European Conservation Agriculture Federation

Conservation Agriculture and the CAP 2020

Climate Change

2011/2012

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World soils are an important pool of active carbon and play a major role in the global carbon cycle and have contributed to changes in the concentration of greenhouse gases (GHGs) in the atmosphere.

Agricultural ecosystems can play a significant role in the production and consumption of greenhouse gases, especially carbon dioxide (CO_2). Agriculture contributes approximately 10% to total European Union (EU) greenhouse gas emissions. Fuel burning by agricultural machinery is often regarded as the main source of CO_2 emissions in the primary sector, neglecting the CO_2 fluxes derived from agricultural land caused by the 'burning' of organic litter left after harvest and soil organic carbon (SOC) losses caused by intensive plough based tillage, which is still considered 'normal' and 'good agricultural practice'.

Intensification of agricultural production is an important factor influencing greenhouse gas emissions, particularly the relationship between intensive tillage and soil carbon loss (Reicosky & Archer 2007).

According to estimates over decades of measurement, soil organic matter (SOM) levels have decreased considerably due to agricultural land use (Reicosky, 2001). A one per cent reduction of SOC in the 30 cm topsoil layer results in losses of approximately 45 tons of carbon, or 166 tons of CO_2 per hectare, to the atmosphere. This calculation clearly illustrates the impact that agriculture has on the release of CO_2 to the atmosphere where land use practices lead to a depletion of SOC.

On the other hand, it also reveals the potential for carbon sequestration, which a change of the agricultural practice could have, if it succeeds in restoring at least some of the SOC lost over decades of traditional tillage. This would increase not only the levels of SOM but also soil fertility and the long-term sustainability of agriculture and food production. The reduction of CO_2 emissions would be due to the reduction in energy use through the manufacture and utilization of agricultural machinery and the adoption of conservation agriculture to reduce CO_2 emissions from soils. Methane production could be reduced through composting of manure and a widespread implementation of grass-based grazing systems. Finally, the release of nitrous oxides could be lowered through the reduced application of inorganic fertilizers as a result of improved soil fertility through the increase of SOM, and the use of targeted and slow release fertilizers.

It is widely accepted that both emission reductions and an increase in potential sinks would have to occur if there is to be a positive effect on climate change. Numerous sinks have been identified by many authors and assessments are being made to quantify their potential in terms of carbon sequestration. With regard to agricultural land, reduced tillage and especially zero or no-tillage, coverage of the soil surface with straw residue, cover crops and rotations, and improved management practices, which result in increased crop and biomass productivity, are recognized as the main practices necessary to turn agricultural soil into a significant carbon sink.

Countries that have ratified the Kyoto Protocol have already given an obligation to reduce their GHG emissions, including carbon, to the atmosphere and many more will have to do so in the future. It is unlikely that these obligations can be met without realizing the benefits of soil carbon sequestration. The advantage of promoting carbon sequestration is that it can be achieved in the short term using technologies that are readily available while at the same time there are also considerable production and environmental benefits.

Dual Benefits of Carbon Sequestration and Soil Conservation

Lands under agriculture and forestry production systems are important pools in the global carbon cycle and the land management practices used can determine whether these lands are sources or sinks of carbon.

For example:

- Management factors to increase SOC must increase organic matter inputs to the soil, and decrease decomposition of SOM and oxidation of SOC. Such practices include: reduced tillage intensity, decreased bare or cultivated fallow periods, the use of winter cover crops, increased rotation cropping with the inclusion of legumes, balanced nutrient management and efficient nutrient management.

Increasing the level of soil carbon or soil organic matter can provide considerable dual environmental and production benefits:

- Increased organic matter improves soil aggregation which in turn improves soil aeration, soil water storage, reduces soil erosion, improves infiltration, and generally improves surface and groundwater quality.
- Increasing the SOC content of soil through sequestration improves nutrient cycling by stimulating soil biology and biodiversity. This stimulates the decomposition rate, enhances the nutrient supplying power of the soil, and reduces the need for inputs such as mineral fertilizers.
- In addition, increased water storage capacity and improved soil fertility provides some degree of mitigation against droughts and crop failures in dry years.

Potential of CA to reduce CO_2 emissions and increase C-sequestration in Europe

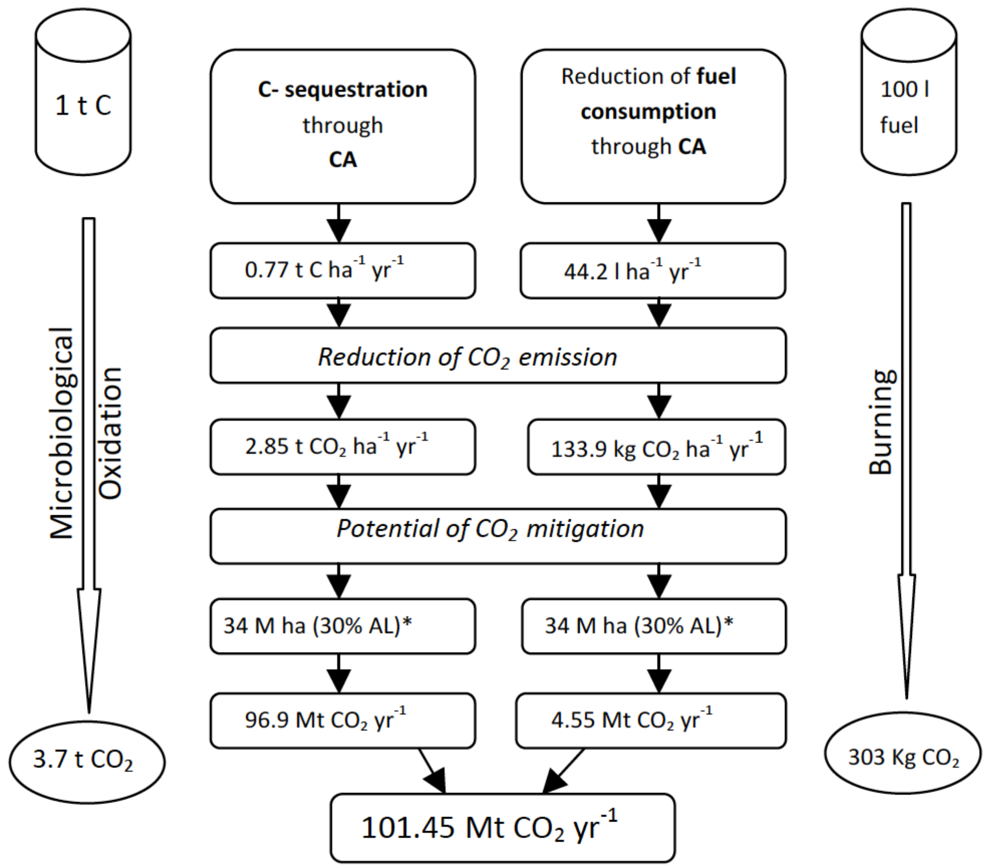
Assessing the potential for carbon sequestration through the adoption of conservation agriculture requires an estimate of the potential land area which could be converted to this form of soil conservation, and the rate with which carbon is accumulated per unit of time and area following uptake. There are several studies available from a number of countries with the main focus being on the USA. However, with regard to Europe, very little information is available on the extent to which conservation agriculture could contribute to carbon sequestration. This is largely due to the fact that conservation agriculture has low adoption rates among European farmers and most long-term data on the effect of conservation agriculture practices on carbon sequestration under European conditions is available from experimental sites only.

One of the few attempts made was by Smith et al. (1998), who estimated that carbon sequestration through no-tillage was approximately 0.4 t ha^{-1} per annum. According to the authors the maintenance of 2 to 10 tons of straw would have an additional effect on carbon sequestration of approximately 0.2 to 0.7 t C ha^{-1} per annum. Based on this information and the conservative estimate that 30% of the total arable area in EU countries (EU-27) would be suitable for the adoption of Conservation Agriculture (CA) practices (no-tillage with crop residue retention) the potential CO_2 mitigation for EU member states through uptake of CA is shown in Figure 1. The key values used in this calculation are:

- carbon sequestration (reduced CO_2 emissions) under CA:	0.77 t C $ha^{-1}yr^{-1}$*
- reduced fuel consumption under CA:	44.2 L $ha^{-1}yr^{-1}$
- percentage of arable land suitable for NT:	30%

* figure adopted from the McConkey et al. (2000).

Consequently, the potential carbon sequestration in the soil that could be achieved in the EU-27 through the adoption of conservation agriculture practices totals 26.2 Mt per year, which represents a total annual CO_2 mitigation of 97 Mt. Compared to this amount, the saving of around 4.5 Mt CO_2 yr^{-1} through less fuel consumption, due to no-tillage operations, appears rather small. Overall, the carbon sequestration together with CO_2 emissions reduction would account for almost 40% of CO_2 emissions (266.4 Mt CO_2 yr^{-1}), which the EU-15 member states agreed to reduce by 2012 (Tebrügge, 2001), and corresponds to one third of what EU-27 member states were able to reduce between 1990 (4.35 Gt CO_2) and 2010 (4.05 Gt CO_2) (Olivier et al., 2011).



** When applied on 30% of total European Arable Land (AL), 113.4 M ha (Source: Eurostat, 2010).*

Figure 1: Estimation of the potential reduction CO_2 emissions through the application of Conservation Agriculture in Europe (EU-27).

Similar calculations were conducted for the USA, resulting in a potential carbon sequestration of between 0.45 and 1.0 t ha^{-1} per annum giving an average annual agricultural soil sink of 180 Mt of carbon. Thus, soils sinks could offset about 30% of the CO_2 emission reduction target of the USA (Lal et al., 1988).

Climate Change and future CA Adoption

The agronomic, environmental, and economic feasibility of conservation agriculture systems has been proven under many soil and climatic conditions. It has been well established that soil organic matter and soil carbon levels can reach a new higher equilibrium with the application of conservation practices, especially where crop residues are maintained on the field and permanent crop and soil cover is achieved. The adoption of these sustainable management practices on a substantial part of the EU arable land area could reverse the continuous decline of soil organic matter and soil fertility and contribute decisively to the necessary reduction in CO_2 emissions and CO_2 levels in the atmosphere as agreed under the Kyoto Protocol.

European agriculture can contribute decisively to the realization of the obligations set out in the Kyoto Protocol.

What is needed now:

- Effective knowledge and technology transfer for the farming community on conservation agriculture using a combination of scientific and practical expertise
- Active involvement of key stakeholders including environment agencies, local authorities, government ministries, farmer organizations and the food industry
- Incentive programmes to encourage the adoption of conservation agriculture under existing agri-environmental measures in Member States
- Long-term agronomic research projects on conservation agriculture systems at both farm and research levels throughout the EU
- Establish a market for carbon credit trading based on soil carbon sequestration
- Use of accepted soil carbon sequestration rates based on international use and research findings
- Ongoing research to monitor SOC changes in CA systems under different climate and site conditions with a view to updating these applicable standards

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