ON CLAY AND SILTY SOILS - DIRECT-DRILLING IN EARLY AUTUMN INSTEAD OF PLOUGHING FOR WINTER CROPS

2011 Authors: M. Bechmann, T. Krogstad, B. Ulén

Description
The procedure involves sowing with a direct drilling machine. The seedbed is prepared without any cultivation before sowing.

Rationale, mechanism of action
Tillage operations enhance N mineralisation and may destroy the soil structure, includeing soil aggregation that is responsible for good infiltration and percolation of water. Conversely, direct-sowing of soils provides greater crop residue cover, less susceptibility to surface sealing and a finer surface for tractor traffic due to the more consolidated and uniform soil structure [1]. Avoiding tillage may result in (1) less compaction without development of a plough pan, (2) more biological activity due to an increase in organic matter, and (3) no disturbance of species such as earthworms.

Applicability
In warmer climates, it is usually important to minimise decomposition of soil organic matter and reduced tillage may be strongly advisable. Other benefits of reduced tillage include increased water storage and a reduction in water losses by evaporation. In Norway, studies have shown great variation in yields under no-till, with both higher and lower yields compared to conventional autumn ploughing before drilling [2]. Another Norwegian study [3] showed reduced concentration of soil particles in runoff from a lysimeter study comparing winter wheat with direct drilling and ploughing before sowing. In Sweden, direct drilling is quite popular and is practised in 30-75% of cases after rape and 0-25% after peas [4]. In China, crop yields under no-till have been shown to be equivalent to, or higher than, those from conventional tillage methods, especially in dry years, but during wet years the yields tend to be lower (by 10-15%) [5]. Early sowing of winter crops (in southern Sweden 15 September instead of 1 October), so that more crop biomass is present before winter, is also desirable, since significantly more N is taken up by the crop (15-20 kg N ha^{-1}), which means that the potential for N leaching in the coming winter is reduced [6].
On soils with poor structure (sandy or loamy soils), reduced tillage is less effective since the soil needs to be loosened by regular deep tillage. Direct drilling is usually successful for silty and clayey soils, even heavy clays. For silty soil with no-till, soil crusting is avoided and less water remains in the soil profile.
Straw residues on the soil surface are considered to be a problem when reduced tillage system is used. In Norway, straw has shown a positive effect on yields under no-till [7]. Additionally, under no-till, erosion has been reduced by 30-40% when straw is left on field compared to removing straw [8]. The method is especially suitable for winter wheat following rape, since there are usually fewer pathogens after rape. Volunteer rape seeds may even germinate and act as a catch crop for N and P in the following winter.

Effectiveness, including certainty
Nitrogen leaching under no-till has been estimated to be reduced by 3-8 kg ha^{-1} in the south of Sweden [9]. Based on long term lysimeter studies, direct drilling is estimated to reduce erosion by 80% and correspondingly P losses by 50% compared to autumn

ploughing before drilling in Norway [10]. Chopping and spreading straw, instead of baling and removing, consistently reduced Total-P losses from a clay soil in UK, typically by 30-60% in eight events from land under minimum tillage [11]. In Sweden there are currently no data available for P but the method will soon be tested.

Time frame
Effect of direct drilling of winter cereals on erosion risk can be expected on short term. The effects of no-till on soil structure and improved infiltration may however, take some more time. Several farmers in Sweden already practise direct drilling when the weather and soil conditions allow. Unfavourable weather conditions (Wet autumn followed by mild winter) may totally override nutrient load decrease achieved by small changes of tillage practice [12].

Environmental side-effects
Reduced tillage is difficult to combine with cultivation of catch crops, and in addition there is a risk of increased demand for pesticides. Weeds, especially coach grass tend to increase [13] and the greater amount of straw and stubble on the soil surface poses a risk of some pests surviving from one year to another. Therefore with no tillage a good crop rotation is very important. Direct drilling has been shown to increase the level of Fusarium and Mycotoxin in cereal yields [14]. Furthermore, severe topsoil compaction may ensue when reduced tillage is applied on structurally unstable soils [15]. A number of studies have also highlighted an increase in a more biologically active dissolved fraction of P under conservation than under conventional tillage due to the preferential accumulation of available P at the surface of non-inverted soils [16, 17].

Relevance, potential for targeting
Direct drilling is highly relevant for many clayey and silty soils where erosion is a problem. The measure is easy to promote but the potential for targeting is difficult in practice. The technique must be adapted to local soil and climate conditions and requires a high degree of management skill.

Costs: Investment, labour
A well functioning seed drill is usually necessary but investment in new machinery is a one-time cost. A slight reduction in crop yields (5-7%) may occur after direct drilling and, in addition, a higher seed rate is needed. However, direct drilling involves only one operation and machines for direct drilling and for powerful seedbed cultivation use less fuel than conventional ploughing. All kinds of minimal tillage techniques generally reduce the costs associated with fuel and labour. However, direct drilling may result in increased herbicide application, which can eliminate any previous cost savings.

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