Conventional and conservation tillage from pedological and ecological aspects, The SOWAP project

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Introduction

Conservation agriculture is in a way the new discovery of „old fashioned” agriculture, i.e. of the agriculture practised before the discovery and application of high tech machinery in agriculture. Even before the usage of soil cultivation machines cultivation was performed by inverting the soil using the plough or similar tools. According to our understanding conventional agriculture is based on tillage and it is highly mechanised. Conventional agriculture causes severe land degradation problems including soil erosion and pollution as well as other environmental damages like biodiversity and wildlife reduction, low energy efficiency and a contribution to global warming (Boatman et al. 1999).

According to the SOWAP project (Soil and Surface Water Protection Using Conservation Tillage in Northern and Central Europe, 2003) definition *Conservation Tillage (CT)* is understood as tillage practices specifically intended to reduce soil disturbance during seedbed preparation. The objective being to improve soil structure and stability. Conservation tillage encompasses a range of tillage practices up to and including „Zero (no) Tillage”.

Conservation Agriculture (CA) is a holistic approach to crop production, which encompasses „Conservation Tillage”, and also seeks to preserve biodiversity in terms of both flora and fauna. Activities such as Integrated Crop, Weed, and Pest Management form part of Conservation Agriculture. The concept of „As little as possible, as much as is needed” will be the guiding principles for SOWAP in crop production, when it comes to chemical usage.

Sustainable Land Management (SLM). This is one step beyond „Conservation Agriculture” and includes other „non-crop” activities used to promote biodiversity (landscape) historic character in the wider „farmed” landscape.

Conservation tillage is practised on 45 million ha in the world (Holland 2004), first of all in North and South America and with an increasing trend in South Africa, Australia and in other semi-arid areas.

It is interesting that the application of CA in Europe has developed slower than in other parts of the world. Table 1 shows data about CA and direct drilling in different EU countries. Switzerland and the UK are in leading position with 40% and 30% of the agrarian surface.

Table 1. Estimation of surface under Conservation Agriculture and Direct Drilling in different European Countries (data obtained from ECAF National Associations)

	Surface under Conservation Agriculture	**% Agrarian Surface**	**Surface under No-Till**	**% Agrarian Surface**
Belgium	140.000	10%		
Ireland	10.000	4%	100	0,3%
Slovakia	140.000	10%	10.000	1%
Switzerland	120.000	40%	9.000	3%
France	3.000.000	17%	150.000	0,3%
Germany	2.375.000	20%	354.150	3%
Portugal	39.000	1,3%	25.000	0,8%
Denmark	230.000	8%		
United Kingdom	1.440.000	30%	24.000	1%
Spain	2.000.000	14%	300.000	2%
Hungary	500.000	10%	8.000	0%
Italy	560.000	6%	80.000	1%
TOTAL	**10.054.000**		**960.250**	

The reasons why Europe is behind the rest of the world can be summarized as follows (European Conservation Agriculture Federation, 1999). (1) There is less need to take risks because the

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reduction of costs is not as important than elsewhere. (2) Lack of technology. (3) Lack of technology transfer. (4) Lack of institutional support.

Soil degradation has not been considered to be a major problem in many European countries until recently. According to Oldeman et al. (1991) in Europe water erosion endangers 12% of the total land area and wind erosion 4%, 16% of the cultivated land is prone to different kinds of soil degradation. Today there is an effort to reduce production costs as well.

Generally it can be said that CA is an important tool in those regions of the world where soil erosion is a major problem and where the retention of soil moisture is an important goal. Keeping the water in the soil is equally important if flood and drought are to be avoided.

Benefits for the soil

The main benefit of CT is that the soil will be preserved more or less in semi-natural conditions as soil disturbance by cultivation in minimized and physical and chemical depletion are reduced.

Soil structure remains very good with drainage, porosity, adsorption capacity and structural stability (Lavier et al. 1997).

Compaction and loss of soil structure can be stopped or reduced by applying CT as well, since there is less traffic on the field and crop residues will not be buried in the soil. It is good for soil organic matter, too.

As it is well known, organic matter influences soil structure, soil stability, buffering capacity, water retention, biological activity and nutrient balance, all of these determining erosion risk as well (Holland 2004). Loosing organic matter can be catastrophic for erosion. If the C content of the soil is below 2% erosion may take place (Evans 1996). The OM content of the soil diminishes under conventional cultivation rather quickly. Kinsella (1995) estimates that most agricultural soil loose 50% of soil C. When CT is applied crop residues remain on the soil surface offering a very good protection against erosion.

The SOWAP project

Recognising the benefits of CA a demonstration project started in 2003, supported by the EU LIFE Programme, involving the organisations listed at the end of this paper. This three-year, 4 million € project is co-funded (50:50) by EU Life and Syngenta.

SOWAP (SOil and WAter Protection) aims to assess the viability of a more “conservation-oriented” agriculture, where fewer tillage practices replace the numerous cultivations carried out under more “conventional” arable farming systems. The use of appropriate chemicals is tested, and their potential for off-site contamination assessed, to ensure that any suggested approaches are environmentally sound.

The main study topics of the project are as follows:

(1) Soil erosion studies are based on erosion plots, which are used to compare conventional, farmer and SOWAP practice and to measure sediment, pesticide and nutrient loss and runoff from these systems.

(2) Aquatic Ecology studies are an important part of the ecology – environment block of SOWAP. Soil disturbance produced by tillage creates high runoff rates and silty water that drains into streams, ditches and ponds. This results in reduced water clarity, enhanced levels of nutrients, organics, pesticides and silty bottom sediments. SOWAP will study the effects of „conservation” tillage on stream biodiversity (fish, invertebrates and plants) water chemistry and sediment loading

(3) Biodiversity – Birds and Terrestrial Ecology. Key biological indicators will assess the impacts of differing land management practices on ecosystem sustainability. Counts of foraging farmland birds in winter and in the breeding season will be undertaken. Of particular interest is the comparison of UK agriculture with the currently, lower intensity agriculture of Hungary. The abundance and availability of seed and invertebrate food resources will also be assessed. Earthworm numbers will be important indicators of soil „health”.

(4) Soil Microbiology. The soil microbiology component of the project will complement the physical and chemical measurements of soil undertaken in the erosion topic by monitoring biological indicators. The work will involve micro and macro biological survey recording indicator species and communities/populations thereby indicating levels of bio-diversity in the soil. Details on microbial biomass and community structure and function will add to the complex picture of biological activity in the soil under the different management regimes.

(5) Agronomy. Changes in the way crops grow and are grown in response to different soil management regimes are important to understand and disseminate. To facilitate this understanding, various assessments e.g. crop cover, date of emergence, disease prevalence, weed incidence will be made during the season and over the three year duration of the project, thereby taking into account the farm's crop rotation.

(6) Economics. The economic viability of the practices employed will be key to their successful uptake by farmers inside and outside the project. Project farmers will be encouraged to keep farming calendars throughout the project duration, noting economic inputs (costs of land preparation, treatment application, cultivations and management practice, harvesting costs, marketing costs, transport, variable and fixed costs, gross margins) and outputs (yields).

Environmental benefits

The environmental benefits of CA include on-site and off-site effects, the latter having local, regional or global importance.

From global aspects carbon and other greenhouse gases have to be mentioned first. CA means the reduction of energy consumption and mechanical work, reducing the emissions of CO_2 and CO gases. CA promotes carbon sequestration in soils. Reduced mechanical activity means less SO_2 emissions from motors mitigating acidification of the atmosphere.

As a consequence of CA, air pollution is also reduced.

Concerning global biodiversity, CA offers better nesting sites and better food supplies (Belmonte 1993). CA fields host higher bird, small mammals and game population (Guedez 2001).

The benefits for soil biodiversity are self-evident. Excellent food and habitat are provided for microorganisms, earthworms and insects, promoting bioactivity and biodiversity of the soil.

As mentioned above, soil moisture conditions are much better, than under conventional agriculture. Better water management of the soil is manifested in reduced runoff by 15-89% (Holland 2004).

Above the positive influence of CA on infiltration, runoff, leaching CA helps to reduce the risk of pollutants to reach surface and groundwater. There is an indirect positive affect of CA on aquatic ecosystems.

Details about the Hungarian sites will be given in the conference papers of Bádonyi – Madarász.

Organisations involved in SOWAP

- Agronomica, U.K.
- Cwi Technical Ltd, U.K.
- FWAG, U.K.
- Harper Adams University College, U.K.
- Geographical Research Institute of Hungarian Academy of Sciences, HU
- National Trust, U.K.
- Cranfield University – NSRI, U.K.
- RSPB, U.K.
- Syngenta, U.K./HU
- The Allerton Trust, U.K.
- The Ponds Conservation Trust, U.K.
- University of Leuven, Belgium
- Vaderstad, U.K./HU
- WOCAT, The Netherlands
- Yara (UK) Ltd, U.K.

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