Trends in soil cultivation

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The challenges facing soil cultivation technology are considerable – crop production, phytosanitary and soil protection requirements must be given equal consideration, all against the backdrop of severe restrictions on the active ingredients used in crop protection products. This means that all conceivable options for preventing soil degradation, humus loss, diseases and pests must be exploited. Post-harvest management and soil cultivation play a central role in this. The agricultural machinery industry offers a broad range of equipment for stubble and basic soil cultivation, as well as sowing, that leaves virtually no wish unfulfilled. Primary soil cultivation is preceded by field hygiene measures such as harvest residue mulching and/or ultra-shallow tillage.

Post-harvest treatments

Even lateral straw distribution is desirable, but this is not automatically achieved with the chopping technology on the combine harvester – it requires the system to be adjusted for best performance. Working widths of >7.0m necessitate additional centrifugal distributors to achieve even distribution, especially in the face of unfavourable conditions such as cross winds and slopes. While straw harrows can be used here to improve straw distribution, these are primarily used in the cultivation system for the purpose of achieving ultra-shallow stubble tillage in order to block brome and other grasses. The occasional new development crops up time and again in this area, for example in the combination of harrow tines plus discs plus packer roller. However, the time window required for ultra-shallow tillage is more likely to be found with summer crops and less likely for winter crops. Otherwise, harrows are becoming increasingly important in mechanical weed control – further developments such as the control of individual harrow times will be seen.

Straw mulching offers the best protection against the uncontrolled evaporation of soil moisture. In wet weather years, however, shallow stubble tillage using a compact disc harrow or a large spring tine harrow must be carried out between August and October on clay soils, because otherwise these soils will not dry out underneath the straw mulch, and will not allow deeper basic soil cultivation in the autumn due to excessively high moisture. Some farms use the residual moisture to sow a catch crop immediately after harvesting – in 2018, however, moisture levels were often not sufficient to ensure reliable germination.

While this year’s sudden grain maturation led to the situation where stems were still green during threshing, high cutting with the subsequent use of mulchers was almost certainly helpful for the workflow and the rotting process. Stubble mulching in maize cultivation is also sensible for two reasons: first, to mechanically destroy the pyralid moth and its winter quarters, and second, to achieve a better residue for working-in and rotting, and therefore
helping to avoid mycotoxins in the grain.

**Soil cultivation from shallow to deep**

The range of products on the market is so complex that selection is difficult. There have been no ground-breaking hardware developments. Instead, electronics are increasingly making their way into the implements, thus enabling better communication between the tractor and implement. However, controlling settings by means of ISOBUS remains the exception, because complete compatibility between all manufacturers is still not guaranteed. In part, depth control of a cultivator, for instance, is enabled by measuring the electrical resistance in the front attachment. However, the corresponding algorithms still have to be derived to be able to draw reliable conclusions regarding harmful soil compaction, for example. All implements should essentially be equipped with hydraulic depth adjustment, irrespective of whether control is carried out manually or with GPS support.

Farms can choose between a solo compact disc harrow, a solo cultivator or a combination of a disc unit and a cultivator tine unit in a single machine. If a cultivator is selected as a universal implement for stubble tillage and basic soil cultivation (that is as a substitute for ploughing), a share exchange system and a second packer roller are necessary. Wing shares are still available for shallow tillage; however, these are unable to work in a truly shallow way due to the tip's bottom flange and wings that are raised at the sides. These protrude 10 to 12cm into the soil when working, which is clearly too deep for the emergence of grasses and oilseed rape. In addition, the straw is not worked evenly into the topsoil, but is "swathed-in" instead.

In the second, deeper operation, cultivators with inversion or double-heart shares achieve good harvest residue mixing. Nowadays, the tips are usually armoured, which significantly reduces wear – this can also be indicated electronically. Chisel coulters with a width of 6cm are suitable for deep loosening of the topsoil; the line spacing should then be <30cm. What remains is the problem with the working width: if, for instance, a 180kW tractor is at the limits of its tractive power during shallow cultivation using a cultivator with a working width of 4.5m at a speed of 10km/hr, the cultivator should be no wider than 3m for deep topsoil cultivation in heavy soil. This means that a compromise is made in terms of both the working depth and the tractive power requirement with combination implements.

**Using two implements provides the solution**

The solution in this case is the use of two special implements. Initial, shallow stubble tillage is undertaken relatively well by compact disc harrows with a disc diameter of 50cm – with 180kW, a working width of 5.0m to 6.0m and a vehicle speed of >12km/hr are entirely reasonable. High work rates are achieved thanks to the tractive power requirement, which is lower on the whole than that of a cultivator. The disc harrow segment has been extended to larger disc diameters of 65cm or 73cm – their main area of application is in working-in large quantities of residual substances such as grain maize, for instance, or in cultivating clay soils, particularly in the case of dry soil conditions. Due to their high weight, these machines should be equipped with suspension – this also applies to cultivators with a working width of more than 4m, because only this will support protecting the soil, particularly on the headland. The suspension can also undertake a supporting function for cultivators if the packer roller has to be deactivated in moist soil conditions. The high investment costs for a compact disc harrow pay off for large farming operations and can be reduced on medium-sized farms by means of cooperative alliances.

Shallow cultivators or large spring tine harrows can be used as alternatives to compact disc harrows. For shallow stubble tillage, the line spacing should be >15cm. An implement working width of up to 6.0m is also possible with support rollers. Thanks to the spring tines, they crumble the soil well and leave sufficient organic material on the surface to avoid capping.
Strip-till methods have not become generally widespread, but are encountered on sandy and partially loamy, relatively free-flowing soils. They work well where fermentation substrate and liquid manure has been spread, and also where maize, sugar beet, oilseed rape and leguminous crops are being sown.

Very careful consideration must be given to deep soil loosening as a general measure before planting deep-rooting crops. Essentially, breaking up basic topsoil compaction with rigid or driven loosening tools leads to instability in the soil matrix. High mechanical loads are then passed on without buffering into the subsoil and can lead to the impairment of soil function. The routine loosening of tramlines should also be carefully considered – the use of 540mm to 600mm wide tyres with an inflation pressure of about one bar also protects these tramline areas. Earthworm activity in the tramlines is a sure sign that loosening is superfluous.

**How is the intensity of soil cultivation developing?**

If focus is placed on soil protection aspects due to areas that are at risk from erosion or soil pressure-sensitive areas, the cultivation intensity is a key factor. Cross-compliance requirements as well as the rules of "good technical practice" demand a sufficient degree of soil coverage to prevent surface capping and soil erosion. Organic material on the surface fosters earthworm activity and thus the creation of biogenic vertical pores; these ensure a high infiltration capacity of water, which is then available to the crops during dry periods.

An integral element of this system is a non-selective herbicide that ensures the control of weeds, grass weeds and dropped grain without reducing the degree of coverage. If these agents are no longer available in the future, control must be carried out solely through mechanical means. This means an increase in operations involving a disc harrow or cultivator, leading to the extensive decimation of the degree of surface coverage. Additional diesel consumption, with greater CO2 emissions, humus depletion and an increase in soil erosion and water eutrophication will be the result. Against this background, conservation tillage systems with a non-selective herbicide should continue to be permitted in vulnerable conditions.

The sustainability of the soil will decrease and the risk of soil compaction will increase due to more intensive soil tillage and loosening. The industry is therefore called upon to develop tools that lead to the effective removal of weeds on one hand, while simultaneously preserving the degree of coverage and the humus content on the other hand.

**Summary**

Soil cultivation technology assumes a central role between crop establishment, the avoidance of phytosanitary problems and consideration of aspects of relevance to soil protection. In the future, the industry will have to bear this in mind when designing the tool form, tool configuration, working width and weight. Farmers will have to be able to adapt to different requirements by controlling loosening, organic residue mixing, tilling and consolidation.

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**Editors note:**
1,580 words; reprint free of charge