



Lines after stubble ploughing, subsoiling and levelling by shallow tillage

Preparing the land

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A comprehensive diagnosis of the land potential to bear trees (studying the soil, climate, topography, etc.) allow farmers to choose the appropriate species to plant. It also helps identify appropriate soil cultivation operations to be carried out before planting.

This preparatory work aims to reduce or eliminate the crop residues (stubble ploughing), to control the grass development next to the trees to encourage a fast and deep expansion of their root system while improving water supply and soil aeration (subsoiling) and to level the ground before planting. These operations will greatly impact the growth and reduce the mortality of the trees, therefore the increasing overall productivity and profitability of the agroforestry system.



This decompactor with 3 teeth is fissuring the ground to a depth of 40 cm

Preliminary weeding

The young trees have a low tolerance to grass competition which causes a reduction of growth and a high mortality. The soil at the base of each seedling has to remain completely clean on a 1 m² area for a minimum of three years. **It is easier to remove the invasive grasses before planting the trees than afterwards.** Several soil cultivation operations can help with this objective and can be selected according to the context (weed pressure, type of soil, etc.).

Stubble ploughing is the first tillage operation to start with on any soil with abundant grass cover. This is done using a disk or a tooth stubble plough (chisel), preferably during summer time, and will mix up the soil surface without turning it over. It is a solid technique to control grass spread and to clear the surface of the soil before carrying out later steps of the project (planting and mulching of the trees). A 5 to 8 cm deep tillage is keeps more residues on the surface compared with a tillage between 10 and 15 cm. The former will carry a lower risk of soil erosion.

The **false seedbed technique** is usually used in arable crops and consists of several surface cultivation operations done before sowing. This will encourage germination of seeds from previous crops and weeds. A second tillage 3 to 4 weeks later will destroy the emerging plants. In general, the seedbed technique decreases the seed density of the main weed species without eliminating them entirely from the soil seedbank. Efficient on annual species (rape, cereals, ray-grass, etc.), it is ineffective on perennials (bindweed, thistles, rumex, quackgrass), making it not appropriate to every context. As with every soil cultivation operation these are costs associated with fuel use and increased risk of soil compaction and these should be assessed prior to use.

Ploughing can be used to deal with contexts where weed pressure is high. Most of the weeds germinate in the first 2 cm of the soil. If buried deeper by ploughing some of them will lose their ability to germinate within one to three years. However, this effect is limited to broadleaf weeds.



Subsoiling

Subsoiling is a deep tillage that does not mix or turn the soil over. Unlike the decompacting tillage that works on the arable layer (from 15 to 40 cm in general, but usually 20 to 30 cm), subsoiling is affecting the deeper layers of the soil, that are rarely cultivated (> 60 cm depth). This operation is carried out using a subsoiler during the dry season on a crumbly or hard soil (except if the soil is a clayey one).

The main goal of the subsoiling is to facilitate the expansion of the trees roots in-depth. The hard, compact and impermeable layer under the arable layer (compact pebbly bed, hardpan, calcareous tufa, plough-sole) cannot be considered as arable layer and limits the root growth, which can impact the strength of the tree. These layers remain a barrier for the air and water circulation causing a clogging by water stagnation in the superficial layers during winter and rainy seasons.

What is a plough pan?

A plough pan is a compacted soil layer created under the ploughshare and located at the bottom of the plough line. Regularly-ploughed soils usually present a plough pan at between 20 cm and 35 cm depth with a thickness of few centimeters.

A plough pan creates anoxic conditions (lack of oxygen), limiting the air circulation and drainage. The soil becomes more prone to waterlogging and root growth is impacted.

An adapted tool going 10 cm-deeper than the plough-pan is necessary to destroy this layer.

Subsoiling is **a fundamental step to guarantee successful establishment of the trees**, leads to soil clumps being moved and creating air pockets that are harmful to root life. Therefore, it is important that subsoiling is done early enough before planting so the soil can sink down again before the trees come.

Soil preparation is completed by a shallow tillage (<15 cm) to level the ground and make the particles thinner, facilitate the plantation, the mulching and setting of the individual tree protections.



Tooth stubble plough (chisel)



Subsoiler with a straight frame and inclined teeth (F. Gallois - CNPF)



The rotary tine harrow levels the ground effectively and makes the particles thinner

Philippe VAN LERBERGHE

The Institute for Forestry Development (IDF)
philippe.vanlerberghe@cnpf.fr
www.agforward.eu

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