The role of conservation agriculture in the management of hilly watersheds

Ádám Kertész

Geographical Research Institute, Hungarian Academy of Sciences, Budaörsi út 45. H-1112 Budapest, Hungary

Abstract

Keywords: minimum tillage, conservation agriculture, soil erosion, biodiversity

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.

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.

Conservation agriculture is beneficial for the soil. The main benefit of CT is that the soil will be preserved more or less in semi-natural conditions. Soil structure remains very good with drainage, porosity, adsorption capacity and structural stability.

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 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.

Soil moisture conditions are much better, than under conventional agriculture. Better water management of the soil is manifested in reduced runoff.

Recognising the benefits of CA a demonstration project, the *SOWAP project* started in 2003, supported by the EU LIFE Programme, involving several organisations[1]. 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. The main study topics of the project are as follows: (1) soil erosion, (2) aquatic ecology, (3) biodiversity, (4) soil microbiology, (5) agronomy and (6) economics.

[1] 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.

The project started on study sites in Belgium, Hungary and U.K. In Hungary two sites were selected near Lake Balaton, in the vicinity of Keszthely (Fig 1). For the soil erosion survey 4 plots were installed at Szentgyörgyvár (2 conventionally tilled, 2 minimum tilled), each 50 x 24 m in size. For the terrestrial ecology survey 24 plots (12 conventionally tilled, 12 minimum tilled, each between 3-5 ha in size, in total 107 ha) were selected. The ecological survey includes the survey of weeds, soil microorganisms, birds and earthworms-insects-seeds as important food sources for birds.

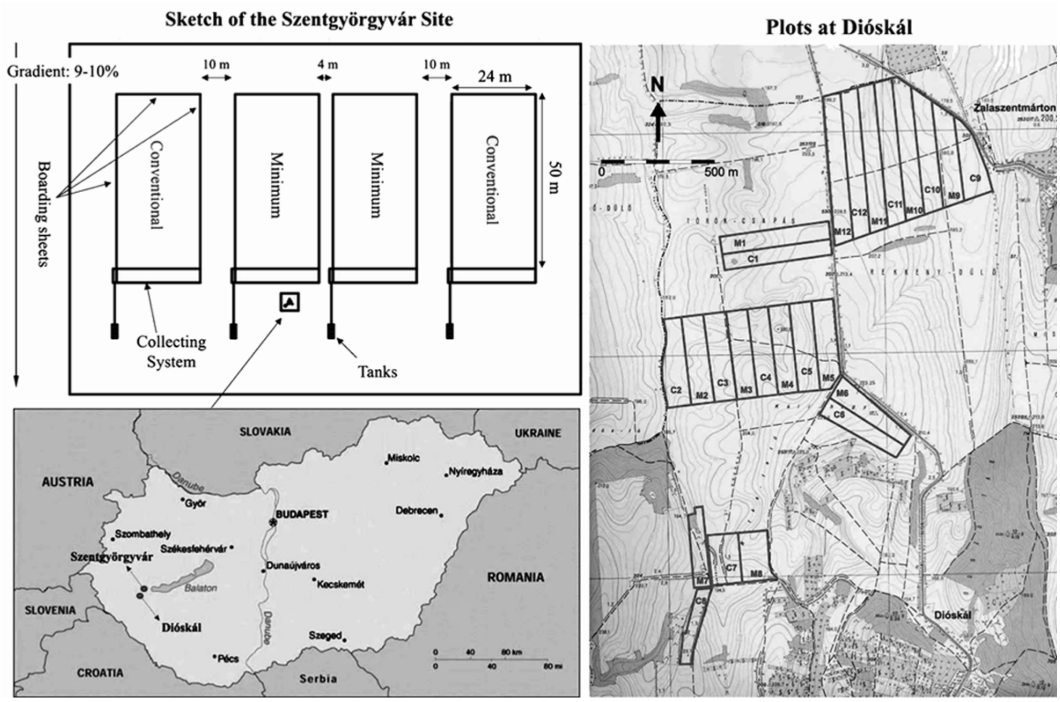
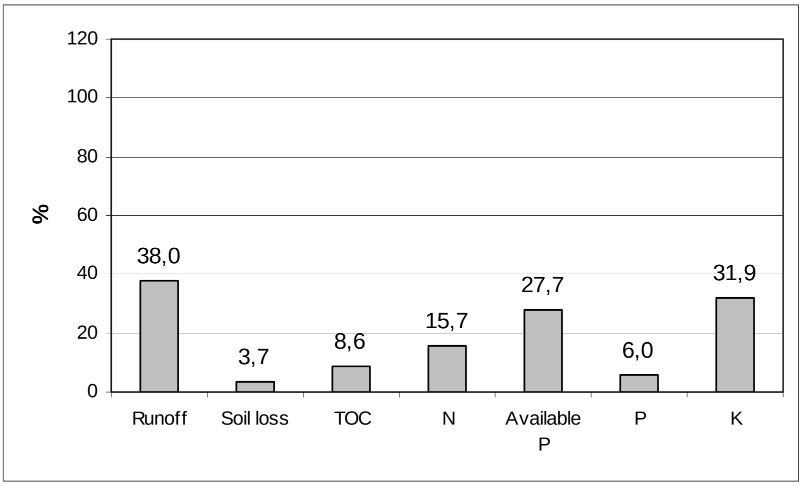


Figure 1. Location of study sites

Results

Both *runoff and soil loss* were always less on the SOWAP plots then on the conventionally tilled plots (Figure 2). This stament is also supported by rainfall simulation experiments. Gravimetric *soil moisture* content measurements supported the presence of excess water content of the soil. There was cca. 200 m^3ha^{-1} more water in the uppermost 100 cm on the SOWAP plot. Ponding could be observed on the soil surface of the conventional field and no ponding took place on the SOWAP plot.

Figure 2 Average runoff, soil loss, TOC and nutrient loss of conservation plots as a percentage of the conventional plots (2004-2005, Hungary)



With smaller runoff and soil loss values the loss of nutrients is also reduced. The average loss of N, P and K was 61%, 53%, and 27% less on the conservation plots.

Rill erosion studies show that the difference between conventional and SOWAP tillage fields is very remarkable. On the conventionally tilled fields rill occurred almost in every row and there were hardly any rills on the SOWAP plot. The explanation of much better conditions on the SOWAP field is obvious, it is due to the protecting effect of plant residues from last year and of the remnants of the winter cover crop (rasp) which was disced after the harvest into the soil.

Crop yield on the ecological plots was practically the same under the different tillage systems. On the maize field yield was 3.7% less on the conservation field. The difference in winter wheat yield was only 1.1%. On the erosion plots at Szentgyörgyvár crop yield was 16% more under conventional tillage. These plots are, however, are much smaller (< 1 ha) than the ecology plots (altogether 107 ha), therefore crop yield values on the ecological plots are much more relevant.

Ecological survey.Conservation agriculture offers better conditions for the activity of earthworms. Alltogether 37 bird species were registered during two winter seasons including 28 protected species (76% of total). One third of these species are significant from European perspective indicating that agricultural areas are also important from the aspect of natural protection. Seeds play a crucial role in the nutrition of 22 species (60 %) and as a consequence of this it is important feature of agricultural fields that theyprovide food in the critical winter period.

Conservation agriculture plots proved to be more favorable for birds, first of all for small warblers like Skylark (*Alauda arvensis*), Goldfinch (*Carduelis carduelis*), Yellowhammer (*Emberiza citrinella*), Greenfinch (*Carduelis chloris*), Tree Sparrow (*Passer montanus*) than traditional plots in both of the investigated winter seasons. Conservation agriculture provides a better food supply and improves winter survival reducing the negative effect of agriculture on bird fauna.

Conclusions

Conservation tillage techniques have reduced soil loss and water run-off from fields compared to ploughing. On some of the conservation-tilled field plots, soil erosion has been reduced by up to 90% and water run-off by up to 40%. The amount of nutrient loss is also reduced. Soil loss due to rill erosion as well as the number of rills is remarkably less. Soil moisture conditions are also much better under conservation tillage. Rainfall simulation experiments point first of all to the protecting effect of plant residues under conservation tillage.

Yields of winter wheat, winter oilseed rape, sugar beet and maize are similar from both ploughed and conservation-tilled fields. Preliminary results, not dealt with in the present paper, inform us about much better biodiversity conditions on the conservation plots.

CA compared with conventional has significant advantages both for the soil itself and for the environment and it can be highly recommended also in hilly and mountainous regions where agricultural activity is carried out.