

Joachim Brunotte, Brunswick

Trends in tillage

Below, important trends in tillage are presented, which will be reflected by the machine and implement programme shown at the Agritechnica 2007. This preview cannot replace a trade fair visit. It only provides pre-information and does not claim to be complete.

At the high-yielding locations in Central Europe, tillage processes are playing an increasing role. They are marked by the necessity to find a balance between optimal plant growth, potential savings in machinery and labour expenses, soil protection requirements, and the demand for high-quality food. Is the development going in the direction of less and less work and machinery-intensive direct drilling or in the direction of flexible machine-technological solutions, which can adapt to the soil type, the soil water content, and crop-rotation-specific conditions?

Do existing classifications of tillage techniques remain valid?

Of course, the distinction between stubble and basic tillage as well as seedbed preparation and sowing remains valid. However, these traditional work steps are classified differently with regard to efficiency increase and soil protection. Worldwide, more and more equipment for direct drilling is being offered, which does not require any previous soil cultivation and allows no more than one comb pass (fuel consumption: 2 to 3 l/ha) and one glyphosate application to be carried out. Since only approximately 20% of the areas in Germany are suitable for direct drilling, this development may imply that top-soil loosening during "conservation tillage" should permanently be avoided, which means mulch drilling without loosening.

Loosening intensity, crop rotation, and choice of implements

The choice of tillage strategies focuses on crop rotation, the location, and the requirements of soil protection and food quality. What conditions must be fulfilled in order to meet the very different demands by means of superficial cultivation up to a depth of 10 cm?

- Soils must be biologically and structurally active without stagnant moisture, or soil water must be scarce at the chosen locations.
- Harvest residues should not exceed 80 dt/ha.
- After the harvest, no more than the tyre prints of the harvesting machine may be visible at the soil surface.
- The time window for tillage as part of crop rotation must be three to five weeks.
- The harvesting machinery and the equipment for tillage and sowing must meet the highest standards.
- Due to longer cultivation breaks, summer crops promote good straw rotting.
- The propagation of mice and snails must be given particular attention.

Heavy combs, short-disc harrows, superficial cultivators, and cultivator-disc-harrow combinations suggest themselves as technical solutions for superficial cultivation. Whether this work step is carried out once or twice depends on the desired rotting time of the straw and the use of a non-selective her-

Dr. Joachim Brunotte is a scientist working at the Institute for Production Engineering and Building Research of the Federal Agricultural Research Centre in Brunswick and compiled the present overview shortened by the editors on behalf of the DLG.

Keywords

Trends in tillage, new and further development of machines

Fig. 1: Under the name "Speedliner", Kuhn presents a new series of trailed universal and mulch drills (company photo)





Fig. 2: In the DuraMaxx system from Lemken, wearing parts can be replaced without tools

bicide. Combs scratch the soil, bring germinable material into contact with the soil and trigger the process of germination if the soil contains enough water.

Short-disc harrows are characterized by large area capacity and low fuel consumption (5 to 7 l/ha). Since the discs are sprung separately and held by the share shaft instead of sitting on a shaft, they adapt well to uneven terrain. Reliable penetration into the soil requires implement weights of approximately 750 kg per metre of working width. If the packer roller rests on the disc harrow, this increases the ability of the tools to penetrate into the soil under dry conditions.

More and more manufacturers use the reconsolidation roller as a chassis and thus save an additional chassis. This semi-mounting protects the soil structure of the headland because the implement does not rest on the rear wheels of the tractor alone. However, this restricts the possibility of changing the reconsolidation roller. Under moist soil conditions or during preparation for a summer crop in autumn, open rollers (cage rollers) are desirable. If soils are driven over in a wet condition, this system of permanently superficial soil cultivation poses the danger of harmful soil compaction due to "abandoned topsoil". After careful analysis of the soil structure, crop-specific loosening of the topsoil under dry conditions in combination with biological stabilization by plant roots is required.

Many manufacturers additionally equip the mentioned stubble cultivation imple-

ments with a drilling unit, which consists of a seed tank, a pneumatic conveyor, and baffle plates directly in front of the reconsolidation roller for cost-effective drilling of intermediate crops.

Mulch drilling and loosening

(loosening depth > 10 cm) includes loosening down to topsoil depth and is carried out by cultivators with chisel shares instead of an inverting plough under the conditions of "conservation tillage". This kind of cultivation is appropriate if

- large residual harvest quantities (80 to 120 dt/ha) must be incorporated
- harvest residues must rot quickly because little time remains until the cultivation of the following crop
- vehicle tracks from the harvest must be eliminated and
- the soil water content is too high.

This is also a process chain where potential savings are being discussed. Is one superficial and one deep cultivation pass necessary under the conditions of tight winter cereal sequences, or is one deep pass operation (fuel consumption: approximately 18 to 20 l/ha) sufficient for all cultivation measures? Short stubble and even straw distribution are important prerequisites. If the multi-beam cultivator is used diagonally, the straw can be drawn in by 20 to 40 cm. After a high combine cut, long stubble "swims" at the surface and is incorporated incompletely. Accelerated rotting requires two passes with a time interval between them because the straw-soil mixture must be rearranged in order to intensify exposure to microorganisms for decomposition.

At clayey locations, narrow shares (5 to 6 cm) are suitable because more fine soil provides a good straw-soil flow. For the incorporation of large straw quantities, spiral or double heart shares (7 to 8 or 13 to 14 cm wide) are better suited because fresh soil rises along the share and falls onto the straw from above. Lately, shares have been offered which maintain their angle of attack at different degrees of wear. Steeply standing tool carriers need a lot of tractive power. For the first, superficial pass and the elimination of snail burrow systems, the required strong reconsolidation is achieved by means of closed rollers (e.g. tyre packer, trapezoidal ring, wedge ring, prism rollers). For the second, deeper pass, generally open rollers (e.g. cage, STS, cam ring, cutting edge rollers) are sufficient. In the case of prior basic tillage, the latter neutralize weather extremes better by interrupting the capillarity of the soil under very dry conditions, by reducing evaporation, and by providing sufficiently coarse pores (7 to 10% coarse pores) under moist

soil conditions, which guarantee quick drying.

If in principle two passes at different depths and at different times are planned (~ 25 to 28 l/ha of fuel), these passes should be scheduled within the cultivation time window of four to six weeks such that glyphosate application is not necessary. If stubble and basic tillage are combined in one pass, the selection of cultivator shares and end rollers as well as the time of glyphosate application must be precisely coordinated:

- Glyphosate four to five weeks after the harvest => cultivator pass three to six days before drilling
- Cultivator pass in the first two weeks after the harvest => glyphosate three to four days before drilling.

If in addition different kinds of soil with varying degrees of soil moisture and different straw yields must be considered, cultivators with hydraulically adjustable tine fields suggest themselves. These implements are an established part of precision farming and are going to gain in importance in the future.

What would a universal implement have to look like?

If a universal implement for stubble and basic tillage is sought, the first choice would be a cultivator with a share change system, different reconsolidation rollers without a chassis function, a hydraulically adjustable tine field, and stone protection tines. This implement does not have to be designed for general subsoil cultivation because this kind of cultivation is required only very rarely after careful analysis of the soil structure.

Conclusion

In principle, the following rule applies to a tight crop sequence with a concentration on winter cereals: The more work is saved in straw management as well as stubble and basic tillage, the more work-intensive secondary tillage and drilling must be in order to guarantee reliable crop establishment. Thus, the expenses for labour and machinery can only be reduced to a small extent.

If one considers tillage in the crop sequence, summer crops after cereals as well as cereals after leaf crops are far less demanding with regard to harvesting technology because a long time is available for the rotting of residues or quick degradability is given due to a very close C-N ratio. Here, loosening depth must be adapted more to the repair of soil compaction and less to the even incorporation of large harvest residue quantities. If the harvest took place under dry conditions, topsoil-deep loosening can be dispensed with.