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Soil Cultivation and Sowing

Definitions of Soil Cultivation and Sowing Systems

KTBL

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1 Introduction

The aim of soil cultivation is to create optimal conditions for germination and growth of the type of crop to be planted through a physically favourable soil structure. This is achieved with the aid of a wide range of equipment that meets the needs of the crops and is suited to the soil conditions.

2 Definitions of Soil Cultivation and Sowing Systems

Based on the equipment available, operations have evolved according to the following criteria:

- Operation sequence (primary tillage, seedbed preparation),
- Effect on the soil structure (loosening/inverting, loosening/mixing, loosening, cutting, ridging) and
- Equipment used (plough, cultivator …).

Soil cultivation can be carried out with or without inverting the soil. Sowing can be carried out after or combined with cultivation or as direct sowing without cultivation.

Cultivation systems can include primary tillage, seedbed preparation and sowing (Fig. 1).

Inversion tillage

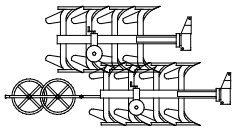
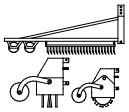
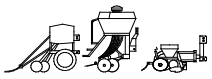
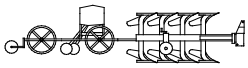
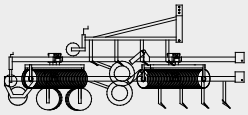
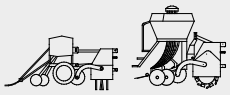
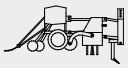
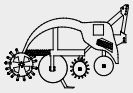
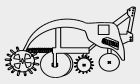
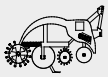
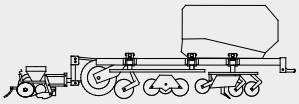
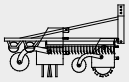
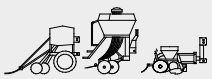
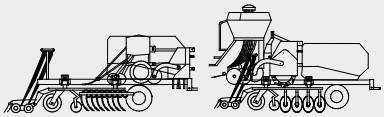
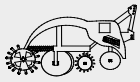
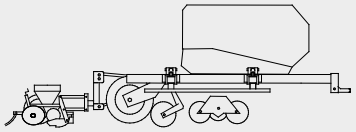
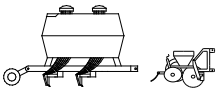
Inversion systems have the most intensive tillage level. Here the level of disturbance of the topsoil down to a depth of 35 cm is very high. Here primary tillage is carried out using inversion implements. A mouldboard plough is a typical example of such a tool.

Non-inversion tillage

Non-inversion systems are less labour-intensive due to their loosening and mixing function. Non-inversion systems are classified into systems that loosen the soil to a depth of up to 25 cm and systems with no loosening function, in which the actual primary tillage is not included and the working depth is limited to 10 to 15 cm.

Direct sowing

Direct sowing is the system with the least intensive cultivation. Seed placement is carried out without previous tillage in the undisturbed soil. Sowing is carried out on less than 1/3 of the row width. Cultivation depth is the seed placement depth.

Method		Primary tillage (intensive loosening)	Seedbed preparation	Sowing	Sequence of operations
Inversion tillage					Separate primary tillage, seedbed preparation and sowing
					Combined primary tillage, seedbed preparation and sowing
					All operations combined
Non-inversion tillage	with loosening				Separate primary tillage, seedbed preparation and sowing
					Combined primary tillage, seedbed preparation and sowing
					All operations combined
					Separate partial[1)] primary tillage, seedbed preparation and sowing
					Partial[1)] primary tillage and seedbed preparation combined, separate sowing
					All partial[1)] operations combined
	without loosening				No primary tillage, separate seedbed preparation and sowing
					No primary tillage, combined seedbed preparation and sowing
					No primary tillage, separate partial[1)] seedbed preparation and sowing
					No primary tillage, combined partial1) seedbed preparation and sowing
Direct sowing					No tillage, less than 1/3 of the row width cultivated, cultivation depth is seed placement depth

[1)] Less than 50 % of the total area is cultivated. Plant residues are left on the untilled soil surface all year round.

Fig. 1: Overview of the cultivation and sowing methods Source: KTBL 2015

3 Description and Mode of Operation of the Machinery and Implements for Soil Cultivation and Sowing

Machinery and Implements for Stubble Cultivation

Stubble cultivation (Fig. 2) is only a shallow cultivation method to loosen, mix or invert the soil after harvesting to promote the emergence of volunteer grain and weed seeds, with a cultivation depth of up to 15 cm. It is assumed that the implements are used as intended. Within the non-inversion method, all further operations with an operation depth of more than 10 cm represent primary tillage.

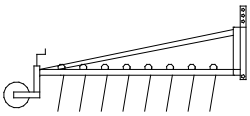
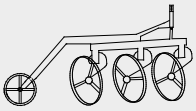
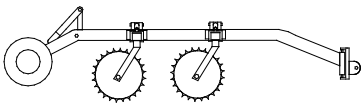
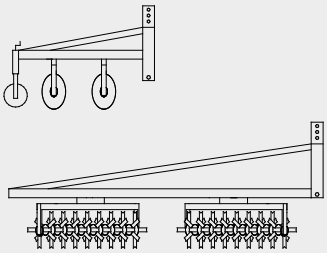
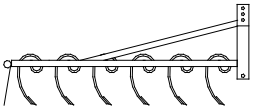
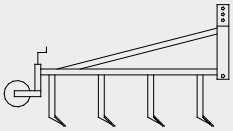
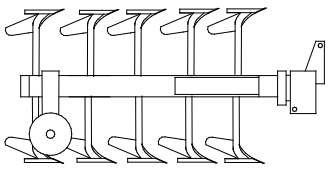
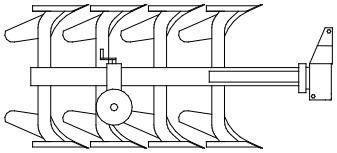
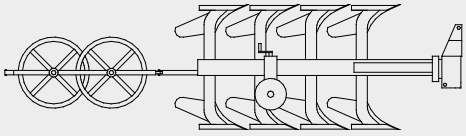
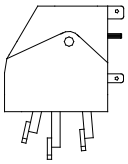
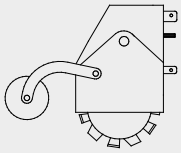
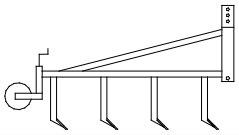
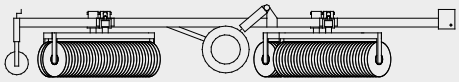
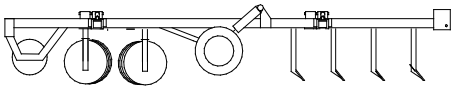
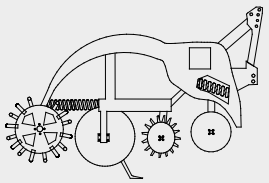
Pictogram	Description	Mode of operation
	Weeder Rotary weeder	Mixing, very shallow stubble cultivation Even spreading of the straw covering The implement reduces covering of the surface with organic residues by 5 %
	Ring cutter	Loosening and mixing, non-inversion stubble cultivation The implement reduces covering of the surface with organic residues by 10 %
	Knife roller	Crushing, cutting and mixing effect on organic residues The implement reduces covering of the surface with organic residues by 10 %
	(Short) Disc harrow Spade roller harrow	Mixing, non-inversion stubble cultivation The implement reduces covering of the surface with organic residues by 40-60 %
	Fine cultivator	Loosening and mixing, non-inversion stubble cultivation (shallow) The implement reduces covering of the surface with organic residues by 20-40 %
	Heavy-duty cultivator	Loosening and mixing, non-inversion stubble cultivation (deep) The implement reduces covering of the surface with organic residues by 50-75 %
	Skim plough	Inversion stubble cultivation Little covering with plant residues on the surface (on < 10 % of ground covering)

Fig. 2: Machinery and implements for stubble cultivation

Machinery and Implements for Primary Tillage

Primary tillage (Fig. 3) is a loosening, mixing or inverting form of cultivation with a cultivation depth between 15 cm and 35 cm. Primary tillage takes place prior to seedbed preparation and sowing. It is assumed that the implements are used as intended.

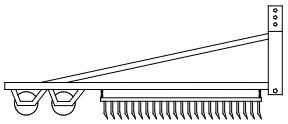
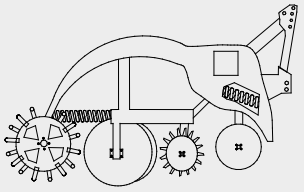
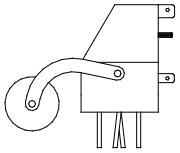
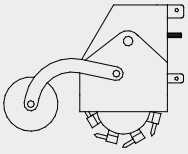
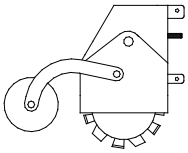
Pictogram	Description	Mode of operation
	Plough	Loosening and mixing, inversion stubble cultivation Intensive soil cultivation, very little covering with plant residues on the surface
	Plough with packer	Loosening and mixing, inversion primary tillage with consolidation and breaking of clods Intensive soil cultivation, leaving very little covering with plant residues on the surface Crumbling and consolidation through trailing packer
	Spading machine	Loosening and mixing, non-inversion primary tillage The implement reduces covering of the surface with organic residues by 85 %
	Deep tiller	Loosening and mixing, non-inversion primary tillage with driven tools The implement reduces covering of the surface with organic residues by 85 %
	Heavy-duty cultivator	Loosening and mixing, non-inversion primary tillage The implement reduces covering of the surface with organic residues by 50-75 %
	Disk harrow	Loosening and mixing, non-inversion primary tillage The implement reduces covering of the surface with organic residues by 40-60 %
	Cultivator-disk harrow combination	Loosening and mixing, non-inversion primary tillage The implement reduces covering of the surface with organic residues by 70-85 %
	Strip tiller	Partial/strip-wise[1)] loosening, non-inversion primary tillage - strip-wise cultivation of the seed rows before sowing Less than 50 % of the total area is cultivated. Plant residues are left on the untilled soil surface all year round The implement reduces covering of the surface with organic residues by 60-70 %

[1)] Less than 50 % of the total area is cultivated. Plant residues are left on the untilled soil surface all year round.

Fig. 3: Machinery and implements for primary tillage

Machinery and Implements for Seedbed Preparation

Seedbed preparation or secondary tillage (Fig. 4) is limited to an operation depth of 5-10 cm. The seed horizon is crumbled finely, loosened and reconsolidated to ensure optimal seed germination. It is assumed that the tools are used for the designated purpose.

Pictogram	Description	Mode of operation
	Seedbed combination	The seed horizon is loosened and crumbled with towed, not driven implements and reconsolidated with a roller. The implement speed of 2-3 m/s is equivalent to a driving speed of 7-10 km/h
	Strip tiller	The seed horizon is partially/strip-wise[1)] loosened and crumbled with towed, not driven implements and reconsolidated with a roller. The implement speed of 3-4 m/s is equivalent to a driving speed of 10-15 km/h The implement reduces covering of the cultivated surface with organic residues by 50-60 %
	Rotary harrow (tines straight or trailed), Rotary cultivator (tines on the grip)	The seed horizon is loosened and crumbled with driven implements operating around a vertical axis, and reconsolidated with a roller. The implement reduces covering of the surface with organic residues by 30 % (rotary harrow); by 50 % (rotary cultivator) The implement speed is equivalent to the driving speed in interaction with the circumferential speed of 3-6 m/s
	Tine rotor	The seed horizon is loosened and crumbled with driven implements operating around the transverse axis and reconsolidated with a roller The implement reduces covering of the surface with organic residues by 50-75 % The implement speed is equivalent to the driving speed in interaction with the circumferential speed of 4-8 m/s
	Tiller	The seed horizon is loosened and crumbled with driven implements operating around the transverse axis, and reconsolidated with a rolle The implement reduces covering of the surface with organic residues by 50-75 % The implement speed is equivalent to the driving speed in interaction with the circumferential speed of 4-8 m/s

[1)] Less than 50 % of the total area is cultivated. Plant residues are left on the untilled soil surface all year round.

Fig. 4: Machinery and implements for seedbed preparation

Machinery and Implements for Sowing

Sowing (Fig. 5) is the defined placement of seed at an optimal depth for the type of crop. It is carried out as row sowing, band sowing or broadcast sowing.

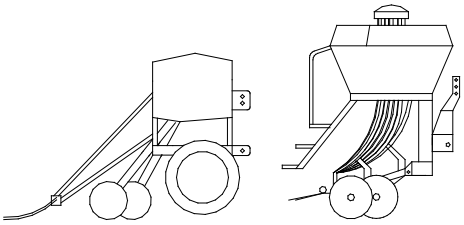
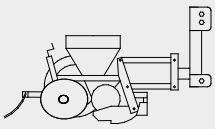
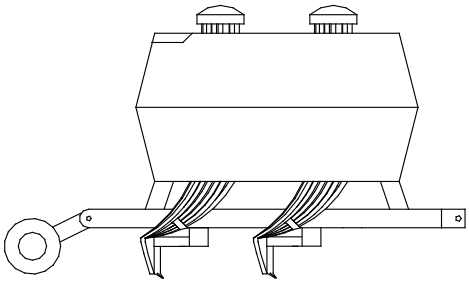
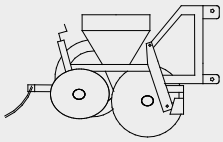
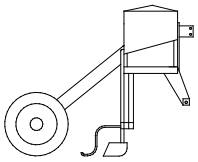
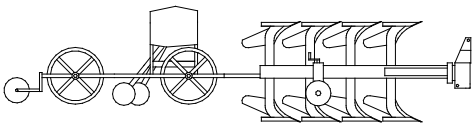
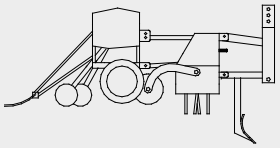
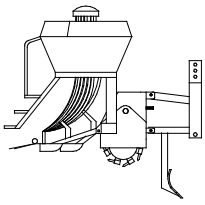
Pictogram	Description	Mode of operation
	Seed drill	Seed placement in rows or bands at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution
	Single-grain seed drill	Seed placement in rows with defined longitudinal grain spacing at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution
	Direct seed drill (no till)	Seed placement in rows or bands with no prior tillage Seed feed through dosing units and mechanical or pneumatic conveyance and distribution Soil disturbance is not more than needed for seed and fertiliser placement Sowing is carried out on less than 1/3 of the row width Cultivation depth is the seed placement depth
	Single-grain seed drill (no till)	Seed placement is carried out without previous tillage Seed placement in rows with defined longitudinal grain spacing at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution Sowing is carried out on less than 1/3 of the row width Cultivation depth is the seed placement depth
	Grassland reseeder	Seed placement is carried out without previous tillage Seed placement in rows at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution

Fig. 5: Machinery and implements for sowing

Machinery and Implements for Combined Methods

Combined methods (Fig. 6) combine several operations with each other. Some methods combine primary and secondary tillage with sowing in one operation. Other methods combine secondary tillage with sowing.

Pictogram	Description	Mode of operation
	Plough sowing	Soil inversion primary tillage with consolidation and breaking of clods Intensive tillage, leaving very little covering with plant residues on the surface Crumbling and consolidation through trailing packer Seed placement in rows or bands at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution
	Cultivator-disc harrow sowing Cultivator-disc cultivator sowing	Loosening, non-inversion primary tillage The seed horizon is loosened and crumbled with driven implements operating around a vertical axis and reconsolidated with a roller The implement reduces covering of the surface with organic residues by 50-75 % The implement speed of the driven implements is equivalent to the driving speed in interaction with the circumferential speed of 3-6 m/s Seed placement in rows or bands at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution
	Cultivator-tine rotor sowing	Loosening, non-inversion primary tillage The seed horizon is loosened and crumbled with driven implements operating around a horizontal axis and reconsolidated with a roller The implement reduces covering of the surface with organic residues by 60-85 % The implement speed of the driven implements is equivalent to the driving speed in interaction with the circumferential speed of 3-6 m/s Seed placement in rows or bands at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution

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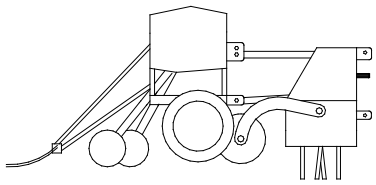
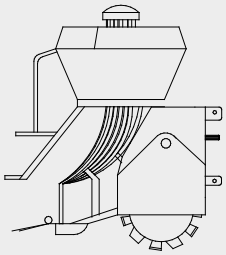
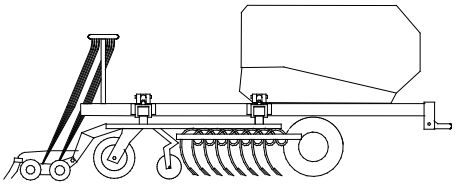
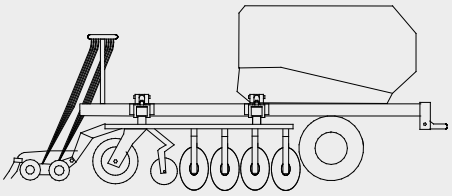
Pictogram	Description	Mode of operation
	Rotary harrow-rotary cultivator sowing	The seed horizon is loosened and crumbled with driven implements operating around a vertical axis and reconsolidated with a roller The implement reduces covering of the surface with organic residues by 35 % (rotary harrow); by 55 % (rotary cultivator) The implement speed is equivalent to the driving speed in interaction with the circum-ferential speed of 3-6 m/s Seed placement in rows or bands at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution
	Tiller sowing	The seed horizon is loosened and crumbled with driven implements operating around a horizontal axis and reconsolidated with a roller The implement reduces covering of the surface with organic residues by 50-75 % Seed placement in rows or bands at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution
	Cultivator sowing	Loosening, non-inversion primary tillage The implement reduces covering of the surface with organic residues by 55-80 % Seed placement in rows at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution
	Short disc harrow sowing	Mixing, non-inversion tillage The implement reduces covering of the surface with organic residues by 45- 65 % Seed placement in rows at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution

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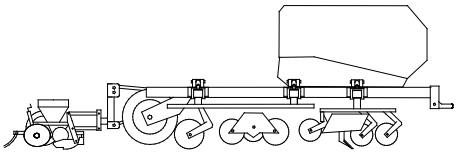
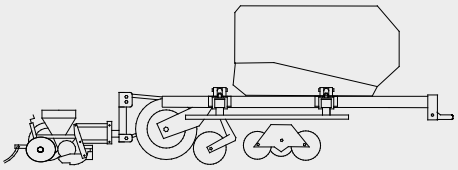
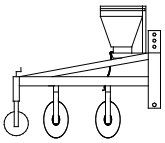
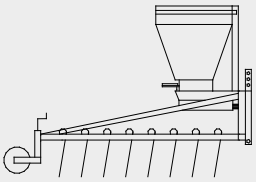
Pictogram	Description	Mode of operation
	Strip tiller[1)] with loosening mainly with precision seed sowing	Partial/strip-wise[1)] loosening, non-inversion primary tillage – strip-wise tillage of the seed rows before sowing The implement reduces covering of the surface with organic residues in strips by 60-70 % Seed placement in rows with defined longitudinal grain spacing at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution
	Strip tiller[1)] without loosening mainly with precision seed sowing	The implement reduces covering of the surface with organic residues in strips by 50-60 % Seed placement in rows with defined longitudinal grain spacing at the defined placement depth Seed feed through dosing units and mechanical or pneumatic conveyance and distribution
	Sowing into stubble	Mixing, non-inversion tillage The implement reduces covering of the surface with organic residues by 40-60 % Extensive sowing method for broadcast sowing of catch crops
	Grassland reseeding	Extensive sowing method for broadcast sowing of grass seeds Seed feed through dosing units and mechanical or pneumatic conveyance and distribution

[1)] Less than 50 % of the total area is cultivated. Plant residues are left on the untilled soil surface all year round.

Fig. 6: Machinery and equipment for combined methods

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