONSUMPTION AND BETTER SOIL MANAGEMENT

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ABSTRACT

The move to Conservation Agriculture (CA) challenges the fundamental beliefs of farmers, agricultural engineers and farm machinery designers, at a time when it has become essential to consider the planet's sustainability. Populations in many countries are growing rapidly and food security is critical, as is the ability of farmers to mechanise, protect the soil, and adopt farming systems that use the minimum of fossil-fuel, water and chemicals.

The broadly-based tractor and farm machinery industry is central to the way in which farmers, across the world, are able and encouraged to use those resources that are scarce, e.g. water, expensive, e.g. chemicals, or running out, e.g. fossil-fuel.

Now that the world at large is moving towards lighter weight cars, buses and trucks, the world's tractor and farm machinery industry is largely moving in the opposite direction, by creating heavier tractors. Not only this but ag-implements are becoming heavier. Additionally, mounting the implements on the tractor adds further weight and thus increases the danger of soil damage by creating soil compaction.

A more holistic approach is now essential and one that brings industry, universities and research organisations, in to a much-revised farming system of the future. These various organisations need to understand the need for change to the farming system but they must learn to synthesize their approach to the future and, in so doing, support the adoption of CA (Zero-Tillage ++) in both arid and temperate zones.

A comprehensive recognition of the impact of ploughing on soil compaction, fuel-consumption, tractor design and development, Ag-implement development and operational efficiency is urgently necessary.

A much higher profile has to be developed so that all of the transportation tasks (e.g. trailer and tanker haulage) and most of the low-draught work tasks (e.g. spreading, spraying, direct drilling, mowing etc), all of which are now conducted so inefficiently by conventional tractors, must now be widely addressed. Currently, these work tasks use far more fuel than would be necessary if a Zero-Tillage system was more widely adopted. Additionally, Zero-Tillage work needs to be coupled to a higher speed farm transportation system with much lighter tractors, trailers, tankers and a strong directional movement away from mounted implements to trailed ones. It is the Agricultural Engineers that have to pioneer lots of these changes and in so doing raise their profile by embracing soil management and green issues.

Keywords: design-changes, tractor-weight, farm-transportation, fuel-consumption, soil-compaction.

ORAL PRESENTATION

SOIL CARBON IN THE CRUCIBLE: THE AUSTRALIAN EXPERIENCE

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ABSTRACT

The concept of government-sponsored, market-driven restoration of agricultural soils through carbon sequestration is in the crucible as the soil carbon market in Australia moves toward a mid-2014 start. The architects of the Carbon Farming Initiative (CFI) http://www.climatechange.gov.au/reducing-carbon/carbon-farming-initiative were given two design principles to guide them: 1. environmental integrity for buyer confidence, and 2. broad farmer involvement for maximum abatement and soil health. Failure to deliver on either would cause the Initiative to fail to achieve its economic, environmental and policy potential. A complex structure of regulations protect the buyer's interests. But broad farmer involvement will be determined by the cost of compliance (in time, money and risk) and the size of the reward. The CFI is the one element of Australia's Climate Change policy to survive a recent change of government. Support from both sides of politics reflects the wider community's support for family farming. The new environment minister said of the authors, "without their efforts, there would be no Carbon Farming Initiative". The challenge of "singlehandedly barnstorming the issue onto the national agenda" was replaced by making the farmer heard during the legislative process and building alliances with policymakers against a backdrop of tension between scientist and practitioner as to the abatement potential of "carbon farming". The most important finding of a €16m research program, it was discovered that the "potential" of soils to sequester was not revealed by measuring the average performance of farmers across a range of individual "activities". Instead it can best be observed in the peak performance of "outliers" in the "wide tail" of a normal soil carbon distribution, data points routinely discarded. Innovative "Outliers" are typically further along the learning curve, many having a decade of experimenting with combinations of activities while 'learning' their landscape and its responses. Some have invented new activities such as pasture cropping and no-kill cropping. The scientist who discovered the "outliers" effect concluded that these farmers must be "cloned" for carbon farming to reach its full potential. Stakeholders argue over whether the focus should be on the mechanistic application of activities or simply carbon outcomes. What many predicted would be insurmountable problems are being solved through knowledge sharing. A scientifically-robust measurement methodology has emerged as well as an actuarial solution to the 100 Years Rule. There is much to be found in the crucible.

Keywords: carbon farming, soil carbon, Australian experience, practice, policy.

ORAL PRESENTATION

OPTIMIZATION OF THE CHOPPING OF THE PRUNING RESIDUES IN OLIVE ORCHARDS AS A METHOD TO SAVE MONEY AND CARBON DIOXIDE

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ABSTRACT

Soil loss is the main threat of the agrarian activity and directly affects to the sustainability of the agricultural ecosystems. This problem is especially important for woody crops, due to the lack of soil cover, contributed by the separation of trees, the tillage as the most common soil management system and the burnt of the pruning residues. The olive tree is one of the main crops in the Mediterranean basin. Occupying in Spain a surface around 2.5 Mha. So, the recycling of its pruning residues, using them as mulch after its chopping, shows as a very effective alternative. Not only to protect the soil from erosion, but also to prevent the emission of CO_2, because of the burnt of these residues. But, this operation has a high fuel consumption and low field capacity, situations that limits its application. Therefore, the aim of this study is to optimize the chopping of the pruning residues in olive orchards, reducing its fuel consumption and time operation, in order to can promote this system in politics of "carbon farming".

This work belongs to an INIA Project, RTA2010-00026-CO_2, and it shows the results of two years study carried out in a rainfed olive orchard in Southern Spain. The experimental design consisted of random blocks with four replications. The two most common chopping machines were studied, with three different working velocities (low, medium, and high) and two volumes of pruning residues (medium "14.9 kg/tree" and high "29.8 kg/tree"). The fuel and power consumption, and the field capacity of each treatment was studied with a instrumented tractor (JD 6420, 82.5 kW), with a flow gauging sensor and a par sensor.

Results showed that existed differences between the two machines studied. Especially, on fuel consumption and field capacity. The fuel consumption varied by applying the medium velocity respect to the low one, between 11.8% to 20.1% depending on the chopper used and the pruning volume. The field capacity was improved more than a 25% and the CO_2 emissions were reduced around 14 kg ha^{-1}. It is important to remark that in all the treatments studied the cover was enough to protect the soil of the erosion. So, if all the pruning residues of Spain were chopped, around 36895 t of equivalent CO_2 and 15.43 M€ could be saved each year by applying the best chopping techniques.

Keywords: olive, pruning residue, chopping machine, climate change.

POSTER

CREDITS FOR CARBON CARE - FINANCIAL INCENTIVES FOR SOIL ORGANIC MATTER MANAGEMENT TO REDUCE CLIMATE CHANGE

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ABSTRACT

Soil carbon: multiple benefits

Organic matter in soils has multiple benefits. It improves water retention, helping adaptation to effects of climate change. It buffers nutrients and thus also helps improve water quality. It enhances soil biodiversity and often also helps prevent erosion. The principal element in soil organic matter is carbon – and this is the link to climate change. Fixing more CO_2 in soils helps reduce net emissions of greenhouse gases. Building up soil organic matter by capturing CO_2 therefore is desirable for several reasons.

Soil carbon as credit

Currently, in many places and among many farmers in Western Europe it is conceived that soil quality is deteriorating; organic matter content is not increasing and many report losses of soil organic matter. The soil's full capacity for fixing CO_2 is not adequately used, primarily because farmers do not give it the priority it would need. This in turn is caused partly by lack of knowledge of the positive effects (no internal incentive) and partly because there is no drive from government policy (no external incentive). With this project Carbon Credits we have identified effective ways to stimulate CO_2-sequestration in agricultural soils, focusing on the internal incentive (farmers' insight) as well as the external incentive: payment for the ecosystem service of carbon sequestration.

Achievements

With this project we have:

- Established that fixing CO_2 in soils fits modern farming practices and can deliver (economic) benefits to the farmer
- Identified the most effective financial incentives for capturing and maintaining carbon in soils.
- Drafted a framework and operational system for financial support to farmers for CO_2-sequestration in soils.

Three pillars

The project was built on 3 pillars:

- Demonstration-farms where farmers test soil management measures, and demonstrate that such measures are applicable in modern farming practice, and that the economic result is neutral to positive (this part is continued).
- A practical internet-tool for farmers to estimate the effects of soil measures on soil carbon and CO_2 emissions and removals, and thus support farmers with a set of options to help fix carbon on their farm. The tool has been based on a new added soil management module to the existing Climate Yardstick of CLM.
- Financial incentives from government policy and market and these have been linked to a newly drafted conceptual framework for assessing financial payments for appropriate soil carbon management and the expected results over time.

Keywords: carbon credits, soil carbon sequestration, management, climate change.

POSTER

EXPERIENCES IN BRAZIL WITH THE ROUND TABLE ON RESPONSIBLE SOY AND ZERO TILLAGE, AS CONTRIBUTIONS TO THE GREEN CARBON FARMING DEBATE IN EUROPE

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ABSTRACT

Zero Tillage/Conservation Agriculture (ZT/CA) is the best strategy for reducing farming's environmental impact; EU-approved Round Table on Responssible Soy (RTRS) certification rewards responsible farming and both contribute to reduced worldwide carbon emissions. Europe´s flagging and failing economies can no longer afford the Common Agricultural Policy, while ZT/CA farming is still limited in Europe to <2% of world total. But Europe cannot expect a net inflow of credits when its carbon footprints are amongst the highest worldwide. So, overcoming ZT/CA's teething problems should be a priority. Four principal alternatives to funding payment of environmental services (PES) for farmers were identified to assist these changes. Besides the soil carbon sink and halving diesel consumption, other positive environmental impacts of ZT/CA occur on wildlife, flood mitigation, water quality, drought avoidance and biological controls, which should also qualify for PES under green carbon farming (GCF). In Brazil, these were conservatively valued at >US$2 billion annually.

Brazil's Ministry of Agriculture pledged a 262 million ton CO_2 Eq reduction in GHG emissions (2010-2020). Their Low Carbon Emission Agriculture programme targets 27 million hectares of pasture renovation, annual crops and agroforestry, with ZT/CA. Bank loans at 5% annual interest (below current inflation) for 5-12 years support this, but there is no transfer of carbon credits to farmers. Crop/winter pasture systems employing ZT/CA in Brazil´s Cerrado region reduce GHG emissions by 0.38 Mg C equiv. ha^{-1} yr^{-1} (net of NO_2 and CH_4 emissions); intensive tropical annual crop systems rotated with grass leys can sequester over 2 Mg C ha^{-1} yr^{-1}, agroforestry over 6 Mg C ha^{-1} yr^{-1} and annual ZT/CA cropping sequesters over 0.3 Mg C ha^{-1} yr^{-1}. Farmer associations, with agro-industry support, have been fundamental in the uptake and development of these technologies supported by on-farm and on-station research. Regarding the transfer of end-consumer premia to farmers, RTRS' chief limitation has been the dilution of identity of the soya fraction in animal products e.g. eggs, milk, meat. The consumers paying premia for organic products are an elite minority resulting from a huge marketing effort. An RTRS certificate trading platform was set up but supply still exceeds demand, despite industry pledges. Individual farm carbon footprinting for payment of carbon credits is expensive; using a farming system life cycle assessment as a proxy would be more feasible, especially if associated with a multi-stakeholder certification alliance. Inhibited by the complex Kyoto procedures, carbon credits reaching Brazilian farmers are negligible, except for biogas generation.

Keywords: zero tillage, sustainable, certification, carbon.

POSTER

AGRICULTURAL POLICIES AND CARBON TRANSFER BETWEEN GEOGRAPHIES

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ABSTRACT

The authors make a comparative analysis between agricultural grain crops systems in Argentina and in France.
They describe in both geographies some of the farming systems producing the most of production of the principal grains, their impact on carbon and nitrogen balance, their impact on organic matter.
The comparison shows unbalanced nitrogen and carbon management, leading in both cases in depleting organic matter and thus robustness of farming ecosystem.
In Argentina, the low carbon/nitrogen balance is caused by intensive use of legumes, driven by governmental policy of export of soy.
In France, the low nitrogen/carbon balance is caused by the deficit of use of legumes in rotations, driven by environmental directive about nitrogen limitation, and lack of local market forced by historic trade agreement about soy and maize in world trade organization.
In both cases, but with totally opposite mechanisms, policies drive to degradation of agricultural ecosystems as well as of economics.
Common need is to restore the robustness, productivity, profitability and sustainability by best agronomic practices.
Farmers can only do this if it is translated into appropriate policies, where priority is given to sustainability under agreed standards.
Consistency of these objectives needs to be built across geographies, and thus be integrated as a priority into international negotiations about trade and economics, social and environmental dossiers.

Keywords: carbon balance, public policies, geographies, transfer, farming ecosystems

POSTER

BIOMASS AVAILABILITY FROM OLIVE FARMING AND OLIVE OIL INDUSTRY IN ITALY. AMOUNT AND LOCATION ESTIMATES FOR THE VALORIZATION UNDER AN ENERGETIC POINT OF VIEW

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ABSTRACT

Renewable energies as indigenous source of energy will have an important role to play in reducing the level of energy imports, mitigate climate change and enhance energy security (Ericsson, 2006). Biomass offers a large unexploited technical potential and is currently competitive and economically viable (COM (97) 599).
This study deals with the availability of the raw material (woody residuals from olive trees cultivation -pruning- and residuals from the olive oil extraction process -pomace-), its location and potential as a biomass source for energy production. A web-based survey was administered to farmers and olive oil producers. The main aim was at identifying the most productive areas to assess suitable places for locating fuel production plants (ready-to-use fuels, namely synthetic natural gas (SNG) and diesel obtained through the Fischer-Tropsch synthesis process).
Collected data were elaborated together with official statistics (Metadata from EUROSTAT, the Statistical Office of the European Union) and estimates of biomass amounts in the targeted areas were performed. The basic framework was drawn from conceptualization of the production frontiers. The coefficient, determined by mean of collected data average yield, had been used to assess the total biomass production at local level (regions) using data (olive growing areas and yields) derived from EUROSTAT.

Keywords: biomass, olive, renewable energy, web survey, production frontier.

POSTER

REFERTIL: BIOCHAR POLICY SUPPORT AND ECONOMIC ASPECTS IN THE EU

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ABSTRACT

There is an urgent need to adopt sustainable EU soil and production system management practices. In order to improve the European food safety and supply security, it is important to reduce mineral fertilizers and chemicals use in the agriculture by recycling treated organic waste as biochar products that applications lead to improved soil quality and health. The EU organic waste streams from agriculture, food industry and other sectors are in mega dimension, still the quantitative and qualitative overall recycling utilization schemes are not sufficient. The objective is to utilize these organic waste streams as resources, for sustainable feed supply to biochar productions, so the processed biochar processing input materials does not compete with human food, animal feed and plant nutrient supply. The objective driven goal of the FP7 REFERTIL project (2011-2015) is to improve the currently used biochar treatment systems towards advanced, efficient, economical and comprehensive bio-waste treatment and nutrient recovery process with zero emission performance. Additional core element element is to provide strong support for policy makers for the revision of relevant policies, most importantly to the FERTILIZER REGULATION revision process. In this context the REFERTIL is setting up future common bio-waste recycling targets, common quality standard requirements for treatment, bio-char quality and trading requirements. The added value transformation is made by improved pyroylsis and biotechnological formulation, with particular attention to the recovery of phosphorous and nitrogen. Both types of biochar systems developed with complex beneficial effects and functionality, such as the high carbon content plant based biochar for soil amendment and the high phosphorous mineral content food grade animal bone based bonechar for slow release organic fertilizer applications. The targeted high quality biochar products aiming to reduce mineral fertilizer and intensive chemical use in agriculture; enhancing the environmental, ecological and economical sustainability of food crop production; reducing carbon footprint and overall contributing to climate change mitigation. The improved output biochar products are safe, economical, ecological and standardized compost and bio-char combined natural fertilizers and soil amendment agricultural products used by farmers. Proactive and coherently integrated cooperation made between multi level stakeholders, with result oriented potential benefit and interest to SME farmers for more efficient utilization of the biochar products by the end-users. As a result the improved REFERTIL biochar treatment process opens new technical, economical, environmental and social improvement opportunities, while improving the economical and ecological effectiveness, and safety of the resulting biochar products in agriculture.

Keywords: biochar, bonechar, pyrolysis, phosphorous, fertilizer.

POSTER


GREEN CARBON:
MAKING SUSTAINABLE
AGRICULTURE REAL