Prevention of soil erosion, surface runoff, pesticide and nutrient loss with minimum tillage and direct- seeding

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Abstract

In Austria more than 400.000 ha arable land are seriously endangered by soil erosion. Soil loss, nutrient loss, water runoff and pesticide loss are environmental risks and also danger for settlements. The same situation we find in almost every country, depending from the topography. Minimum tillage systems can significantly reduce soil erosion and all the negative consequences. In combination with effective cover crops we can introduce the system of permanent covered arable land with a maximum protection of soil against soil erosion, surface runoff, nutrient- and pesticide loss. The technical requirement and the farmers know how are necessary for the success of this system.

Keywords: soil erosion, no tillage, minimum tillage, direct seeding

Introduction

Not tillage and zero tillage research have been performed for more than half a century in many countries around the world because of the benefits of these systems. Less traffic on the arable land, less fuel consumption, less time for cultivation are economic advantages; ecological interests are higher microbiological activity, better C sequestration, humus constitution and prevention of soil erosion with all its consequences.
Soil erosion causes water runoff by a reduced infiltration rate. Are pesticides solute, high concentrations are found in the deposition zone with the result of infiltration into ground water. Pesticides are found there, usually at the end of a slope as groundwater samples from wells demonstrate.

Material and methods

On 7 locations in Lower Austria tillage trials are operated for more than 7 years; on 2 locations tillage trials and soil erosion measurements are arranged in cooperation with the Austrian University of Agricultural Science Vienna, Department of Hydraulics and rural water management for 20 years. In the tillage trials 4 different tillage methods are settled – conventional tillage with plow and cultivator; reduced tillage with cultivator and disc harrow, minimized tillage with disc harrow or light rigid – tine cultivator and no tillage. Net plot harvest allows measuring the yield.
60 m² plots for investigation of soil erosion are located in Pixendorf near Tulln on the river Danube and in Mistelbach 40 km north of Vienna. After every storm event the measurement is analysed in the laboratory of the University.

Results and discussion

The following figure 1 shows the significant reduction of soil erosion from long- time erosion trials on 2 locations in Lower Austria; figure 2 demonstrates the reduction of organic Carbon loss in different tillage systems. The crop rotation is row cultivars (corn, sunflowers, sugar beets) with a high potential risk of soil erosion and cereals.

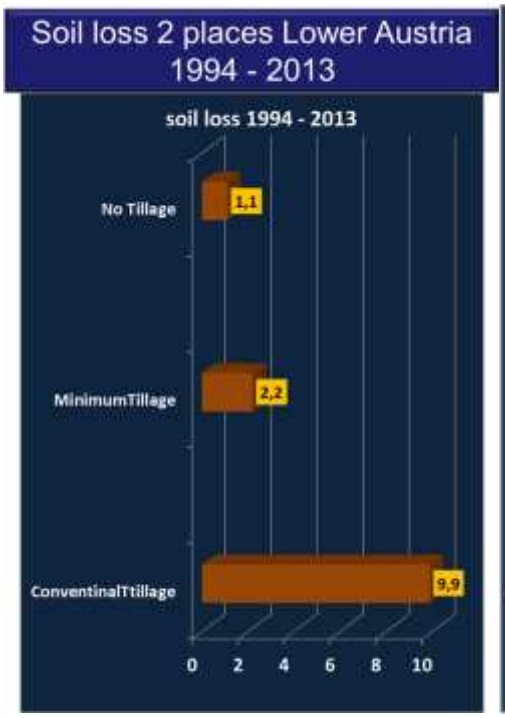


figure 1: soil loss

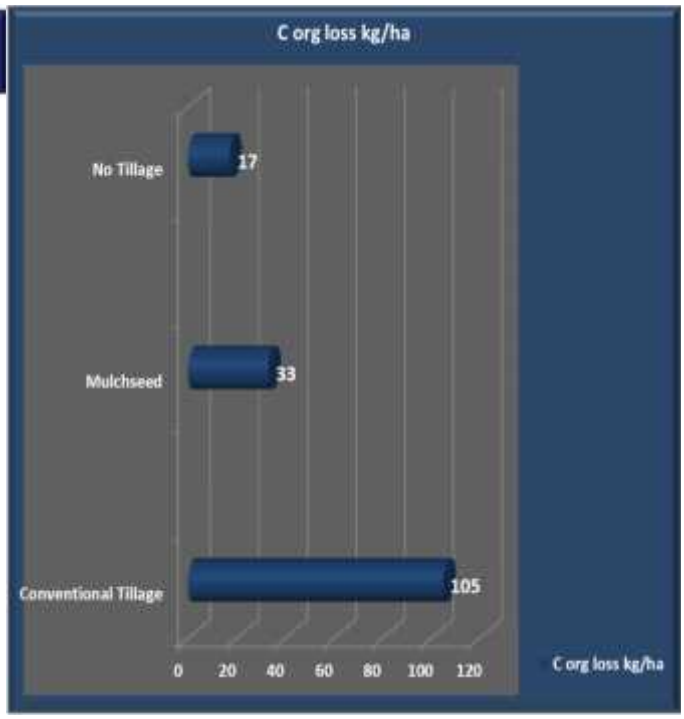
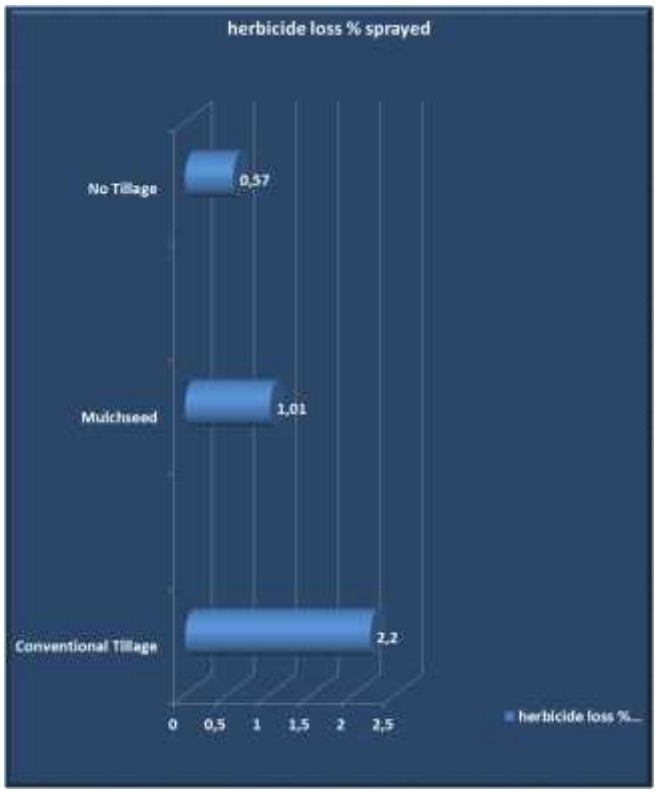


figure 2: organic carbon(C_{org})loss



The storage of C_{org} is important for the aggregate stability in soils and constitutes more than 30 % in Glomalin, a glycoprotein in the Mycorrhiza responsible for stabile aggregates.

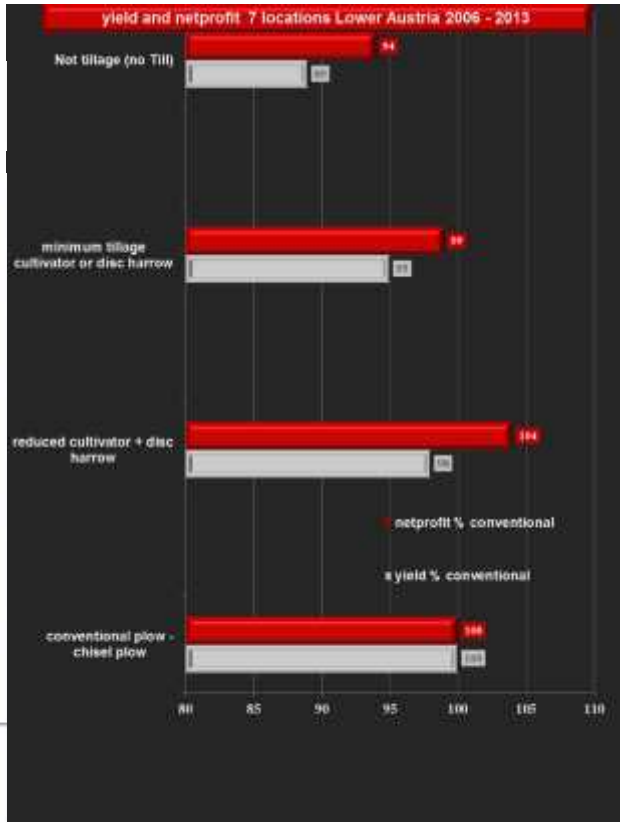
Figure 3:

The herbicide loss of sprayed pesticide can be significantly reduced by mulch- and direct seed and is important for the environment. As finding pesticide residues in surface- or groundwater leads to prohibition of these with negative aspects for plant protection. It is to consider, that in the saturated zone at the end of a slope the concentration of pesticide residues is much higher and an infiltration into the groundwater threatens. The same effect shows the loss of nutrients like Nitrogen and Phosphorous.

Important for farmers are the yields and the net profit. The next figures 4 and 5 show the tendencies in different tillage systems for 7 years.

Yield in relative % 1994 – 2013 Mistelbach-Pyhra(St.Pölten)-Pixendorf(Tulln)
Rosner, Zwatz, Bartmann, Spieß

Tillage method/ Yield kg per ha	Mistelbach	Pyhra	Pixendorf
Conventional Cultivator – plow No cover crop	100	100	100
Cultivator – Mulchseed – Cover Crop: yellow mustard, california bluebell, buckwheat, red clover, oil radish	96	102	102
Cultivator – direct drilling/NoTill Cover crop : 7 kg/ha California Bluebell, 3 kg/ha Yellow Mustard	93	106	106
Cultivator – direct drilling/NoTill cover crop : 80 kg/ha winter rye	89	93	93
Cultivator – direct drilling/NoTill Cover crop :120 kg/ha summer barley	97	112	112



Conclusion

Minimum Tillage an no tillage are practicable and allow lower working time, lower fuel consumption, significantly reduced soil erosion and all solved nutrients and pesticides. The technical equipment is well developed but often not announced to the farmers in Europe, other continents like South America use these tillage operations for several decades successfully and could decrease the severe soil erosion to an acceptable amount. Yields are stabile in minimum tillage and decreasing in No tillage – but only on heavy soils and on sandy soils and with sugar beets in crop rotation. Often the poor work of speeders is responsible for bad field emergency and following low yields. The right equipment like coulter discs for producing loosened soil for closing the seed slot is the key of success (figure 6)

Figure 6:

coulter discs for loosening soil for closing the slots after seeding

Acknowledgements

Soil erosion can be minimized by mulch- and direct seed. The environmental effect is as big as the economical. Deposition of soil in villages, on streets and in ditches is an environmental risk and intensive in costs. Lawsuits in the past consider conventional tillage on slopes and row crops as an incorrect land management and compensation for damages has to be paid by the causer – in that case the famer.

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