

# 3

## Field preparation and planting

**C**ONVENTIONAL TILLAGE – with hand hoes, discs or mouldboard ploughs – damages the soil structure and leaves it exposed to the wind and rain. Farmers plough the soil for various reasons: to prepare a bed where seeds can germinate easily, to loosen and aerate the soil, to incorporate fertilizer, and to control weeds. But tilling at the same depth season after season creates a hardpan in the soil. Erosion results, even on moderate slopes. Tillage also cuts the amount of organic matter in the soil, so reducing soil fertility and crop yields.

Tillage has an impact way beyond the farm. Eroded soil pollutes rivers and is deposited as sediment behind dams. Tillage also releases carbon dioxide (CO<sub>2</sub>) into the atmosphere, adding to climate change and global warming.

Conservation agriculture avoids these problems. It reduces the amount of tillage, and can even eliminate it altogether when seeds are planted directly into the soil. It maintains a cover of vegetation or mulch on the surface. It raises the organic matter content of the soil, improving fertility and reducing the amount of CO<sub>2</sub> that is produced. It protects the soil from erosion, so helps keep rivers free of silt.

This chapter describes how to prepare your field and plant crops when using conservation agriculture. It shows how to do conservation agriculture with the simplest equipment (a hoe and a piece of string), as well as with animal-drawn equipment or with a tractor.

- The chapter first describes how to remove problems such as **compacted soil, hardpans** and **ridges and furrows** before you start using conservation agriculture.
- It then describes several ways of preparing the field for planting: using **planting basins, planting spots, and ripping**.
- It goes on to describe various ways to plant seeds: using **planting basins, a planting stick, a jab-planter, and animal- and tractor-drawn planters**.
- Finally, the chapter describes how to make sure you are using the **right amount of seed and fertilizer**.

## Before starting conservation agriculture

Before you start with conservation agriculture, you may have to deal with various types of soil problems. Three of the most common problems are:

- **Compacted soils**
- **Hardpans**
- **Ridges and furrows.**

The next few pages tell you how to deal with each of these problems.

You may also want to combine conservation agriculture with other techniques, such as **terraces** and **water-harvesting** methods. For example, if soil erosion is a serious problem in your field, you should deal with it before starting conservation agriculture. [See Chapter 8](#) for some ideas on how to do this.

## Compacted soils

Compacted soils have a hard, dense layer at or near the surface. It is difficult for water to move through this layer, and for seedlings to grow in it.

Soils may be compacted when tillage destroys the soil structure by breaking down the natural system of pores and channels. The soil can then be compacted more easily by heavy rainfall, animals' hooves, and wheels of tractors and carts.

- **Heavy rainfall** on a tilled soil compacts the surface and may form a crust. This crust can prevent seedlings from growing and reduces infiltration by rainwater. The water then runs off, causing erosion.
- **Animals' hooves** compact the top 5 cm of the soil.
- **Tractor wheels** compact the soil at a depth of 10–15 cm.

All soils may become compacted. Sandy soils can be compacted over time because they do not swell and shrink like clay soils. But the problem is more serious in clay soils if they are compacted when wet.

Compacted soils make it hard for crop roots to grow and to reach water and nutrients. They prevent water and air from moving into the soil. This can lower yields and make crops more susceptible to drought. If the soil is compacted, it is harder to till.

If your soil is compacted, you should loosen it before starting with conservation agriculture. See below for how to do this.

**Mulch** protects the soil surface from heavy rain and stops a crust from forming. It also helps reduce compaction by animals and equipment. By not ploughing, the pores and channels made by roots, earthworms and other soil life are preserved. They let water and air move into the soil – which is good for crops.

## Hardpans

A hardpan is a dense layer in the soil that is difficult for water and roots to penetrate. Hardpans can form in two main ways:

- If the soil is ploughed or hoed at the **same depth** season after season.
- If the soil is **clayey**, hardpans can form naturally without any ploughing.

Hardpans prevent water from moving downwards in the soil. The water is trapped above the hardpan, resulting in waterlogging. This may damage or kill the crop.

Hardpans also prevent roots from growing downwards. The roots may be shorter than usual or bent sideways. They cannot reach nutrients and water deep in the soil, so the crop may be starved of food and may dry out quickly in a drought.

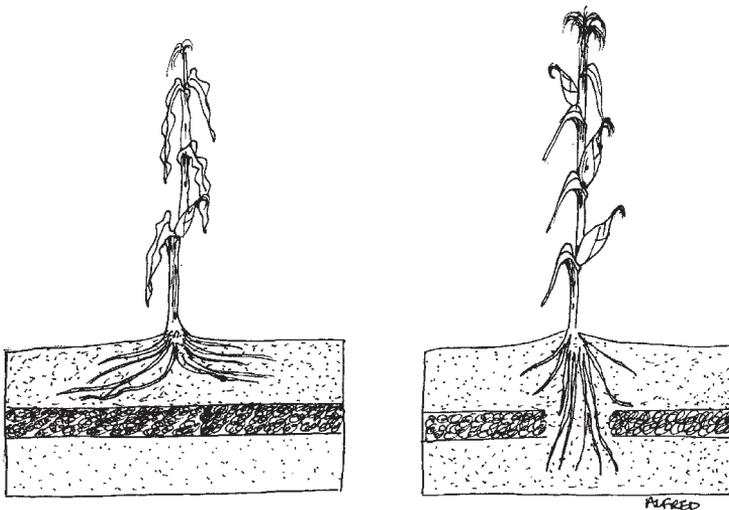
If your soil has a hardpan, you should break it in order to get good yields. See below for how to do this.

## How to tell if a soil has a hardpan

Check for the following signs.

- **Stunted, uneven crops** Crops may grow poorly because their roots cannot reach down to nutrients in the soil.
- **Yellow leaves** Yellow leaves and other signs of nutrient deficiencies (purple leaves, stunting, brown leaf edges, etc.) may be caused by poor rooting systems.
- **Rapid wilting** Crops may wilt quickly during dry periods as the surface layers of the soil dry out.
- **Distorted roots** Dig up plants and look at their roots. If they grow sideways at a certain depth, there is probably a hardpan ([see Photo 18](#)).
- **Waterlogging** Puddles on the surface after heavy rains mean that water cannot drain down into the soil easily – perhaps because of a hardpan.

To check if a soil has a hardpan, use a hoe or spade to dig a small pit about 30 cm (1 foot) deep. You should be able to tell the depth where it becomes much



*Roots deformed by a hardpan (left). The roots cannot reach water and nutrients in the soil beneath the hardpan. The crop is stunted, and wilts easily. Breaking the hardpan (right) enables water and roots to reach down deeper into the soil.*

harder to dig. If you find it difficult to dig, roots will probably find it hard to grow downwards too. Push a knife blade into the side of the pit at various depths. A hardpan will make it difficult to push the knife in and pull it out again.

## Treating compacted soils and hardpans

Loosening the soil and breaking the hardpan allow crop roots to penetrate deeper into the soil and reach more nutrients and water.

There are four main ways to loosen the soil and break up a hardpan:

- Using a **ripper**
- Using a **subsoiler**
- Using **planting basins**
- Sowing a strong-rooted **cover crop**.

If your soil has a hardpan, make sure you break it up when you first switch to conservation agriculture. If you do not, then your crops will not grow well. You may have to deal with it again in the near future. That can be expensive and take a lot of time.

### ***Ripping***

If the soil is fairly light, and if the compaction or hardpan is near the surface, you can use a ripper to loosen the soil.

A ripper is a chisel-shaped implement pulled by animals or a tractor. It breaks up surface crusts and opens a narrow slot or furrow in the soil, about 5–10 cm deep. Unlike a mouldboard plough, a ripper does not turn the soil over. You can rip the soil during the dry season, or at planting time. If you rip at planting time, you can sow seeds in the slot by hand, or using a planter attached to the ripper.

[See page 47](#) for more information on ripping.

### **Do's and don'ts when ripping and subsoiling**

- Use the subsoiler when the ground is dry to crack and shatter the hardpan.
- Follow the contours when subsoiling or ripping. This encourages water to infiltrate into the soil rather than running off.
- Always dig a soil pit to see whether there *is* a hard pan, and how deep it is. Then work with the subsoiler to slightly below this depth.
- Don't use the subsoiler when the soil is wet

## Subsoiling

If the hardpan is deeper or if the soil is heavy, you may have to use a subsoiler. A subsoiler is a chisel-shaped implement that looks like a ripper but works at a greater depth and has narrower tines, up to 20 cm long. It is designed to work at a depth of about 20–30 cm, just below the level of the hardpan. It breaks the hardpan and allows water to infiltrate easily into the soil.

You may need at least four strong oxen to pull a subsoiler. Subsoilers can also be mounted on a tractor. Subsoiling deep hardpans in heavy clay soils generally needs a tractor.

You do not have to subsoil every season! You may have to do it only once, when you first switch to conservation agriculture. It may be necessary to do it again periodically, once every few years. Consider hiring someone to do it for you rather than buying the equipment and doing it yourself.

## Planting basins

If you do not have draught animals or a tractor, and cannot hire them, then you may have to use a hoe to loosen the soil and break up a hardpan. The easiest way to do this is to use planting basins. Instead of hoeing the whole field, you dig basins only where you want to plant the crops. Dig the basins slightly deeper than the depth to which you normally hoe, so they break through the hardpan.

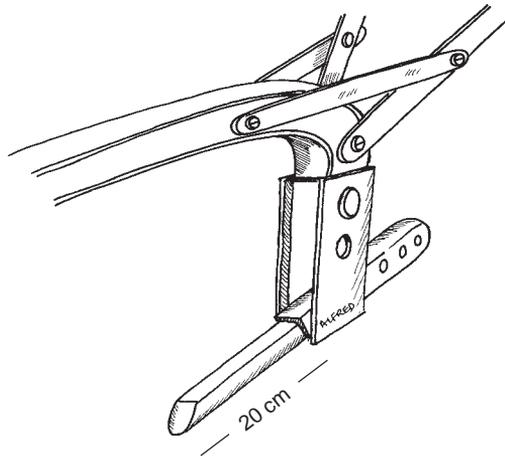
[See the next page](#) for more on planting basins.

## Strong-rooted cover crops

Some cover crops have strong roots that can help break up hardpans, especially if they are not yet too hard. These cover crops can be planted after ripping, subsoiling or digging planting basins.

Some examples of strong-rooted cover crops:

- Pigeonpea (*Cajanus cajan*)
- Sunn hemp (*Crotalaria juncea*)
- Radish (*Raphanus* spp.).



This subsoiler fits on to a standard plough beam ([like the ripper shown on page 48](#))

### Subsoiling again?

You may need to subsoil or rip your field every few years if you find your soil becomes compact or a hardpan reforms. That may happen on certain soil types, if you cannot prevent animals from grazing your field, or if you cannot keep the soil covered all the time.

Plant these crops as cover crops or in rotation with your main crop to break up a hardpan.

## Removing ridges and furrows

If you plan to use a wheeled direct planter, you should try to remove ridges, bumps and furrows from the field before starting conservation agriculture. This is because the planter's drive wheel controls when the seeds are planted. If the wheel hits a bump, it may sow too many seeds, or not enough. That will produce an uneven crop stand. Some types of sprayers may also not work well on uneven ground.

You can get rid of ridges and furrows by ploughing once, before you start conservation agriculture.

You may want to preserve ridges and furrows if you irrigate your crops, or if you use them to conserve water or control soil erosion. Remember, though, that they will make it difficult for you to use a wheeled planter.

Other structures, such as terraces and bunds, can help control erosion on slopes. Usually these structures are very useful – so keep them! [See Chapter 8](#) for more on soil conservation.

## Planting basins

You do not need a tractor, draught animals or special equipment to practise conservation agriculture. You don't need money. You can do it using just a hoe and a piece of string.

Using planting basins can work under almost all conditions in Africa. You can do it simply and easily, and you can adapt it to suit your own circumstances ([see Photos 1 and 2](#)).

Planting basins are small pits in the ground used for planting many types of crops. They are about 15 cm wide, 30–35 cm long, and 15 cm deep – about the size of a man's foot. They are best suited to areas with about 1000 mm of rain a year.

You can dig the planting basins at any time during the dry season, so they are ready for planting at the beginning of the rainy season.

Here are the basic principles. Adapt them to suit your own situation.

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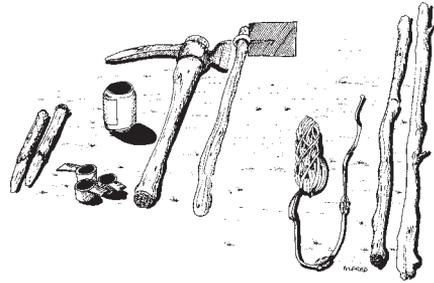
*You do not need special equipment to start using conservation agriculture. All you need is a hoe and a piece of string!*

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## Equipment

You will need the following tools:

- A **hoe** or *chaka* hoe (a type found in Zambia and Zimbabwe). It should be as narrow as possible (10 cm wide is good size).
- A long **string** (called a “*teren* rope” in Zambia). This is used to measure off the correct distance between the basins. Tie knots in the string at the plant spacing you want. (In Zambia, for example, farmers space their maize plants about 70 cm apart.) Instead of tying knots, you can clamp bottle-tops to the string at the correct intervals with pliers. Clamp them tightly so that they will not slip.
- Two **sticks** to mark the rows and to make sure the rows are parallel.
- Two strong **pegs** to hold the string at both ends.
- **Fertilizer cups** to apply fertilizer or lime.
- An empty **drink can** to apply manure.



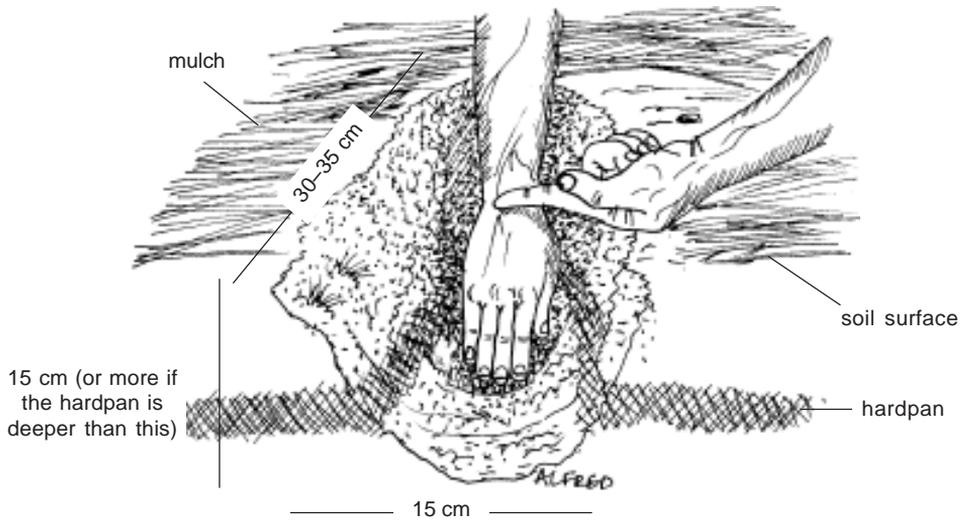
*Basic equipment needed for basin planting*

## How to make the basins

- 1 Stretch the rope across the field, at right angles to the slope, and fix both ends in place using the two pegs. Keep the string well clear of the ground so that it stays straight despite any vegetation. The knots or bottle-tops mark where to dig each basin. They act as guides for accurate spacing, since you will use the same basins again and again in the following seasons.
- 2 Starting at the first knot or bottle-top at one end of the string, dig a rectangular basin about 15 cm wide and 30–35 cm long (about the size of a man’s foot). The basin should be about 15 cm deep (about as deep as your hand). If there is a hardpan, make sure you dig deep enough to break through it.



*Digging planting basins*



*Close-up of a planting basin. The hand shows how deep the basin is: it should break through the hardpan.*

- 3 At the next knot or bottleneck, dig another basin the same size. Work backwards along the string so you do not tread on the basins you have already dug.
- 4 When you reach the end of the row, use the sticks to measure the distance to the next row. Move the pegs and stretch out the string again between them. Stagger the holes so they are not directly next to the holes in the previous row. This will help catch more rainwater and stops it from running away downslope.

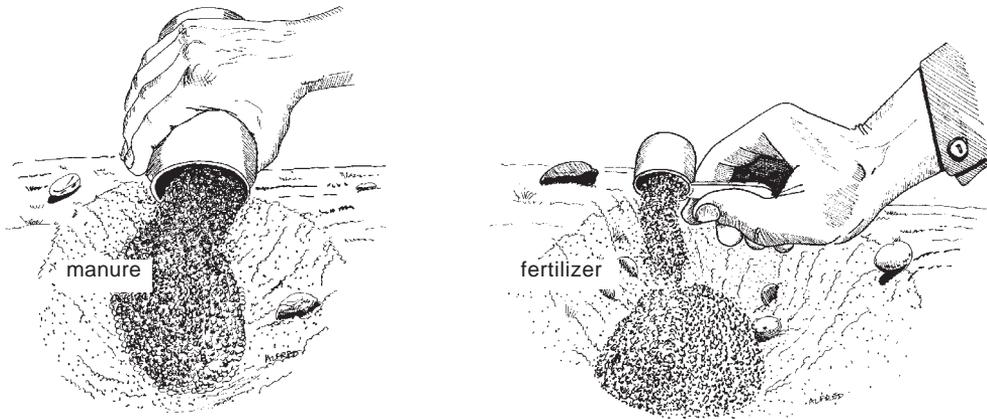
## Applying fertilizer, manure and lime

If you have dug the basins properly and spaced them correctly, you can apply fertilizer, manure and lime very precisely to avoid wastage. Do this when you plant, or about 2 weeks before (doing it beforehand speeds up planting).

- **Manure** Put 1–2 drink cans of manure in each basin. This amounts to 3–4 tons of manure per hectare.
- **Compound fertilizer** Put a small container (8 g) of compound fertilizer in each basin.
- **Lime** If your soil is acidic, put in two containers of lime as well.

After you have applied manure, fertilizer or lime, use a hoe to partially fill the basins with soil. Leave the surface about 5 cm (2 inches) lower than the original ground level so water will tend to collect in the basin.

You can also apply compound fertilizer at planting time instead of 2 weeks beforehand.



*Use containers to measure and apply organic manure and fertilizer*

- **Urea** Apply 2 containers of urea per basin. The best time to apply urea depends on the crop. For maize, apply it as a top dressing when the maize is knee high (make sure the soil is moist when you apply it).

## Planting

Deciding when to plant is one of the most important decisions a farmer has to make. The main aim is to make sure the seeds germinate quickly and evenly. Some guidelines:

- Plant seeds during heavy rain, or within 48 hours after it stops.
- Plant only if there is enough moisture for the seeds to germinate evenly. Mulching will improve the moisture level in the soil where you put the seed.
- Plant at the right depth for your crop. This helps the seeds to germinate and emerge evenly.
- Try to finish planting a field in one day.

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*Correct planting depth  
= good germination*

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## How many basins, how many seeds?

The key is to know how many plants you need per hectare. Here are 2 examples:

- In **Lesotho**, farmers aim for about 35,000 maize plants per hectare. They do not dig 35,000 basins! Instead, they dig about 17,500 basins at a spacing of 75 x 75 cm. They put 3 maize seeds in each basin. They then thin the plants back to an average of 2 per basin.
- In **Zambia**, farmers aim for 47,000 maize plants per hectare. Their spacing of 90 x 70 cm gives them about 15,500 basins per hectare. They put 4 seeds in each basin, then thin them back to an average of 3 per basin.

What do you need to know?

- What is the average **rainfall** in your area?
- What is the best **planting population** of your crop?

Below are two simple tables to help you. You can use these to calculate the spacing of your basins, and how many seeds to plant in each.

*Note:* these are only guidelines. Adapt them as needed for your area.

### How many basins?

Rainfall (mm per year)	Spacing of basins	Number of basins per hectare (rounded off)
> 1500	60 x 60 cm	27,500
1000–1500	70 x 70 cm	20,100
800–1000	75 x 75 cm	17,500
700–800	80 x 80 cm	15,500
600–700	85 x 85 cm	13,500
500–600	90 x 90 cm	12,500
< 500	100 x 100 cm	10,000

### How many seeds per basin?

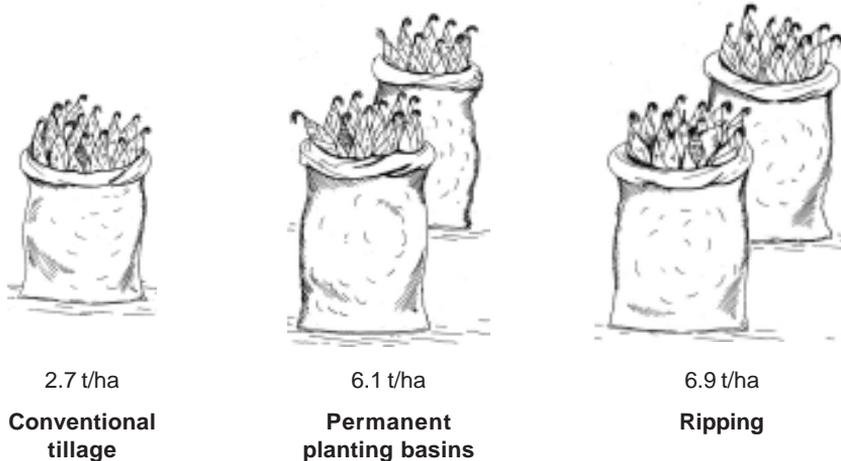
Crop	Number of seeds/basin	Planting depth
Maize	2–4 (then thin one)	2.5 cm
Sunflower	2–3 at each end of the hole	2 cm
Cotton	4–5 on each side	1 cm
Soybeans	8–12	1 cm
Groundnuts	6–10	3 cm
Cowpeas	5–7	2.5 cm
Green gram	6–8	2 cm
Sorghum	8–12	1 cm

### Do's and don'ts when using planting basins

- Remember that the basins are permanent, and you will come back to plant the same place next season, and the season after that. So take care the first time.
- Train the whole family to make the basins. Everyone in the family should understand the ideas of conservation agriculture. If they understand why and how, they can help do it.
- Don't plant in a basin which is not nearly filled with soil – the crops will drown!
- Don't dig basins during the rainy season. Hardpans are best dealt with in the dry season.

## Higher yields from basins

In an experiment in Zambia, planting basins and ripping gave more than twice the yield of conventional tillage. Over 100,000 farmers in Zambia use basins to plant their crops.



*Average maize grain yield, 2000–1 season, Zambia*

*More information: Zambia National Farmers Union, Conservation Farming Unit; Cecilia Ruben*

## Advantages

- It is easy to make and use planting basins. Elderly people, children and disabled people can all use them to grow the food they need.
- The required equipment (a hoe, string, bottle caps, drink cans) is readily available.
- You can dig the basins in advance, perhaps immediately after the harvest. This spreads the labour needs over a long period and means that planting can be done early – it is not necessary to wait for the soil to be ploughed before sowing the seed.
- Using basins makes it possible to plant early. They make weeding and applying fertilizer easier and quicker.
- Marking out the correct spacing of basins and rows gives the best plant population. Planting basins give better yields than conventional ploughing, and almost as good as rip planting (see the box above).
- Basins allow you to use the right amounts of seed and fertilizer, at the correct time. This avoids waste and saves money.
- You can use the same basins year after year. Plant a different crop in the same basins next season. The soil fertility in the basins builds up, guaranteeing a good yield.

## Disadvantages

- Making the basins takes time, especially in the first year. It is a lot more work if the soil is compacted. That may make it difficult if the family has limited labour or if some of the family members are ill.
- There may be lot of weeds in the field. It is important to deal with them promptly ([see Chapter 7](#)).

## Planting spots

If you do not have the time to dig planting basins, you can just scrape out shallow planting holes in the unploughed soil. Sow the seed in the holes, then cover them over. This approach is common throughout the Sahel (Mali, Niger, Chad, and other countries). The only equipment needed is the hand hoe and a planting stick. You can plant in the dry or just after the rains.

- 1 Dig small shallow holes at the correct distance from each other. Make the holes just deep enough to plant the seeds.
- 2 Put the correct number of seeds in the hole, and cover them with soil.
- 3 About 2 weeks after the crop emerges, use a stick to make a hole about 10 cm away from each plant. Put fertilizer into the hole.

## Advantages

- Planting spots require less labour than planting basins or conventional cultivation. That makes them an attractive option for vulnerable households.
- Planting can be done on time: there is no need to wait until the soil is ploughed.
- Planting spots do not require expensive equipment – just a hoe and a stick.

## Disadvantages

- It may be difficult to control weeds.
- Planting spots do not break a hardpan caused by hoeing at the same depth year after year. Crop roots may not grow as well as with planting basins, and less water will infiltrate into the soil.

## Ripping and planting

Ripping opens a narrow slot or furrow in the soil surface, about 5–10 cm deep. It is often used to break up a surface crust or a shallow hardpan, especially on lighter soils ([see page 39](#)). It can also be used to open a furrow for sowing seeds – either by hand or using a mechanical planter attached to the ripper itself.

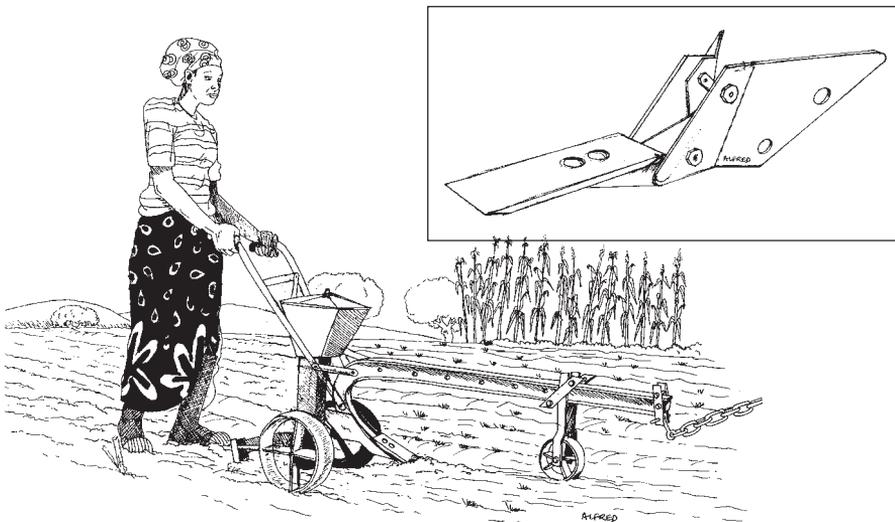
Using the ripper allows you to sow the crop earlier and faster than if you plough the soil and then plant.

If used for planting, ripped lines are usually spaced about 75 cm apart. The ground in between the rows is left undisturbed, except for controlling weeds. Rainwater concentrates in the planting lines and sinks into the soil where the crop roots are growing.

## Equipment

You will need the following:

- **A ripper** There are many variations on the basic chisel-point design, and rippers vary depending how they are made. Animal-drawn rippers made by local blacksmiths are popular in eastern Africa.



*Animal-drawn ripper with planter attachment. Inset: The Magoye ripper body with wings to make ridges. This body can be replaced by a narrower subsoiler to break up a hardpan ([see the drawing on page 40](#)).*

### Ripper with planter attachment

As the ripper-planter's wheels turn, they drive the delivery of seed and fertilizer. If the wheels skid, or if they hit a bump, the planter will apply too little seed and fertilizer (or too much). That is why it is important to remove any ridges and furrows from the field before starting conservation agriculture. Some makes of planter have wheels with strakes (spikes) to prevent skidding.

One commercially available version (the **Magoye** ripper) consists of a ripper that fits on a standard mouldboard plough beam. It also has a mechanism to sow seed, known as the **Palabana** ripper-planter.

- **Draught animals or a tractor** Ripping takes a lot of power (though not as much as ploughing), so you may need two strong oxen. You may be able to use donkeys to pull the ripper if the soil is light, if the ripper has a narrow blade, and if the ripping depth is shallow. On heavy soils or for deep ripping, you may need a tractor.
- **A planting tool** Some rippers have a planter attachment that can do both ripping and planting in a single pass. The attachment sows the seed (and perhaps applies fertilizer), then covers it over ([see Photos 7-14](#) and the [drawing on the previous page](#)). If you do not have a ripper-planter, you can sow seeds in the ripped furrow by hand, or using a machete or planting stick.

## How to do ripping and planting

It is best to do ripping when the soil is dry. That avoids compacting the soil further, and ensures that the hardpan is broken.

If the field has a cover crop, slash it (or use a herbicide to kill it). When it has dried out, you can use a ripper through the mulch. The mulch protects the soil surface from heavy rain and prevents weeds from growing.

If your field is on a slope, rip along the contour (at right angles to the slope). This will help control erosion.

Heavy clay soils will be difficult to rip when they are dry. If you are using draught oxen, feed them well beforehand so they are strong enough to pull the ripper easily. You may have to rip the field twice to make sure the soil is loosened enough. If you use four animals, you may need to make only one pass.

Ripping heavy clay soils will produce large clods, especially if the soil has been compacted. It is a good idea to leave these soils until the first rains have moistened them a little before ripping them. You can plant seeds at the same time. If clods are formed, someone should follow behind to make sure the seeds are well covered.

How far apart to space the ripped slots? This depends on the optimum row width for the crop you want to plant; about 75 cm is a common distance. Animals are generally trained to follow the previous furrow, so the row width will be determined by the length of the yoke between the animals. [See Photo 10](#) and [page 58](#) for how to adjust this.

As soon as you have ripped the soil, you can sow seeds in the ripped opening. You can use any suitable method: by hand, using a planting stick or machete, or with a planter attached to the ripper. Cover the seed after sowing so it is not eaten by birds or animals.

You can rip along the same lines season after season. If possible, plant a different crop in the row in the next season to rotate the crops.



*Animal-drawn ripper*

## Tractor ripping

Medium- and large-farmers often use tractors to rip the soil. Some small-scale farmers hire a tractor to rip their fields.

Tractor ripping is faster than with draught animals, but it needs a larger area to be profitable. Tractor ripping produces better results in heavy soils. Some tractor-rippers also have a planter attachment.

## Advantages

- Ripping attachments that fit on a normal plough beam are cheaper than complete implements.
- Rippers can be used to make planting slots in dry soil. This allows you to plant early and gives you a head start for other field operations.
- Ripping disturbs the soil less than ploughing. It reduces soil erosion and encourages water infiltration into the soil.

## Disadvantages

- Ripping needs strong draught animals or a tractor.
- Ripping is difficult if there is a lot of residue on the surface, because the residue wraps around the ripper shaft. You may have to clear it away from the lines to be ripped, or cut it into pieces to stop it from tangling around the ripper.
- Ripping disturbs quite a lot of the soil surface: up to 30%.
- It may be difficult to control weeds between the rip lines. You may need to use hoes or herbicide to get rid of weeds.

## Horticulture

You can use conservation agriculture to grow vegetables. Many vegetable crops grow well without tillage.

- **Root crops (such as carrots)** Use a pick to break the soil and make a hole so the root can grow down. Put in the seed and cover it with soil.
- **Tomatoes** These grow very well under conservation agriculture. Make a hole in the soil and put compost or manure in it. Cover the compost with a little soil, and plant your seedling in the hole.
- **Potatoes** Spread a lot of manure on the area to be planted (say, 5 m x 5 m). Place your potato seed at 30 cm intervals on top. Cover the seed with a thick layer of mulch (up to knee height). The plant and tubers will be able to grow well.

Try to apply the principles of minimum soil disturbance, soil cover and rotation in your garden. Try growing other vegetables on a small scale. Do not be afraid to make mistakes: you will quickly learn what works.

## Controlling weeds and the cover crop before planting

Conservation agriculture tries to keep the soil covered with a cover crop or with crop residues. Before you plant, you may have to kill the cover crop, along with any weeds. If you do not, they will smother your crop before it has had a chance to grow.

You can do this in many different ways:

- **Hand-pull** weeds or use a **hoe** to kill them.
- Slash weeds and the cover crop with a **machete** or **billhook**.
- Use an animal- or tractor-drawn **knife roller**.
- Apply **herbicides** with a wiper or sprayer.

[See Chapter 8](#) for how to use these different methods.

## Planting methods

You can plant seed in various ways:

- By hand in **planting basins**.
- Using a **dibble stick** or **machete**.
- Using a **jab-planter**.
- Using an **animal-drawn planter**.
- Using a **tractor-drawn planter**.

All these methods disturb the soil as little as possible, and help maintain a permanent soil cover (two of the three principles of conservation agriculture). No-till planters are designed to plant seed in the soil through the surface mulch. This makes them different from conventional planters, which are designed to work in tilled soil without surface residues.

## Hand-planting in basins

If you are using planting basins, plant seeds in the basins, add fertilizer, then cover with soil. [See page 41](#) for more information.

## Using a dibble stick or machete

You can use a planting stick or machete to make holes to plant the seed. Cut a hardwood stick from the bush, sharpen the point, and use it to make planting holes. Make the holes in lines at evenly spaced intervals. That makes it easier to weed and apply fertilizer or manure.

Adding a sharpened steel tip to the planting stick makes it last longer and easier to use. Such sticks are often available from the village blacksmith.



*A simple planting stick is all you need to direct-plant your crops*

### Reduced tillage for tef

Tef, a major grain crop in Ethiopia, has very small seeds. It cannot be planted in rip lines because the tiny seeds do not come into enough contact with the soil. Farmers often plough as many as five times in a crisscross pattern to produce a very fine seedbed. This repeated tillage encourages erosion.

One alternative is to rip the field once, in rows 75 cm apart, before the rains. This allows water to infiltrate into the soil easily. Subsoiling along the ripped lines is used to break a hardpan. On heavy black soils, subsoiling is not needed because deep cracks form on these soils in the dry season, breaking the hardpan.

The farmers then plough just once, 2–3 weeks before planting, using a *maresha* plough modified to turn the soil to one side only. They can then plant tef seeds using a sweep: an implement like a winged cultivator or a blade harrow that operates at a depth of 5 cm.

*More information: Melesse Temesgen*

If you are planting into ripped lines, you may need a machete to open a hole for the seed and to cover it over again with soil.

## Using a jab-planter

A jab-planter makes planting seed easier and quicker. A jab planter is a simple device that is operated by hand. It has two shafts made of metal or wood, with handles at the top and a steel beak at the bottom. A hopper on one of the shafts holds the seed ([Photos 4-6](#)).

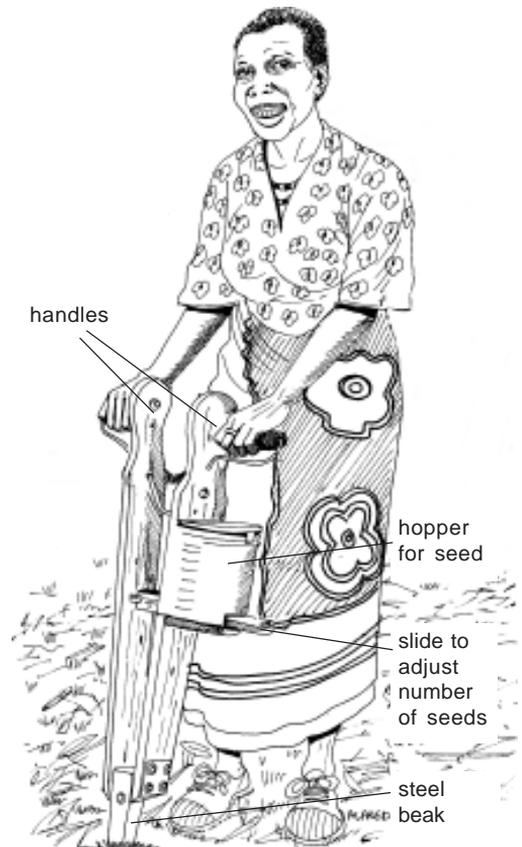
Using a jab-planter is easy, but does require practice:

- 1 Hold the handles apart. This opens a slide and allows a seed to fall into the closed beak.
- 2 Jab downwards so the beak pushes into the soil.
- 3 Push the handles together. This opens the beak, so the seed falls into the hole you have made.
- 4 Keeping the handles together, lift the jab-planter out of the soil. The soil will fall back into the hole, covering the seed.

Some jab-planters have two hoppers, one for seed and one for fertilizer. You can control the number of seeds and the amount of fertilizer that is applied by moving a slide at the bottom of the hoppers.

Make sure you plant at the correct spacing for your crop. As a guide, a man's normal stride is about 60 cm long. If you want to plant at a spacing of 70 cm, you will have to take a long stride between "jabs". Test yourself with a measure until you can judge the right distance.

You can keep in a straight line by sighting on a tree or hill in the distance, and head towards it while planting. You can keep the right distance between rows by checking the marks you made in the previous row.



*A simple jab planter. Some models have two hoppers: for seed and fertilizer*

## Using an animal-drawn planter

Animal-drawn planters open up a narrow slot in the soil, plant the seed, then cover the seed over with soil. There are several types.

### **Hand-operated planters**

With the simpler, cheaper types such as those designed by **Triple W Engineering** ([Photos 7-8](#)), the operator drops seed down a tube into the slot cut by the ripper. Wings on the ripper cover the seed with soil. The operator must drop the seed down the tube at the right rate in order to get required seed spacing and plant population. Again, this takes practice.

The planter can plant any type or size of seed without adjustments. These planters can be made locally using inexpensive raw materials, such as used car springs. The planter equipment can be taken off the frame and replaced by other tools, such as a weeder.

### **Automatic planters**

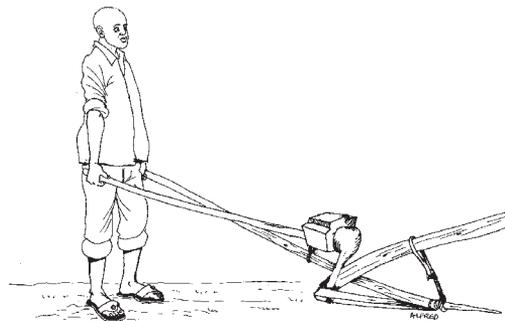
More sophisticated models have a seed hopper and metering system that sows the right number of seeds automatically, and perhaps a second hopper for fertilizer. Some planters can be attached to a ripper ([see page 49](#)).

The **Fitarelli No. 12 planter**, for example, is attached to a yoke pulled by draught oxen. A disk cuts through vegetation and mulch on the surface, and a chisel point opens a furrow for the seed and fertilizer. The rear wheel drives a mechanism that drops seeds and fertilizer through tubes just behind the chisel. The rear wheel then covers the seed with soil. The operator can correct the seed spacing in the row by adjusting the gears on the wheel.

Other planters (e.g., **KnapiK**, **IADEL** and **Triton**: [see Photos 13-14](#)) are attached to a chain that is pulled by draught animals. Like the Fitarelli machine, they have a vertical disc to cut through mulch, and a chisel point or a pair of inclined discs to open a furrow. They have hoppers for seed and fertilizer, and a mechanism to control how much of each is applied.

### **Semi-automatic planters**

One problem with automatic planters is that their wheels may sometimes skid, especially on stony or muddy ground. The wheels control the release of seed and fertilizer, so leave unplanted gaps if they do not turn.



*A semi-automatic row planter, developed by the Ethiopian Agricultural Research Organization. More information: Melesse Temesgen*

A semi-automatic row planter, developed by the **Ethiopian Agricultural Research Organization**, avoids this problem. The operator moves a handle back and forth to release seeds and fertilizer. The planter has no wheels, so can be used in fields where other planters would be hard to manage.

### Equipment suppliers

African farmers can choose from several makes of animal-drawn planters and fertilizer applicators. [See Chapter 14](#) for a list of manufacturers and suppliers.

## Tractor-mounted planters

Tractor-mounted planters can plant and fertilize several rows at a time. They have several hoppers for seed and fertilizer (typically 3–6 for small and medium tractors), mounted side-by-side ([Photo 12](#)). They work in a similar way to the animal-drawn equipment described above, but are faster and more accurate – and of course, more expensive.

It is possible to use a hand-tractor to pull a ripper or planter. Such tractors may be useful if draught animals are scarce – for example if there is not enough fodder in the dry season to feed livestock.

## Using the right amount of seed and fertilizer

When using equipment that plants seed or applies fertilizer, it is important to make sure that the right amount is being applied. If you do not, you will end up with the wrong plant spacing, plant population and fertilizer dosage. You risk getting lower yields and wasting money.

### Working out how many kilograms of seed you need

You want to know how many kilograms of seed you will need to plant your field. You will need to know how big your field is, and what the recommended seeding rate per hectare is.

- 1 Borrow some scales (from a shopkeeper?) and weigh out 10 grams of the seeds. Then count the number of seeds you have weighed.
- 2 Work out how many kilograms of seeds you need for your field:

$$\text{Number of seeds in 1 kg} = \text{Number of seeds in 10 grams} \times 1000 \quad \text{(Equation A)}$$

$$\text{Kilograms of seeds needed} = \frac{\text{Number of seeds needed per hectare} \times \text{Size of field (hectares)}}{\text{Number of seeds in 1 kg}} \quad \text{(Equation B)}$$

### Example

You count the number of seeds in 10 grams, and find there are **23 seeds**.

The recommended seeding rate for this crop is **50,000 per hectare**.

You want to plant a one-fifth of a hectare (**0.2 hectare**).

$$\text{Number of seeds in 1 kg} = 23 \times 1000 = 23,000 \text{ seeds}$$

$$\text{Kilograms of seeds needed} = \frac{50,000 \text{ seeds} \times 0.2 \text{ hectare}}{23,000}$$

$$= 0.43 \text{ kg}$$

You will need **0.43 kg** of seed.

## Adjusting a jab planter

You have to adjust the settings of a jab planter so it delivers the right amount of each. There is a slide at the base of the hoppers that determines the amount of seed and fertilizer that drop through when you pull the planter handles apart. How many seeds drop through depends on how big the seeds are.

Move the slide until the right number of seeds crop through – for example, two or three maize seeds each time. Check this by opening and closing the handles 10-20 times, then counting the number of seeds that drop.

You can open and close the jab planter over someone’s hands to show how much seed and fertilizer it delivers.

## Calculating the planting distance and plant population for a jab planter or planting stick

If you know **the number of plants you want per hectare**, you can use this equation to calculate the planting distance within the row:

$$\text{Planting distance within row (m)} = \frac{10,000 \text{ m}^2}{\text{Number of plants per hectare} \times \text{Distance between rows (m)}} \times \text{Number of seeds per hole}$$

(Equation C)

**Example**

You want **35,000** plants per hectare at a row spacing of 75 cm (**0.75 m**) and **2 seeds** per hole. How far apart should you space the planting holes?

$$\begin{aligned} \text{Planting distance} &= \frac{10,000 \text{ m}^2}{35,000 \text{ plants} \times 0.75 \text{ m}} \times 2 \text{ seeds per hole} \\ \text{within row (m)} & \\ &= 0.76 \text{ m} \\ &= \text{about } \mathbf{75 \text{ cm}} \end{aligned}$$

If you know the **planting distance**, you can calculate the number of plants per hectare using this equation:

$$\begin{aligned} \text{Number of plants} &= \frac{10,000 \text{ m}^2}{\text{Planting distance} \times \text{Distance between}} \times \text{Number of seeds} \\ \text{per hectare} & \quad \text{within row (m)} \quad \text{rows (m)} \quad \text{per hole} \end{aligned}$$

**(Equation D)**

**Example**

You want to use a planting distance of 75 x 75 cm (**0.75 x 0.75 m**) and **2 seeds** per hole. What will your plant population be?

$$\begin{aligned} \text{Number of plants} &= \frac{10,000 \text{ m}^2}{0.75 \text{ m} \times 0.75 \text{ m}} \times 2 \text{ seeds per hole} \\ \text{per hectare} & \\ &= 35,555 \\ &= \text{about } \mathbf{35,000 \text{ plants}} \end{aligned}$$

## Calculating the amount of fertilizer to apply with a jab planter or planting stick

How much fertilizer should you apply in each hole? You need to know the **planting distance within the rows**, the **distance between the rows**, and the **fertilizer recommendation** per hectare. You can then use this equation:

$$\begin{aligned} \text{Grams of fert-} &= \frac{\text{Planting distance} \times \text{Distance between} \times \text{kg of fertilizer}}{\text{izer per hole}} \\ & \quad \text{within row (m)} \quad \text{rows (m)} \quad \text{per hectare} \end{aligned}$$

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**(Equation E)**

**Example**

You want to apply 100 kg of fertilizer per hectare. Your planting distance is 0.75 x 0.5 m. How much fertilizer should you apply in each hole?

$$\begin{aligned} \text{Grams of fertilizer per hole} &= \frac{0.75 \text{ m} \times 0.5 \text{ m} \times 100 \text{ kg}}{10} \\ &= \mathbf{3.75 \text{ g}} \text{ per hole} \end{aligned}$$

If you are using a jab planter with a fertilizer hopper, fill the hopper, adjust the fertilizer delivery slide, then open and close the jab planter until a constant amount of fertilizer falls to the ground. Open and close the jab planter 20 times, then weigh the fertilizer that has fallen through. If it is more (or less) than 20 times the amount you need, close (or open) the slide a little and test it again.

## Adjusting the distance between rows with an animal-drawn planter

If you are using draught animals, how can you make sure your planting rows are spaced the right distance apart?

Draught animals are trained to follow the previous furrow or planting line. So the distance between the rows will be half the distance between the animals – which is determined by the length of the yoke (crosspiece) between them.

For a row spacing of **75 cm**, the animals must be **150 cm** apart. Use a yoke a little longer than this so it is long enough to harness the animals to it.

## Adjusting an animal-drawn planter

You can adjust the number of seeds that a planter delivers in different ways. How to make this adjustment depends on the particular planter you are using.

Here is how to work out the planting distance and number of seeds per hectare for planters that use a wheel to control the seeding.

- 1 Make sure you are using the right seed plate for your seed. Seed plates are designed for graded seed. If your seed is ungraded (if the seeds are different sizes), you will get different numbers of seeds in each planting hole. Choose a plate that gives you the best number on average for your needs.
- 2 Mark one point on the drive wheel (the wheel that runs the seed and fertilizer feed). Put the planter in the gear you will use, then pull it in a line along the ground, counting how many times the drive wheel turns. Pull it

until the wheel has gone round 10 times. Now measure the distance you have pulled it.

- 3 Now fix a plastic bag over the bottom of the seed spout. Put some seeds in the hopper and hold the planter up so the drive wheel is clear of the ground. Without moving the planter, turn the wheel 10 times. Turn the wheel at the same speed as if animals were pulling the planter.
- 4 Count the number of seeds that are collected in the plastic bag.
- 5 You can now work out the **planting distance** for this seed size and planter setting:

$$\text{Distance between seeds (m)} = \frac{\text{Distance covered in 10 wheel turns (m)}}{\text{Number of seeds dropped}} \quad (\text{Equation F})$$

### Example

You pull the planter along and count drive wheel turning 10 times. You measure the distance, and find you have pulled it **15 m**.

When you rotate the drive wheel 10 times, you collect **37 seeds** in the plastic bag. What is the planting distance?

$$\begin{aligned} \text{Distance between seeds (m)} &= \frac{15 \text{ m}}{37 \text{ seeds}} \\ &= \text{about } 0.4 \text{ m} \\ &= \mathbf{40 \text{ cm}} \end{aligned}$$

- 6 You can also work out the **number of seeds per hectare**:

$$\text{Number of seeds per hectare} = \frac{10,000 \text{ m}^2}{\text{Planting distance within row (m)} \times \text{Distance between rows (m)}} \quad (\text{Equation G})$$

### Example

Using the same planter settings as above, you want to plant at a distance of 75 cm (**0.75 m**) between rows. How many seeds will you plant per hectare?

$$\begin{aligned} \text{Number of seeds per hectare} &= \frac{10,000 \text{ m}^2}{0.4 \text{ m} \times 0.75 \text{ m}} \\ &= \mathbf{33,333 \text{ seeds}} \end{aligned}$$

- 7 Test the planter on a sandy piece of soil to demonstrate where it places the seeds. Measure the distance between the seeds to make sure your calculations are correct.
- 8 You can adjust the seeding rate by changing the gears or sprockets on the planter. The settings are different on each machine.
  - o On the **Fitarelli** planter, slide the gears along the drive shaft until the one you want is engaged.
  - o On other planters (e.g., **Knapik**, **IADEL**, **Triton**), remove one sprocket and replace it with a large or smaller one to get the seed rate you want ([Photos 15-16](#)).

## Adjusting fertilizer amounts

The best amount of fertilizer depends on the type of fertilizer, the soil and the crop type. You will have to adjust the planter for each situation.

You can calculate the fertilizer application rate in a similar way to the seeding rate:

- 1 Tie a plastic bag over the fertilizer spout, raise the wheel off the ground, and turn it 10 times. Weigh how much fertilizer is collected in the bag.
- 2 Calculate the fertilizer delivered per hectare using this equation:

$$\text{Kilograms of fertilizer per hectare} = \frac{\text{Amount of fertilizer delivered in 10 wheel turns (grams)} \times 10}{\text{Distance covered in 10 wheel turns (m)} \times \text{Distance between rows (m)}} \quad \text{(Equation H)}$$

### Example

Your planter delivers **70 g** of fertilizer when you turn the wheel 10 times. When you pull the planter so the drive wheel turns 10 times, it travels **15 m**.

Your row spacing is **0.75 m**. How much fertilizer will you apply per hectare?

$$\begin{aligned} \text{kg of fertilizer per hectare} &= \frac{70 \text{ g} \times 10}{15 \text{ m} \times 0.75 \text{ m}} \\ &= \mathbf{62 \text{ kg}} \text{ per hectare} \end{aligned}$$

- 3 Adjusting the fertilizer rate is different on different planters.
  - o On the **Fitarelli No. 12 planter**, you can change the star wheels. There are two of these wheels, one half the width of the other. The smaller wheel will deliver half the amount of fertilizer. You can use more than

one wheel, and you then slide a metal plate along to prevent fertilizer from leaking.

- On the **Knapik planter**, you can change the drive sprocket to set the amount of fertilizer delivered. You can fine-tune the amount by adjusting the cover on the fertilizer spout.
- On the **IADEL planter**, you can change the drive sprocket, and raise or lower the hopper to allow more or less fertilizer to be fed into the delivery tube.

## Used to acres?

If you are more used to acres rather than hectares, you can use these equations. The equation letters (**B**, **C**, etc.) are the same as in the preceding pages.

$$\text{Kilograms of seeds needed} = \frac{\text{Number of seeds needed per acre} \times \text{Size of field (acres)}}{\text{Number of seeds in 1 kg}} \quad \text{(Equation B)}$$

$$\text{Planting distance within row (m)} = \frac{4,048 \text{ m}^2}{\text{Number of plants per acre} \times \text{Distance between rows (m)}} \times \text{Number of seeds per hole} \quad \text{(Equation C)}$$

$$\text{Number of plants per acre} = \frac{4,048 \text{ m}^2}{\text{Planting distance within row (m)} \times \text{Distance between rows (m)}} \times \text{Number of seeds per hole} \quad \text{(Equation D)}$$

$$\text{Grams of fertilizer per hole} = \frac{\text{Planting distance within row (m)} \times \text{Distance between rows (m)} \times \text{kg of fertilizer per acre}}{4} \quad \text{(Equation E)}$$

$$\text{Number of seeds per acre} = \frac{4,048 \text{ m}^2}{\text{Planting distance within row (m)} \times \text{Distance between rows (m)}} \quad \text{(Equation G)}$$

$$\text{Kilograms of fertilizer per acre} = \frac{\text{Amount of fertilizer delivered in 10 wheel turns (grams)} \times 4}{\text{Distance covered in 10 wheel turns (m)} \times \text{Distance between rows (m)}} \quad \text{(Equation H)}$$

### Useful numbers

#### Weight

1 kg = 1000 grams

1 soft drink bottle cap of fertilizer = about 3–4 grams

1 soft drink can of compost = about 150 grams

#### Distance and area

1 m = 100 cm

1 m = 3.28 ft

1 hectare = 10,000 m<sup>2</sup>

1 hectare = 2.47 acres

1 acre = 4048 m<sup>2</sup>

1 acre = 43,560 sq ft