



Animal traction and single-axle tractor drawn planters in Conservation Agriculture

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Summary

This practice describes how small-scale farms can use oxen-drawn for soil ripping in Kenya. This practice improves water storage capacity and the productivity of the land.

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.

1. An overview of manual direct seeder or hand jab planter

In order to speed up the process of planting, hand jab planters (or matracas in Portuguese) have been developed. It is a hand-held tool that allows the farmer to plant from a standing position and faster than with other hand tools (average 2 days per hectare). The tool comprises two long levers joined with a hinge to form a V with a pointed tip. The metal pointed tip is pushed into the soil. By closing the levers the tip is opened to release the seed and fertilizer into the soil. At the same time new seed

and fertilizer is charged into the metering mechanism. The planter is pushed into the soil at every step, allowing a regular spacing.

Disadvantages include:

- The wooden levers are sometimes too weak and easily damaged by powerful farmers.
- The planting beak becomes clogged with soil, especially when the implement is used by novices in very moist clayey soils.

1.1 Types of jab planters

There are two types of jab planters:

- with broad tip; and
- with narrow pointed tip.

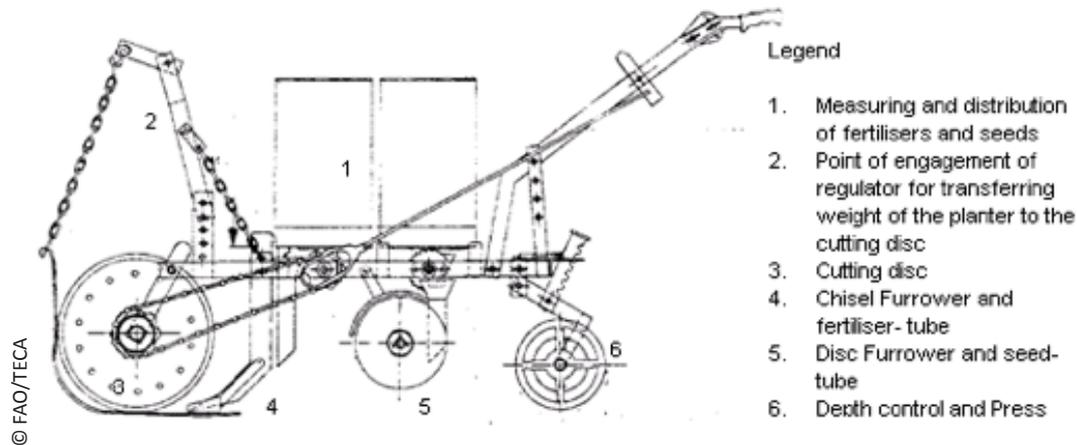
The former type is used on prepared land, for example when the planting line is ripped. The second one with the narrow pointed tips is designed for manual no-till planting and thus more recommended for conservation agriculture.

One of the modifications to the planter is a second hopper, opposite the seed hopper, for fertilizer. This allows the farmer to fertilize and plant at the same time.

If the jab planter is provided with a second hopper to apply fertilizer and seeds in one operation, it has two separate delivery tubes and points to



Figure 1. Basic design of a direct planter



make sure the seed and fertilizer are not deposited too close to each other.

2. Direct seeding

Direct seeding (Figure 1) implements for animal traction and single-axle tractors have been designed to manage residues on the soil surface and at the same time to place the seeds and possibly fertilizer in the soil.

This seeding practice favors better conservation of the soil properties due to that minimum disturbance and the preservation of residues that incorporate organic matter and improve the soil structure. The use of animal power or single axle small tractors enables small scale farmers to adopt this practice without investing in high cost machinery, and using locally available livestock as animal power or buying affordable equipment.

It is known that the improvement of soil properties is achieved with the lower disturbance and residue preservation, directly improves the crop yield under normal conditions, and makes the crop system more resilient in the event of natural disasters such as droughts or heavy rainfall.

3. Working elements of direct seeders

3.1 A disc to cut through the surface mulch and open a slot in the soil.

The efficiency of the disc (Figure 2) that cuts the cover crop residues depends on various factors.

3.1.1 Soil conditions

Texture, resistance to penetration, humidity and porosity

3.1.2 Straw and residue conditions

Resistance to cutting, humidity, quantity and management.

3.1.3 Seeder

Weight and dynamics.

3.1.4 Disc

Size, shape and profile.

3.2 Obtaining results

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
- when using animal traction, never try to



seed when more than 5 tons of dry matter per hectare is left on the surface.

Figure 2. Cutting Disc



Inefficient cutting leads to an accumulation of residues between the different parts of the seeder and results in seed and fertilizer placement problems, (Figure 3), i.e. irregular spacing or complete absence of seeds (Ribeira et al., 1999).

Figure 3. Accumulation of residues



The soil needs to be firm enough to facilitate cutting through the residues, otherwise these will be pressed into the soil, resulting in hair pinning 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.

3.2 A furrow opener (a tool that makes a channel or flute in the ground) to place the fertilizer or the seed

Furrow openers for seed and fertilizer on animal traction or micro-tractor planters are usually a chisel tine (long, straight piece of metal with a flat end) or hoe, double discs or by rolling 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 forward speed; the texture and density of the soil; the quantity of residues; and the vertical loading placed on it by the seeder.

It can take the form of:

1. A chisel tine: commonly used in soils that have a higher resistance to penetration, but results in more problems with clogging up the implement with residues, and cannot be used in areas with stones, trunks or a lot of roots. Chisels are preferred for animal drawn implements as they require less weight due to the better penetration characteristics.
2. Double discs, either the same diameter or not and offset at an angle forming a "V" to each other. The additional effect is that residues that may not have been very well cut by the main 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. If double disc openers are used at all, then offset double discs of different diameter are therefore the preferred option for animal traction planters.

4. Common furrow types

4.1 V-shaped slots

In conservation agriculture, V-shaped slots are almost always created by twin discs (Figure 4) which touch at the leading edge and are angled outwards at the rear. 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 vertical double discs is their ability to handle surface residues without blockage. The construction is relatively simple and maintenance free.

Figure 4. Planter with double disc coulters



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When the front edges of the two discs leave a gap open at ground level, this can cause problems with the entry of residues and soil. 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 as to present a single cutting edge; or
- replacing one of the two discs by a smaller one; the larger disc becomes the leading edge to cut the residues.

4.1.1 Disadvantages of V-shaped slots:

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

4.2 U-shaped slots

All of these designs produce some loose soil on the surface near the slot that can be used to cover the slot again.

Hoe and chisel 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 (Figure 5).

Figure 5. Working elements of a power tiller furrow opener



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4.2.1 Hoe type openers

Hoe type openers (Figure 6) 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.

Figure 6. Planter with hoe openers for fertilizer and seed



4.2.2 Advantages of hoe openers

- Low cost;
- they penetrate the soil better than discs, requiring less weight of the implement. This makes them the best option for animal traction;
- they do not tuck residues into the slot, but 'brush' them sideways; and
- they do not create smear surfaces at the sides of moist planting slots and so create a better seedbed.

4.2.3 Disadvantages of hoe openers

- Problems with stones and other obstacles;
- requires a good cutting disc for long residues; and
- considerable soil movement depending on shape and width.

2. The rolling punch injection

The rolling punch injection (Figure 7 and 8) is another form of furrow opener. It handles residues quite well, but tends to clog when used in sticky soils.

Figure 7. Rolling punch injection



5. Placing seed and fertilizers

For annual crops, it is recommended that fertilizer should be placed about 5 cm to the side and beneath the seeds. In a direct seeder this would mean that the opening device for fertilizer is placed outside the line of work for the seeding slot. However, in animal drawn direct seeders the fertilizer is placed under the seed, but in the same line.

Figure 8. Single rolling punch injection planter



Figure 9 shows detail of the inside of the seed hopper (A funnel-shaped container in which materials, such as grain or coal, are stored) of a direct planter, showing the seed plate and expeller to distribute the seeds.

Seed plates inside the hoppers (see the description above) control the plant density in the field. They are rotated by a transmission from one of the wheels either with a chain or gear. The distance between the soil and the delivery tube inlet defines the precision of planting. If the distance is



bigger, the chance is greater of the seeds deviating from the desired plant spacing.

Figure 9. Detail of the inside of the seed hopper of a direct planter



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Seed plates in animal traction planters can be custom made by the planter-manufacturer. To reduce seed damage, the diameter of the plate should be large enough, so that the revolution speed of the plate is not too high.

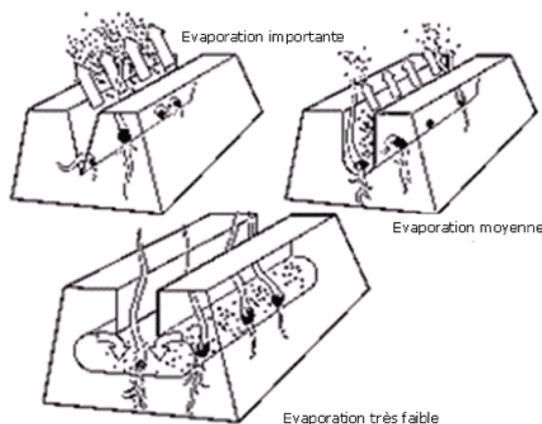
Animal traction planters with small metering discs should only be used with oxen and not with horses, as horses have higher forward speeds. Most modern animal traction planters now use standard discs designed for tractor planters, which can cope with the speed of any draught animal.

For many years, scientists have thought that the best cover for seeds is loose soil. This thinking has evolved from situations with tilled seedbeds. However, especially under dry conditions, it can be observed that seeds under mulch cover germinate better than those covered by loose soil.

Since under tilled conditions (loose soil) the macropore (A pore in soil of a large enough size so that water is not held in it by capillary attraction) system in the vicinity of the seeds is completely destroyed the soil moisture equilibrium and the capillarity is disturbed. In undisturbed soil, the soil humidity equilibrium is intact providing optimal exchange of moisture between soil particles

and pores. This allows the capillary supply of soil water to the soil surface while reducing the evaporation loss with the mulch cover. In conservation agriculture, soil moisture loss takes place in the slot, and depending on the type of slot more or less moisture is lost (Figure 10). Further details of the relative moisture-conserving benefits of the different types of slot can be found in Baker et al. 1999.

Figure 10. Moisture loss from different slot shapes



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6. Press wheels to close the slot in order to secure a good contact between soil and seed

The wheels at the back of the implement serve to press humid soil or crop residues on the slot in order to place the seed into close contact with the soil. Some seeders lack this wheel and in that case it is the operators of the planter who put the seeds into contact with the soil, as they walk on the slot.

Surface residues are an important resource for promoting seedling emergence from dry soils and it is possible to obtain more effective seedling emergence from a dry soil by direct seeding than by tillage, provided the correct technique and equipment are used. The animal traction prototype seeders (Figure 11) were originally made to plant one row at a time, but planters are now



manufactured that can seed more rows. Multi-row versions might even provide an operator's seat.

Figure 11. Two row ride on seeder for animal traction



7. Further reading

- Ribeira, M.F.S., A.G. Araújo, R. Casão Jr. and D.A. Benassi. 1999. Máquinas para semeadura direta em solos de baixa aptidão agrícola. In: Uso e manejo do solos de baixa aptidão agrícola. Muzilli and Castro Filho (Eds.) IAPAR Circular Técnica 108. p. 139-152.

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- Baker, C.J., K.E. Saxton and W.R. Ritchie. 1996. No-tillage seeding. Science and practice. CAB International, University Press Cambridge. 258 pp.

8. Related/Associated Technologies

- 7413;
- 7414;
- 7415; and
- 7417.

9. Objectives fulfilled by the project

9.1 Labour-saving technology (LST)

This practice speed up the seeding process and is not as manual seeding which is labour intensive.