



Direct seeding equipment for tractors (Conservation Agriculture)

Source	Conservation Agriculture in FAO
Keywords	Conservation Agriculture, plants, seeding, no till, tractor
Country of first practice	General
ID and publishing year	7417 and 2014
Sustainable Development Goals	No poverty and life on land

Summary

This practice describes how direct seeding without mechanical seedbed preparation and with minimal soil disturbance since the harvest of the previous crop can benefit crops growing.

Description

Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment.

The three fundamental principles of CA are:

1. Direct planting of crop seeds,
2. Permanent soil cover, and
3. Crop diversity.

The term direct seeding is understood in CA systems as synonymous with no-till farming, zero tillage, no-tillage, direct drilling, etc. Figure 1 shows the basic design of a direct planter.

One of the advantages of direct seeding is that together with other CA practices, it increases the resilience of the agrosystem against climate associated risks. Also, farmers will benefit with the potential increase in crop yield and cost saving, allowing them to diversify investments and thus, be less vulnerable to disasters.

No till planters or seeders have either all or some of the following components:

1. Hoppers for seed (a tool to funnel seed into the furrow/soil) and, if applicable, for fertilizer with the respective metering mechanisms and delivery tubes.
2. Row cleaner, if necessary, to remove excess mulch from the plant row.
3. Cutting disc to cut through residue cover.
4. Furrow opener (a tool that makes a channel or flute in the ground) for fertilizer.
5. Furrow opener (see description above) for seeds.
6. Seed press wheel.
7. Furrow closing wheel (often in combination with depth control).
8. Furrow press wheel.

1. Components of seeders or till planters

1.1 Row cleaner

Under some circumstances, direct seeders have a row cleaner just before or combined with the cutting disc. (Figure 2). Row cleaners make the seeding more efficient under the following conditions:

- heavy or difficult mulch;
- delicate seeds; and
- in cold climates to warm up the soil.

TECA

TECHNOLOGIES
and PRACTICES
for SMALL
AGRICULTURAL
PRODUCERS



Figure 1. Basic design of a direct planter

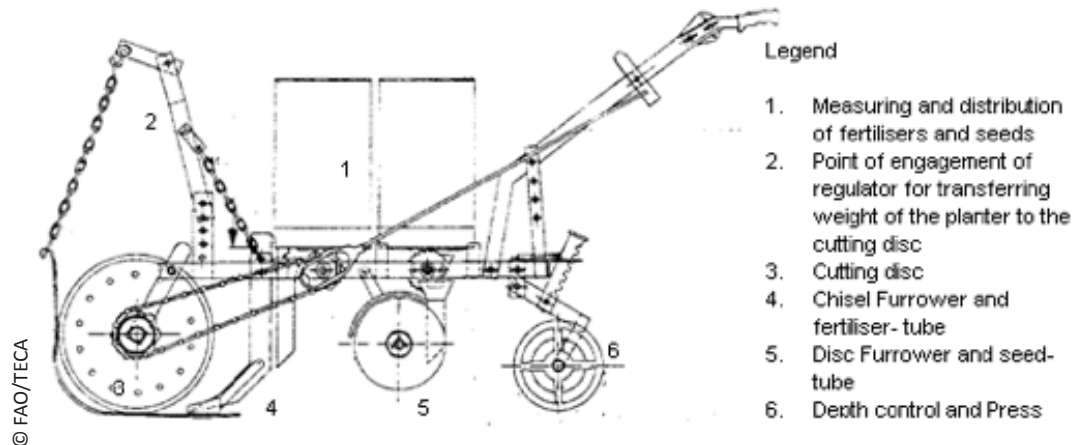


Figure 2. Row cleaner



1.2 Cutting disc

A cutting disc is usually necessary to make a clean cut through residue cover and avoid residue collection around the planter elements or the pressing of residues into the seed row.

They are particularly important with heavy residue covers and with chisel type furrow openers. The efficiency of the disc that cuts the (cover) crop residues depends on various factors. Some of these factors are:

- Soil conditions: texture, resistance to penetration, humidity and porosity.
- Straw and residue conditions: resistance to cutting, humidity, quantity and management.

- Seeder: weight and dynamics.
- Disc: size, shape and profile.

For good results it is recommended to

- work during the warmest hours of the day (after 10 in the morning);
- work when the straw is either green or completely dried, never when it is only wilted;
- operate when soil moisture is at the point of soils being friable; and
- never try to seed when more than 5 tons of dry matter per hectare is left on the surface, when using animal traction.

Inefficient cutting leads to an accumulation of residues between the different parts of the seeder and results in seed and fertilizer placement problems, i.e. irregular spacing or complete absence of seeds (Ribeira et al., 1999).

The soil needs to be firm enough to facilitate cutting through the residues, otherwise these will be pressed into the soil, resulting in hairpinning and bad soil contact for the seed. Blockage of the equipment could also result from incomplete residue cutting on soft soils (Casão and Yamaoka, 1990). The cutting discs have either smooth edges that facilitate penetration into the soil or wavy



or fluted edges if more soil movement is desired, for instance when *Fusarium* (= a large genus of filamentous fungi widely distributed in soil and in association with plants) infestation is expected and a drier soil is needed, or to improve disc rotation and avoid blockage.

1.3 Furrow opener

A furrow can either be opened by a chisel tine (long, straight piece of metal with a flat end) or hoe, single disc at an angle to the furrow, double discs or by punch type injection. Usually the furrow opener is placed just before or on the tip of the tubes that drop the fertilizer and the seeds.

The performance of the furrow opener depends on its geometric characteristics, the speed, the texture and density of the soil, the quantity of residues and the pressure placed on it by the seeder. It can take the form of:

1. A chisel tine or hoe: commonly used in soils that have a higher resistance to penetration, but these will result in more problems with clogging the implement with residues, and cannot be used in areas with stones, trunks or a lot of roots. Chisel openers, either exclusively or in combination with discs are usually preferred for lightweight no-till planters used with smaller tractors as they require less weight due to their better penetration characteristics.
2. Single discs at an angle to the furrow.
3. Double discs, either the same diameter or not and placed in an angle forming a "V" to each other. The additional effect is that residues not completely cut by the cutting disc, are cut by these discs resulting in less obstruction of the implement. The implement has less capacity to penetrate the soil, especially

in clay soils (Ribeira et al., 1999). Discs of different diameter and offset axles have better self-cleaning and penetration characteristics than those of similar diameter.

4. Other types of openers, like inverted T and cross slot.

There are different opinions about the function of furrow openers in direct planters and seeders. Some believe that the furrow opener should, while placing the seed into the soil, at the same time provide some seedbed preparation in the furrow.

The planters for this purpose often use hoe-type furrow openers and create considerable soil movement. This leads to higher draught power requirements, soil moisture losses and the germination of weed seeds might be stimulated.

Under CA it is therefore preferred to use furrow openers which are designed to create a minimum of soil movement, regardless whether they are chisel or disc type (Figure 3). Generally, there are four basic slot shapes (Baker et al., 1996):

1. V-shaped slots
2. U-shaped slots
3. Inverted T-shaped slots
4. Cross slot.

Figure 3. Till planting with hoe type furrow openers creating considerable soil movement





1.3.1 V-shaped slots

V-shaped slots are almost always created by two discs which touch in the front and open at an angle at the back. The angle of the V is usually about 10 degrees. Each of the angled discs pushes roughly an equal amount of soil sideways when both discs are at the same angle to the vertical. The biggest advantage of double discs (Figure 4 and 5) is their ability to handle surface residues, stones and minor obstacles without blockage. The construction is relatively simple and maintenance free.

Figure 4. Double disc furrow opener



© FAO/TECA

Figure 5. Detail of double disc furrow opener



© FAO/TECA

When the front edges of the two discs leave a gap open at ground level, this can cause problems with residues and soil entering. This can be avoided through:

- placing a third disc ahead of, or in between the two angled discs, which cuts the residues; or
- positioning one of the two discs forward

of the other to present a single cutting edge (offset discs); or

- replacing one of the two discs by a smaller one; the larger disc becomes the leading edge to cut the residues.

Disadvantages of V-shaped slots:

- need of high penetration forces;
- intolerance to sub-optimal soil conditions;
- tendency to 'tuck' residues into the slot (hairpinning); and
- tendency to concentrate seed and fertilizer at the base of the slot if applied in the same furrow.

1.3.2 U-shaped slots

U-shaped slots have a broader base than V-shaped slots. They are created by a variety of opener designs:

1.3.2.1 Single angled disc type openers

Single disc coulters (A blade or wheel attached to the beam of a plow that makes vertical cuts in the soil in advance of the plowshare). Characteristics: produce U-shaped slot, simple and robust, compact (often used for small grain seed drills), and good residue handling. Disadvantages are: high penetration force required, and considerable soil movement (depending on the angle).

1.2.3.2 Hoe openers

These refer to any shaped tine or chisel, which is designed to vertically penetrate the soil. Seed is delivered either down the inside of the hollow tine itself or down a tube attached to it, which is usually open at the back. The biggest disadvantage of hoe openers is the fact that they do not handle even modest levels of residues without blockage, unless a leading disc is placed ahead



of the hoe opener to cut the residues. Advantages are: low cost, they penetrate the soil better requiring less weight of the implement, they do not tuck residues into the slot, but 'brush' them sideways. And finally, they do not create smear surfaces at the sides of moist planting furrows creating a better seedbed. In contrast the disadvantages are: problems with stones and obstacles, require a good cutting disc for long residues, and considerable soil movement depending on shape and width

1.2.3.3 Inverted T-shaped

The inverted T-shaped (Figure 6) slot was developed as a result of inverting the wide-top, narrow-base of the V-shape. The main objective for the development was the ability of the implement to fold the residue-covered soil back over the slot for moisture conservation. The second objective was to find a design that would be able to handle proper fertilizer placement at the same time as seeding.

Figure 6. Inverted furrow opener



© FAO/TECA

The implement consists of a vertical shank that curves out at its base to form two wings that are inclined towards their fronts at 5-10 °C. A disc in front is used to cut the residues. Advantages are: no compaction of the soil, self-closure of the slot, maintenance of a constant seeding depth by closely following the

soil surface, and capable of seeding very superficially through reduced inclination of the wings. Disadvantages are: considerable wear on sandy soils, no proper furrow opening on loose soils, and difficult residue handling (requires a cutting disc).

1.2.3.4 The Cross-Slot

The Cross-Slot (Figure 7) furrow opener is a further development resulting from the inverted T-opener. It provides close to ideal germination conditions for the seed. It consists of a vertical cutting disc, with two small wings attached to it on both sides. The wings open a horizontal cut, in which seed is placed on one side and fertilizer on the other, separated by the vertical cut of the cutting disc. Characteristics: ideal germination conditions for seed, efficient separation of seed and fertilizer, low draught requirement, good residue handling; no hairpinning problem, considerable wear on sandy soils, and expensive.

Figure 7. Cross - slot furrow opener (detail)



© FAO/TECA

1.2.3.5 The rolling punch (Figure 8 and 9)

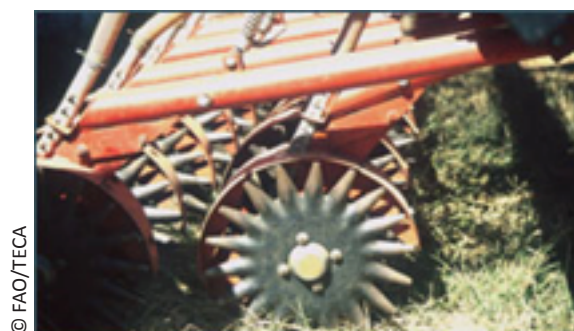
The seed is placed between the fingers of two star-wheels which are at an angle comparable to a double disc, punched into the soil and released. It handles residues quite well, but tends to clog when used in sticky soils. It is recommended for annual crops that

© FAO/TECA



fertilizer should be placed about 5 cm besides and beneath the seeds. In a direct seeder this would mean that the furrow opener for fertilizer is offset to one side of the line of work of the seeder. However, in many planters the fertilizer is placed under the seed, but in the same line.

Figure 8. Detail rolling punch injection planter



© FAO/TECA

Figure 9. Rolling punch injection planter



© FAO/TECA

The relative merits of different shapes of slots and their effect on seed germination have been discussed in the animal traction section, and should be referred to. The relevant reference is Baker et al., 1996.4. Seeders and planters: Different crops and seeds require different ways of seeding or planting. The two major types are:

- Seed drill (Figure 10): the seed is planted in a continuous band into the crop row. This method is usually used

for small grain crops like cereals. The seed is metered with feed rollers of different designs; either positioned one for each seed line and gravity fed or centrally with pneumatic distribution of the seed to the lines. The machines for this type of seeding are usually called seed drill or seeder.

Figure 10. Mechanical no-till seed drill



© FAO/TECA

- Precision planting (Figure 11): single seeds, or a predetermined number of seeds, are placed at an equal predetermined distance within the row. This method is usually used for row crops like maize, beans, cotton, sunflower etc. The number of seeds per planting hole and the distance between each planting location is determined by seed plates which have cells or chambers to meter the seed. The metering can either be mechanical or pneumatic, where the air is either as vacuum or as pressurized air used to select the number of seeds per position.

There are some modern no-till planters which incorporate both options in one machine, the seed drill and the row-crop precision planter. The farmer only has to equip the seed-drill-cum-planter with the desired number of furrow openers and connects them to the respective metering mechanism.



Figure 11. Pneumatic no-till seed drill with two central metering



© FAO/TECA

Figure 12 shows Seed drill-cum-precision planter: on top the feed rollers of the metering system for drill seed, below the boxes for the precision planting seed plates.

Figure 12. Drill-cum precision planter



© FAO/TECA

All of these designs produce some loose soil on the surface near the slot that can be used to cover the slot again. Angled disc type openers scrape soil away from the centre of the slot; hoe and furrow type openers burst the soil upwards; power tiller openers chop the soil with a set of rotating blades; and furrow openers scoop the soil out from the slot zone.

2. Upgrading of old seeders/planters into no-till seeders/planters

No-till seeders and planters often are much more expensive than conventional ones. Therefore the investment in a no-till seeder or planter might create a serious obstacle for the transition process towards CA. In

many cases the old conventional seed-drills or planters can be converted at low cost into no-till seeders or planters, either by the farmers themselves or by mechanical workshops.

For the conversion the metering systems remains the same, the planter frame might have to be reinforced and the soil engaging parts, namely the furrow openers, are replaced by new no-till units.

Figure 13 shows a modified conventional precision planter for no-till use: adding a cutting disc in front and replacing the furrow openers for fertilizer and seed.

Figure 13. Modifying conventional seed drill of no-till use



© FAO/TECA

Figure 14 shows a modified conventional seed drill for no-till use: adding new cutting discs and furrow openers and modifying the frame.

Figure 14. Modifying conventional precision planter



© FAO/TECA

Figure 15 shows the same seed drill after the finished modification. The upgrading was done by a farmer using modification kits.



Figure 15. The same seed drill after the finished modification



3. Related/Associated Technologies

- 7416; and
- 7419.

4. Objectives fulfilled by the project

- Labour-saving technology (LST)
- Resource use efficiency