ON COMPACTED CLAY AND SILTY SOILS - BIOLOGICAL LOOSENING OR DEEP PLOUGHING TO DESTROY THE PLOUGH PAN AND DEEP MACRO-PORES

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Description
Subsoil structural conditions are important for P transport via macropores. A dense plough pan can be loosened biologically by growing crops with effective root systems, such as lucerne, white mustard, chicory, oil radish or wild radish. The plough pan and deep macro-pores can also be destroyed by a specialist deep plough. Sometimes the ploughing is carried out in the furrows. The biological method is that currently mostly practised countermeasure in the Nordic countries.

Rationale, mechanism of action
Water- or air-filled macropores even in frozen soil can pose a risk of P losses, since water content of P can be rapidly transported downwards in the soil. In the subsoil the structure is normally relatively unaffected by cultivation and the downward transport of P through macropores to the drain system can be rapid. One way to decrease leaching of P is to promote rapid flow in the topsoil through breaking up the plough pan, while another is to decrease the flow velocity in the subsoil through deep ploughing. By destroying the deeper macropores, runoff water may have a longer retention time in the P-rich topsoil layer. Some studies have shown that P leaching decreases substantially after ploughing to greater depth in certain conditions [1]. However, after destroying the plough pan with a deep plough, the soil usually soon becomes re-compacted. Therefore deep ploughing is now combined with liming in Sweden. Calcium supplied via liming and the soil organic matter content results in format-ion of Ca-humates, which improves aggregate stability. Even the soil condition can be improved or maintained by planting soil-loosening catch crops, but the loosening effect may not be sufficient to alleviate severe plough pan compaction if the extent of the compacted layer exceeds 6-8 cm [2].

Applicability
Applicable for compacted clayey soils. In practice, oil radish or wild radish can only be cultivated every fourth year due to the risk of pathogens. A serious consequence is that it is impossible to grow oilseeds, since this crop would be competed out by the radish. Deep ploughing will be more applicable under these conditions. At the Norwegian West-coast subsidies are given to deep ploughing of areas after potato-cropping, since the heavy machinery often creates a plough-pan, causing a high risk of erosion on these areas.

Effectiveness, including certainty
Flow velocity in the subsoil may be reduced but the impact on nutrient leaching from these kinds of practices has not been tested.

Time frame
Short-term for destroying the plough-pan by ploughing and more long-term for biological loosening.

Environmental side-effects
Unknown.

Relevance, potential for targeting
It is easy to encourage but difficult for targeting.

Costs: Investment, labour
The costs for deep ploughing are high, both for labour and fuel.

References
[1] Calvert, D.V. 1975. Nitrate, phosphate, and potassium movement in drainage lines under three management systems. J. Environ. Qual. 4, 183-186.
[2] Birkás, M., Jolánkai, M., Gyuricza, C. & Percze, A. 2004. Tillage effects on compaction, earthworms and other soil quality indicators in Hungary. Soil Till. Res. 78:185-196.