Soil Tillage in the Tropics and Subtropics

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10.0 ZERO TILLAGE – DIRECT DRILLING

The development of desiccant herbicides which are deactivated in the soil (such as paraquat and diquat) and, more recently, the systemic herbicide glyphosate have made it possible to omit (under certain conditions) the soil tillage operations which are carried out basically for weed control purposes. The seed is sown directly in the unprepared soil. The first trials with this method were disappointing because of technical constraints (sowing machinery) and it was only when the triple-disc sowing machine became available that the area under zero tillage expanded rapidly in the U.K., the south of the USA, South America, Australia and other countries.

The advantages of the direct drilling system are that it:
- prevents erosion: the soil surface remains closed,
- reduces the number of operations, i.e. savings in man-hours, machine-hours and energy,
- allows correct scheduling, i.e. use of the best sowing period,
- avoids water losses by evaporation,
- conserves and, possibly, increases the amount of organic matter by reducing aeration,
- increases the water and nutrient holding capacity,
- preserves the soil structure,
- causes lower soil temperatures (less damage to seeds),
- improves the biological activities in the soil (anthropods, bacteria).

Direct drilling systems are certainly not suitable for all conditions (soil, climate) and crops. The production method has to be completely adapted to the system and, quite frequently, even the crop rotation has to be changed. The essential prerequisites for a direct drilling system are:
- sufficient water infiltration and drainage capacity in the soil;
- availability of sufficient plant residue to ensure good soil cover when erosion can be expected;
- the straw residue must be well distributed and chopped to ensure that the sowing equipment functions correctly;
- no compacted layers impede the root growth in the soil profile;
- no serious structural damage, e.g. as a result of harvest operations with heavy machinery (including transport) when the soil is wet (the soil on headlands and near the field entrance often has to be loosened);
- no perennial weeds which are hard to control;
- weed seeds and shattered grain should have had sufficient time to germinate, thus permitting succesful control. This is particularly difficult in dryland areas. Cropping in monocultures is often the only solution;
- a smooth soil surface; undulating fields (e.g. with erosion rills) should first be levelled;
- careful (usually multiple) spraying for weed control, requiring accurate adjustment of the nozzles and correctly spaced series of passes (extremely difficult);
- skilful farm management and operators; more skilled personnel required than on farms using conventional systems;
- initial favourable conditions for the crops, e.g. by higher inputs of fertilizer.

The advantages and disadvantages of direct drilling in tropical and subtropical soils have not yet been sufficiently examined. Here again, it is true to say that experience acquired in cooler areas cannot be automatically applied to tropical climates. The surface cover has a detrimental effect on temperatures in cooler climates (e.g. in the northern part of the USA, causing delay in the growth of maize) but is beneficial in

tropical areas where soil temperatures of more than 50 degrees Celsius may be found in the seed zone.

Very heavy soils and soils with poor drainage do not allow direct drilling or, at least, not without previous mechanical loosening. Direct drilling appears to be an interesting alternative for soils susceptible to erosion despite the constraints mentioned above; it is essential for the yields to remain at consistently high levels over long periods.

The zero-tillage system is best suited for grain crops; when harvesting root crops, the soil has to be manipulated which wipes out most of the advantages of this system.

It is essential that suitable herbicides are available for use with direct drilling systems.

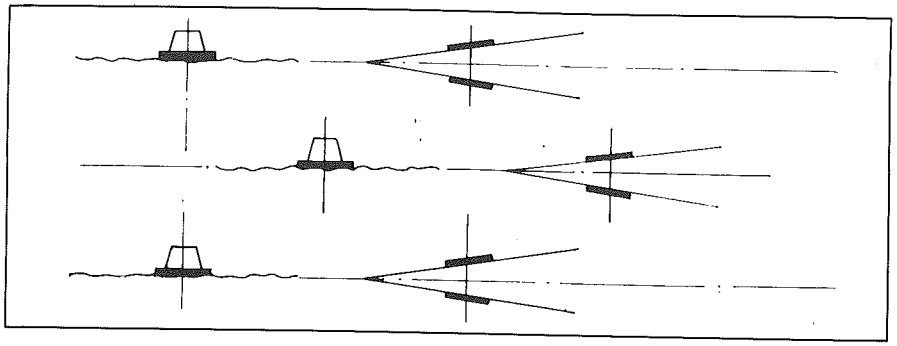

Fig. 131. Disc arrangement of a triple-disc direct drilling machine.

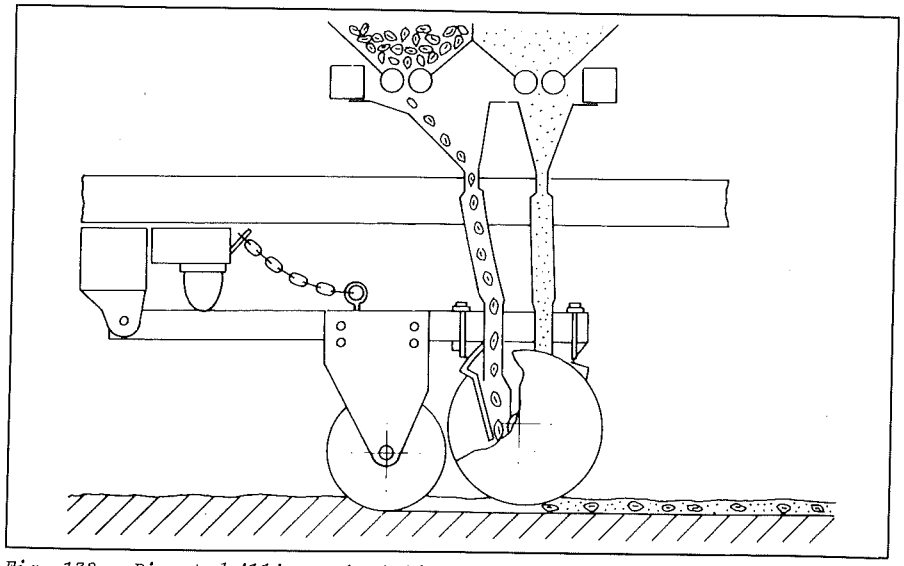

Fig. 132. Direct drilling unit (side view).

The machinery available for this system cannot be examined in detail here. The best known sowing equipment is the triple-disc machine: a front-running, usually fluted coulter cuts through plant residue and opens up the soil while a second pair of plain discs (usually spring-mounted) forming a V-shape, make the furrow (Fig. 131) in which the seeds and fertilizer are placed (Fig. 132). No special tool is used for closing the furrow. The capacity of this type of machine is about 1 ha/h with a working width of 2.5 m.

Other types of direct seeders use tined furrow openers instead of discs. On these models the tines are usually widely spaced and they may be fitted with (low pressure) press wheels to close the furrow. These machines are less expensive than the disc types but are more likely to become clogged with trash.

A rotary tiller with a tine rotor and mounted sowing equipment may also be used for direct drilling. The working sets on the rotor cut a narrow slot for each row. The machine has a lower capacity and this system cannot really be described as "no-tillage" since a (very narrow) strip is tilled.

It is vital for the direct drilling machine to perform accurately if the system is to be permanently used.

A no-tillage system may be an interesting alternative for developing coutries because the shifting cultivation technique is in many respects similar to a no-tillage or reduced-tillage system. Simple equipment for planting (jab planters, sharp sticks, small hoes) and for applying herbicides has been developed but is not generally available.

A change to "manual no-tillage" may give more satisfactory results than a switch to conventional systems with large tractors and expensive equipment but, of course, only if the above conditions are fulfilled.

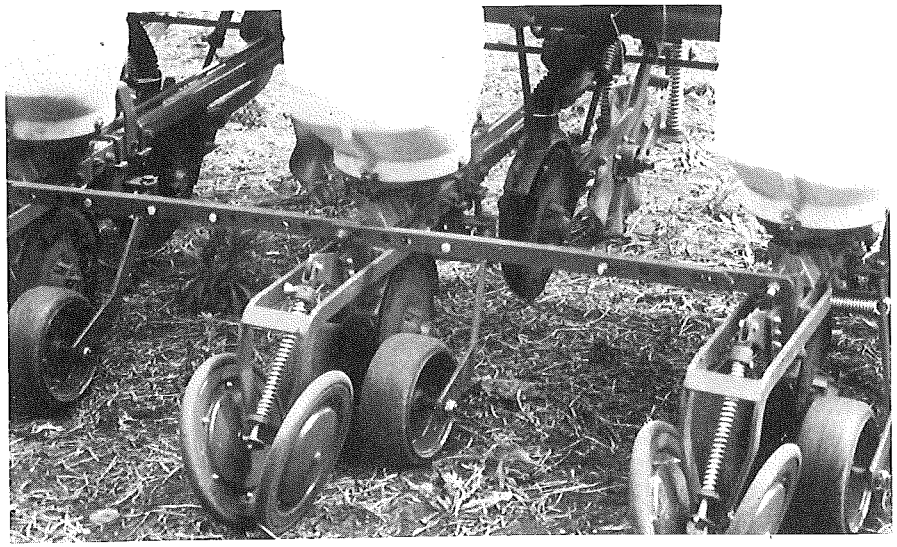

Fig. 133. Direct drilling machine.

10.0.1 Literature

An enormous volume of literature on zero or reduced-tillage systems is available and only a small selection of the most recent and most relevant literature is given below:

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11.0 TRENDS AND NEW DEVELOPMENTS