ON CLAY AND SILTY SOILS - DIRECT DRILLING (NO TILLAGE) IN SPRING COMPARED TO SPRING PLOUGHING

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Description
The term direct drilling involves all crop establishment operations being performed on a single occasion. A direct drill either drills the seeds directly into undisturbed soil or, as is usually the practice, some kind of cultivating equipment is used in front of the drill in order to shallow-cultivate before drilling.

Rationale, mechanism of action
Tillage operations enhance N mineralisation and may destroy the soil structure, including 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.
Direct drilling involves no till during autumn and hence the advantages of stable soil aggregates with low erodibility and vegetation with an established deep root system can take up N and P in the autumn. This mechanism, combined with increased capacity of the soil to act as a filter, can minimise P leaching during the winter. In warmer climates, no tillage is important since the straw over the soil decreases soil water evaporation, while each tillage operation increases it. Soil properties are also improved under Scandinavian climate [1].

Applicability
No tillage is applicable for most structured soil types except for the heaviest clays. Studies on silty soil in NW Sweden demonstrated the need to drill early in spring [2], while untrained operation of the direct drill was followed by low yields in most years. In the Nordic climate, problems can arise since it is usually necessary to get rid of crop residues in order to get the soil sufficiently warm in the spring. Uneven seedbed preparation may cause variable germination and following unstable yields.

Effectiveness, including certainty
Nitrogen: No effect on N losses via surface runoff was demonstrated in NW Sweden compared with conventional tillage or other types of winter-green soils [2].
Phosphorus: The effect of direct-drilling in spring compared to spring ploughing is much less than the corresponding effect of direct drilling in autumn compared to autumn ploughing before seeding. The reason is that there is only a short period in spring before the crop will cover the soil surface and thereby reduce erosion risk and take up mineralised nutrients. Surface runoff of P was low due to the relatively low amount of runoff water, but the proportion of dissolved reactive P was significantly high, especially after use of herbicides [2].

Time frame
The effect of direct drilling on erosion and losses of N and P is expected to be on short term. Only a short time is needed for implementation of no tillage but the long-term effect of non-ploughing or non-tillage should be evaluated. After years of no tillage, a new soil structure is built up. The measure may be good for some types of soil but results in compacted topsoil in others.

Environmental side-effects
Direct drilling gave rise to low yields and high losses of dissolved reactive P from a silty soil in a plot experiment with surface erosion [2]. In direct-sown sites there were a lot of weeds that in some of the years were treated with glyphosate, and dead or frost-damaged vegetation is known to be a source of dissolved reactive P. Thus large amounts of dead organic matter were the most likely reason for the high losses of dissolved reactive P from the direct-drilled treatment.

Relevance, potential for targeting
Direct drilling is highly relevant for clay and silty soils where erosion is a problem. The measure is easy to encourage but should be locally targeted.

Costs: Investment, labour
Investments in direct drills are high. Timing of sowing may be important in order to avoid yield reductions. Direct drilling occupies labour during a busy time of the year and labour costs may therefore be high in practice. However, direct drilling requires only one pass for crop establishment compared with two or more tillage operations plus drilling for conventional tillage. Compared with mouldboard ploughing (soil inversion) and disc cultivation, direct drilling provides savings of about € 1950 on a 200 ha farm [3]. Direct sowing also provides a fuel saving of an average 31.5 litres per ha annually compared with conventional tillage systems. The annual cost reduction in direct drilling of annual crops is between € 40-60 per ha under southern European conditions [3]. Fewer passes save an estimated € 97 per ha on machine wear and maintenance.

References
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