

# Pack 106, Item 10

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**Backgrounder: Using conservation tillage and soil cover in Conservation agriculture**

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***What is conservation tillage and why is this subject important to listeners?***

Conservation tillage includes both reduced tillage and zero or no-till. It typically involves either making planting basins by hand, or using ox- or tractor-drawn rippers\*. Details on both of these approaches are included in the *Key information* section below.

Using conservation tillage has the following benefits:

* Better maintenance of soil organic matter, resulting in improved soil fertility
* Improved soil structure
* Deeper root development because of increased earthworm activity and the roots of deep-rooting green manure plants
* Reduced operational costs on the farm compared to conventional tillage, for example, reduced fuel costs

Conservation tillage allows farmers to maintain soil cover. If you maintain a minimum soil cover of 30% on your land, the combination of conservation tillage and soil cover leads to the following benefits:

* Reduced soil erosion
* Reduced water run-off / loss of water
* Better water infiltration and storage in the soil
* Prevention of overheating of the soil surface
* More abundant soil life
* Reduced labour cost

*For further information, see Documents 1 and 2.*

***Benefits and problems with tillage***

The main benefits of tillage and the reasons why farmers invest labour and time to till their soil are:

* to create good conditions for seeds to germinate, emerge and grow,
* to increase water infiltration and soil aeration\*,
* to reduce weed competition with crops, and
* to incorporate organic material, crop residues, and manure.

In the short term, plowing may increase yields because it releases nutrients and loosens deeper levels of soil. This helps plant roots penetrate deeper into the soil.

But, over the longer term, conventional tillage—with hand hoes, discs, or moldboard plows—depletes soil organic matter and nutrients, damages soil structure, and leaves it exposed to the wind and rain.

Tilling at the same depth season after season often creates a hardpan\* in the soil. Also, turning the soil over results in increased soil aeration, which leads to rapid decomposition of organic matter in the soil.

Continuous conventional tillage can result in declining yields and reduced resilience to drought. Also, repeated tillage leads to disturbance and death for some soil organisms, which affects their ability to decompose organic matter and disturbs soil structure. It also disturbs the soil fungi (called *mycorrhizal hyphae*) which help create good soil structure and make some nutrients available to plants.

Tillage can also lead to crusting and sealing of the surface of the soil. If tillage destroys the soil structure by breaking down the natural system of pores and channels, soils can be compacted.

*For further information, see Documents 2 and 3*.

***What are some key facts?***

* Conservation tillage is used on over 1.2 million hectares of land in Africa.
* Conservation tillage can best be achieved when farmers use effective weed management strategies. In addition to herbicides, which many farmers can’t afford, these include shallow hoeing, planting cover crops, and maintaining crop residues.
* To fully realize the benefits of improved soil and increased yields, conservation tillage must be accompanied by at least 30% permanent soil cover (through mulch, crop residues, growing plants, etc.)

***What are the big challenges of adopting conservation tillage?***

* Changing farmers’ assumption that tillage is necessary.
* Potentially increased labour for weeding, particularly when conservation tillage is not accompanied by applying herbicides.
* The unavailability or unaffordability of machinery such as rippers and direct seeders leads many small-scale farmers to use manual Conservation agriculture (CA) systems (such as planting basins), which may be labour-intensive, at least in the first year.
* Insecurity of land tenure can limit long-term investment in conservation tillage.
* Extension staff may lack sufficient understanding of conservation tillage.
* Crop residues, cover crops, and mulch are sometimes dragged during ripping. As a result, some farmers choose to remove the soil cover before ripping, and then spread it again.

***Is there misinformation about conservation tillage that I should cover?***

* The idea that, for most small-scale farmers, conservation tillage causes a buildup of pests. In fact, some pests may increase, while others will decrease.
* The idea that conservation tillage reduces yields and increases the labour needed to manage weeds. In fact, yields will generally increase over time, while labour will decrease.

***Gender aspects of using conservation tillage***

* Women may be less able to afford to buy or even rent machinery such as rippers and direct seeders. Thus, CA equipment, especially equipment drawn by oxen or tractors, is typically owned and controlled by men. Mechanized approaches to CA can thus shift control of production away from women.
* While some extension programs which support farmers to adopt minimal tillage may target women, extension and advisory services generally serve women more poorly than men.
* Women can be supported to adopt conservation tillage through investing as a group in purchasing mechanization tools (for example, rippers and direct seeders) and then offering services for a fee to other farmers. Groups can raise funds through savings and credit schemes to meet the cost of purchasing equipment, or even to purchase inputs such as herbicides.
* Some farm implements recommended for minimal tillage may not be physically suitable for some women, for example, the Chaka hoe and ripping tools which require the use of oxen.
* Women’s labour is reduced the most in conservation tillage systems which incorporate herbicides, since they significantly reduce labour demands for weeding.

***Predicted impact of climate change on adoption of conservation tillage***

* Because conservation tillage uses available water more efficiently, maintains or enhances soil fertility, and protects soil against the negative effects of sun, wind, and heavy rains, adoption of conservation tillage is rising worldwide as the climate warms and rainfall and other weather patterns become less predictable.

**Key information about reduced tillage**

*Making the transition to conservation tillage*

The process of converting from conventional farming to CA, including conservation tillage, falls into three main stages:

1. ***Before you start***:
	1. *Choosing land for CA*: Select part of a field where you feel able to take a risk, but have a good chance of success. If you start with a field with good potential, you are likely to see results quickly. When you have converted this field to CA, you can start on others—for example, on badly eroded fields on slopes. Start small. Try out what works on one field first. Observe closely and learn what works and what does not. Then you can gradually extend what you have learned to other fields and crops.
	2. *Get support:* It can be difficult to start CA alone. Join with friends and neighbours who are interested in CA. Learn from one another, and visit each others’ fields to check on crops, soil, weeds, pests, and diseases. Get advice from your extension worker or development agent, a local NGO, or knowledgeable farmers.
	3. *Preparing your field:* Before the first cropping season, you may need to do some work to prepare your field. Don’t worry—you will have to do this extra work only once. You may have to do the following:
		1. If the soil is compacted or has a hardpan, use an animal- or tractor-drawn subsoiler\* or ripper to create a furrow which breaks up the soil without turning it over. If your soil has ridges and furrows, plow once, preferably with a chisel plow with a long log or iron bar to remove the ridges and make the surface more even. Because direct planters work better on fairly smooth surfaces, remove rocks or stumps. If the soil is acidic (has a low pH), add lime.
		2. Make planting basins (see below for instructions) or use an ox- or tractor-drawn ripper. This work is best done in the dry season so that you are ready to plant when the rains fall.
2. ***First season***:
	1. *Cover the soil*:
		1. *With crop residues*: If there are crop residues nearby, carry them to your field and spread them on the soil surface as mulch. This takes some work, but costs little. If you do not have any suitable residues yourself, perhaps you can get some from neighbours.
		2. *With a cover crop*: Plant a cover crop in the first season. Choose a crop with deep roots such as lablab to improve soil fertility and soil structure. Consider using fertilizer on the cover crop to help it grow well. It will produce enough mulch for you to grow food crops on the same field during the second season. You could also grow a cover crop on a nearby field, then cut and spread it on the soil at the beginning of the second season. This cover crop can also produce seeds that you can sow or sell to neighbours.
	2. *Control weeds*: It is vital to control weeds, especially during the first few years of CA. Pull them by hand, slash them, or kill them with a herbicide. Then sow cover crops to prevent new weeds from growing. Don’t plow. Instead of plowing, direct-plant your crops through the mulch, or dig planting basins (*see below*) where you can sow seeds.
	3. *Grow crops*: You can grow the crops you normally do, but, if possible, add an intercrop or rotate crops. For example, you might grow maize as normal, but add a legume intercrop. Leave the soil covered. At harvest, leave the residues on the field to cover the soil during the dry season. Leave the cover crop growing, or plant another main crop if you can.
3. ***Second and following seasons***:
	1. There should now be enough cover on your field. If not, carry extra residues from nearby and spread them on your field. It is much simpler to prepare for planting in the second season. Check for weeds. Hand-pull them, slash them, or kill them with a herbicide.
	2. *Crop residues*: Decide if it’s possible to produce enough crop residues on the field for the third season. If not, grow some cover crops nearby, then cut and spread them on the CA field in the third season.

*For further information, see Documents 2 and 3*.

***Making planting basins***

### If land is weedy, begin by clearing weeds with a machete or a very shallow hoeing. Leave all weedy residues on the plot unless they have seeds that would cause problems after planting.

### Stretch a planting rope along one side of the plot.

### Dig planting basins along this rope, using a within-row measuring stick. Basins should be 15 cm deep if farmers use compost or manure, or half this deep if they use chemical fertilizer.

### Move planting rope, using a between-row measuring stick.

### Dig the second row of basins parallel to the first, and use the first row planting basins as a guide.

***Using an ox-drawn ripper***

Ox-drawn rippers are a widely accepted piece of CA equipment. They open up a planting furrow, thus saving the labour of digging planting basins. Because they do not turn the soil, they leave more residue on the surface than a moldboard plow, generally achieving the CA goal of a minimum of 30% soil cover.

Rippers can be bought with various digging points, each of which is adapted to different soil conditions. (*See photo below and Documents 4 and 5*.) The cheapest way for farmers to obtain a ripper is to purchase a conversion kit (for around $40-70 US) which converts a conventional moldboard plow into a CA ripper.

For most farmers, the purchase cost is quickly recuperated because a team of oxen can rip ¼ - ½ hectare per day, which is twice what is possible with a moldboard plow. Also, soils can often be ripped in the dry season, when conventional plowing is impossible, allowing the farmer to plant as soon as the first rains fall.

**Ripping and planting**

Besides breaking up a hardpan, you can use ripping to open a furrow for sowing seeds. After ripping the soil, sow seeds in the ripped opening, covering the seed after sowing.

Using a ripper allows you to sow earlier and faster than if you plow the soil before planting. The distance between ripped furrows depends on the crop you want to plant, but 75 cm is a common distance for maize.

Do not disturb the ground between rows, except for managing weeds. Rainwater concentrates in the planting lines and sinks into the soil where the crop roots are growing.

It is best to rip when soil is dry to avoid further compaction and ensure you break the hardpan. If you are growing a cover crop, slash it. When the cover crop is dry, you can use a ripper though the mulch.

Heavy clay soils are difficult to rip when dry. Ripping heavy clay soils produces large clods, especially if the soil has been compacted. It is best to leave these soils until the first rains have moistened them a little before ripping them.

If you are using oxen, you may have to rip the field twice to ensure the soil is loose enough. If you use four animals, you may need to make only one pass.

You can rip along the same lines season after season.

Note that, while farmers might think that periodic plowing is ok, this will disturb the process of soil improvement, and it is not necessary when fields are managed appropriately, with the exception of very light sandy soils.



*Ox-drawn long beam ripper planter (Photo from FAO)*

***Where can I find other resources on this topic?***

1. FAO Subregional Office for Eastern Africa, 2009, Lamourdia Thiombiano and Malo Meshack, editors. *Scaling-up Conservation Agriculture in Africa: Strategy and Approaches*. Addis Ababa. <http://www.fao.org/ag/ca/doc/conservation.pdf>
2. IIRR and ACT, 2005. *Conservation agriculture: A manual for farmers and extension workers in Africa*. International Institute of Rural Reconstruction, Nairobi; African Conservation Tillage Network, Harare. <http://www.fao.org/ag/ca/AfricaTrainingManual.html>
3. Steiner, Kurt, 2002. *Conservation Tillage: Gateway to Food Security and Sustainable Rural Development – Impact of Conservation Tillage on Soil Quality*. African Conservation Tillage Network, Information Series No. 4. Downloadable at [www.act-africa.org/lib.php?com=5&res\_id=77](http://www.act-africa.org/lib.php?com=5&res_id=77)
4. Zambia National Farmers Union, Conservation Farming Unit, undated. *A guide for farmers: Conversion from ox plowing to min-till ripping using the Magoye ripper*. <http://conservationagriculture.org/uploads/pdf/ADP%20MIN-TILL%20RIPPING%20FARMERS%20GUIDE.pdf> (5.8 MB)
5. Zambia National Farmers Union, Conservation Farming Unit, 2012. *Ox CF: Setting up Ripper and Land Preparation*. <http://conservationagriculture.org/uploads/pdf/CF%20Ox%20Land%20Preperation%202012.pdf> (933 KB)
6. Zambia National Farmers Union, Conservation Farming Unit, undated. *Private Mechanised Min-Till Service Provision for Small and Medium-Scale Farmers*. <http://conservationagriculture.org/uploads/pdf/MECHANISED-MIN-TILL-PROGRESS.pdf> (5.6 MB)

***Key definitions***

**Cover crop:** Crop grown to protect a field from the elements by covering bare soil. Popular cover crops include cowpeas, pigeon peas, and lablab, and non-edible plants like mucuna and carnivalia.

**Hardpan:** Compacted, hard layer of soil that develops under the soil surface after years of turning the soil with hand hoes or plows. This results in rainwater runoff and roots failing to reach deep into the soil.

**Land tenure:** In this context, land tenure relates to the rules and regulations that govern access and ownership of land by small-scale farmers. In some countries in sub-Saharan Africa, this mostly disadvantages married women who are sometimes regarded as secondary partners in a marriage. If not married, they are, nevertheless, considered as secondary citizens in some male-dominated communities.

**Moldboard:** A curved metal blade in a plow that turns the earth over.

**Ripper:** An attachment used to tear and rip apart soil, particularly compacted soils.
**Soil aeration:** Ventilation of the soil, allowing gases to be exchanged between the soil and the atmosphere.

**Soil compaction:** The compression of soil particles into a smaller volume, which reduces the size of pore space available for air and water.

**Subsoiler:** A kind of plow with no moldboard, which is used to loosen the soil at some depth below the surface without turning it over.

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