Soil Cultivation and Sowing
Definitions of Soil Cultivation and Sowing Systems
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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.
<table>
<thead>
<tr>
<th>Method</th>
<th>Primary tillage (intensive loosening)</th>
<th>Seedbed preparation</th>
<th>Sowing</th>
<th>Sequence of operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inversion tillage</td>
<td></td>
<td></td>
<td></td>
<td>Separate primary tillage, seedbed preparation and sowing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Combined primary tillage, seedbed preparation and sowing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>All operations combined</td>
</tr>
<tr>
<td>Non-inversion tillage</td>
<td></td>
<td></td>
<td></td>
<td>Separate partial(^1) primary tillage, seedbed preparation and sowing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Partial(^1) primary tillage and seedbed preparation combined, separate sowing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>All partial(^1) operations combined</td>
</tr>
<tr>
<td>Direct sowing</td>
<td></td>
<td></td>
<td></td>
<td>No primary tillage, less than 1/3 of the row width cultivated, cultivation depth is seed placement depth</td>
</tr>
</tbody>
</table>

\(^1\) 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.

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Description</th>
<th>Mode of operation</th>
</tr>
</thead>
</table>
| ![Weeder](image) | 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](image) | Ring cutter | Loosening and mixing, non-inversion stubble cultivation  
The implement reduces covering of the surface with organic residues by 10 % |
| ![Knife roller](image) | Knife roller | Crushing, cutting and mixing effect on organic residues  
The implement reduces covering of the surface with organic residues by 10 % |
| ![Disc harrow](image) | (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](image) | 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](image) | 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](image) | 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.

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Description</th>
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</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Plough" /></td>
<td>Plough</td>
<td>Loosening and mixing, inversion stubble cultivation. Intensive soil cultivation, very little covering with plant residues on the surface.</td>
</tr>
<tr>
<td><img src="image" alt="Plough with packer" /></td>
<td>Plough with packer</td>
<td>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.</td>
</tr>
<tr>
<td><img src="image" alt="Spading machine" /></td>
<td>Spading machine</td>
<td>Loosening and mixing, non-inversion primary tillage. The implement reduces covering of the surface with organic residues by 85%.</td>
</tr>
<tr>
<td><img src="image" alt="Deep tiller" /></td>
<td>Deep tiller</td>
<td>Loosening and mixing, non-inversion primary tillage with driven tools. The implement reduces covering of the surface with organic residues by 85%.</td>
</tr>
<tr>
<td><img src="image" alt="Heavy-duty cultivator" /></td>
<td>Heavy-duty cultivator</td>
<td>Loosening and mixing, non-inversion primary tillage. The implement reduces covering of the surface with organic residues by 50-75%.</td>
</tr>
<tr>
<td><img src="image" alt="Disk harrow" /></td>
<td>Disk harrow</td>
<td>Loosening and mixing, non-inversion primary tillage. The implement reduces covering of the surface with organic residues by 40-60%.</td>
</tr>
<tr>
<td><img src="image" alt="Cultivator-disk harrow combination" /></td>
<td>Cultivator-disk harrow combination</td>
<td>Loosening and mixing, non-inversion primary tillage. The implement reduces covering of the surface with organic residues by 70-85%.</td>
</tr>
<tr>
<td><img src="image" alt="Strip tiller" /></td>
<td>Strip tiller</td>
<td>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%.</td>
</tr>
</tbody>
</table>

\(^1\) 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.

<table>
<thead>
<tr>
<th>Pictogram</th>
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</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Seedbed combination" /></td>
<td>Seedbed combination</td>
<td>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</td>
</tr>
<tr>
<td><img src="image" alt="Strip tiller" /></td>
<td>Strip tiller</td>
<td>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%</td>
</tr>
<tr>
<td><img src="image" alt="Rotary harrow" /></td>
<td>Rotary harrow (tines straight or trailed), Rotary cultivator (tines on the grip)</td>
<td>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</td>
</tr>
<tr>
<td><img src="image" alt="Tine rotor" /></td>
<td>Tine rotor</td>
<td>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</td>
</tr>
<tr>
<td><img src="image" alt="Tiller" /></td>
<td>Tiller</td>
<td>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</td>
</tr>
</tbody>
</table>

\(^1\) 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.

<table>
<thead>
<tr>
<th>Pictogram</th>
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</tr>
</thead>
</table>
| ![Seed drill](image) | 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](image) | 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](image) | 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](image) | 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](image) | 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.

<table>
<thead>
<tr>
<th>Pictogram</th>
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</tr>
</thead>
</table>
| ![Plough sowing](image1.png) | 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](image2.png) | 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](image3.png) | 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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<table>
<thead>
<tr>
<th>Pictogram</th>
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<th>Mode of operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Rotary harrow-rotary cultivator sowing" /></td>
<td>The seed horizon is loosened and crumbled with driven implements operating around a vertical axis and reconsolidated with a roller</td>
<td>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 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</td>
</tr>
<tr>
<td><img src="image" alt="Tiller sowing" /></td>
<td>The seed horizon is loosened and crumbled with driven implements operating around a horizontal axis and reconsolidated with a roller</td>
<td>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</td>
</tr>
<tr>
<td><img src="image" alt="Cultivator sowing" /></td>
<td>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</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Short disc harrow sowing" /></td>
<td>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</td>
<td></td>
</tr>
</tbody>
</table>

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### Soil Cultivation and Sowing

<table>
<thead>
<tr>
<th>Pictogram</th>
<th>Description</th>
<th>Mode of operation</th>
</tr>
</thead>
</table>
| ![Strip tiller with loosening mainly with precision seed sowing](image1) | 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\(^1\) with loosening mainly with precision seed sowing |
| ![Strip tiller without loosening mainly with precision seed sowing](image2) | 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 | Strip tiller\(^1\) without loosening mainly with precision seed sowing |
| ![Sowing into stubble](image3) | 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 | Sowing into stubble |
| ![Grassland reseeding](image4) | Extensive sowing method for broadcast sowing of grass seeds  
Seed feed through dosing units and mechanical or pneumatic conveyance and distribution | Grassland reseeding |

\(^1\) 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
Soil Cultivation and Sowing

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