

CONSERVATION AGRICULTURE

What is this Action Sheet about?

Annual average nutrient loss from sub-Saharan African soils is estimated at 24 kg/hectare and rising. We need new systems of farming which conserve the soil, keeping it healthy and full of life so it can give good crop yields year after year. This Action Sheet is about Conservation Agriculture or Conservation Tillage, which can do just that.

What is Conservation Agriculture?

Conservation Agriculture means growing crops with as little disturbance to the soil as possible. In tropical areas with high rainfall, it is possible to farm without ploughing at all. This is known as zero-tillage. In dry areas, minimum tillage farming methods have been developed.

Over the last two decades conservation tillage technologies have been perfected and adapted for nearly all farm sizes, soil and crop types and climatic zones. Grain crops, pulses, sugar cane, vegetables, potatoes, beets and cassava as well as perennial crops like fruit and vines can all be grown using conservation tillage techniques.

Conservation Agriculture:

- conserves soil and water
- maintains soil fertility
- reduces soil disturbance
- improves water infiltration
- builds up soil organic matter
- supports soil life

With conservation agriculture techniques, farmers could save millions of hectares of agricultural land from degradation and erosion!

What's the problem with ploughing?

Intensive, full-field tillage was first developed by farmers growing small-grain crops, such as wheat and barley, primarily in Western Asia, Europe, and Northern Africa. Tillage was needed to control weeds and give the crop a head start before a new flush of weeds germinated. It also stimulated transformation of organic forms of nitrogen to forms that plants could use, and created a fine seedbed, thereby greatly improving germination of small-seeded crops like grains.

However, every time a farmer tills land to control weeds, the soil becomes more vulnerable to erosion and the soil structure is destroyed. Mechanical tillage with tractors and ploughs hardens the soil and reduces soil life. Even ploughs pulled by animals can lead to erosion. The very soil in which farmers plant their crops is washed and blown away.

As the soil is ploughed over and over again, it becomes less and less fertile. The fertilizer function of soil organic matter can be taken over by adding chemical fertilizers, and the soil structuring function can be taken over by more intensive ploughing. But mechanical soil structuring does not last very long and calls for ever more tillage, which over the years decreases the amount of soil organic matter and makes the problem even worse.



Pot-holing – A Conservation Agriculture Technique used in drylands (Illustration by Godfrey Semwaiko)

Soil organic matter, when present, not only provides nutrients, but also, more than anything else, is crucial for the stabilization of soil structure. Soils with low organic matter get hard crusts - water cannot soak in, but just flows away over the surface - leading in the end to soil erosion.

Soil loss due to intensive tillage is especially bad in tropical climates. The warm, moist air causes the organic matter to decay rapidly and disappear. The heavy, frequent rains wash away any nutrients in the soil.

So are you saying that if farmers stopped ploughing, then land would not become degraded as quickly?

In many cases, this may be true. One of the most effective remedies for soil degradation is conservation tillage. Undisturbed soil has a mulch cover that protects and feeds soil life. The burrowing of soil creatures like earthworms provides a stable and favourable soil structure with lots of gaps to help water to soak in. There is scientific evidence that water infiltration is highest on untilled soils – and if you've ever cleared a new plot of forested land for planting, you will know that virgin soils are usually more fertile than the soils that have been cultivated for decades.

But isn't soil tillage necessary to grow a crop?

Nature shows that plant growth is possible without any soil tillage; otherwise, all virgin lands would be deserts.

Can conservation tillage actually improve soils that have already been degraded?

Yes, in a soil that is not tilled for many years, crop residues left on the soil surface produce a layer of mulch. This layer protects the soil from the impact of rain and wind and also stabilizes the soil moisture and temperature in the surface layers. A suitable home for a number of living organisms, from larger insects down to fungi and bacteria, is created. These organisms chew up the mulch, mixing it into the soil and break it down so that it becomes sticky humus which keeps the soil structure stable. Earthworms produce very stable lumps of soil as well as holes leading from the soil surface straight into the subsoil, helping water to soak in during heavy rain.

So do living organisms, in effect, take over the task of tilling the soil?

Exactly. This is an important process called biological tillage. Farming with less mechanical tillage is only possible when soil organisms take over the task of tilling the soil. However, this may mean that the use of chemical farm inputs also needs to change. Synthetic pesticides and mineral fertilizer must only be used in ways that do not harm soil life.

Conservation agriculture – and letting soil organisms till your soil – seems like a very revolutionary idea. Where did it come from?

The idea arrived when people realized that mechanical ploughing was causing land degradation on a massive scale, particularly in tropical and sub-tropical countries. In the early 1970s, farmers in North and South America started experimenting with conservation agriculture methods.

What kinds of techniques do conservation farmers use?

Various techniques have been developed for use in different climates and soils around the world. However, the three principles that are always followed are:

- Disturb the soil as little as possible
- Keep the soil covered with mulch and cover crops
- Rotate crops

Techniques include:

Zero-tillage/Direct planting (appropriate for humid areas like West Africa and some parts of the East African highlands)

- Instead of ploughing before planting, using special tools to drill the seeds directly into the soil under the protective layer of mulch
- With zero-tillage, the soil is kept covered and undisturbed at all times.

Minimum tillage (appropriate for semi-arid areas)

- Opening a small planting-line (furrow) with a tine tool. Seeds and compost can be placed in the furrows at the same time.
- Pot-holing: Digging a small hole with a hoe, putting a little compost in, half covering the hole with soil. When the rains come, the seeds are planted in the holes.
- **With minimum tillage, the ground cover should never be less than 30% to prevent run-off and erosion by wind and water. Weed control is more difficult in minimum tillage systems than in zero-tillage systems, and must be done mechanically or with herbicides.**

The following techniques also often form part of both zero- and minimum tillage systems:

Mulching (See Action Sheet 34)

- Leaving crop residues on the fields after harvest, instead of ploughing them in or burning them off

Crop rotation

- For example, cereals followed by legumes (nitrogen-fixing plants) to add nutrients to the soil and prevent build up of pests and diseases in the crops

Cover crops

- Planting cover crops underneath or between crops
- Cover crops are chopped up by hand or with knife rollers and left to dry out. They may be dug in just below the soil surface, but not ploughed in (See Action Sheet 39: Green manures/Cover crops for Biomass Transfer)

But how is it possible to suppress weed growth when using conservation tillage?

When farmers first begin to practice conservation tillage, herbicides or weeding by hand or knife roller machine are often needed to get weeds under control. Herbicides must be used very carefully so that soil life is not destroyed. After a few years, fewer weeds will grow. Because the soil is kept covered, weeds do not get the light they need to grow. The use of cover crops to control weeds, instead of using herbicides, is also becoming more popular.

What about pests and diseases?

Pest control needs to be done in a way that protects the soil life that is now busy doing all the tillage. Pesticides must only be used when absolutely necessary. Using Natural Pest and Disease Control (see Action Sheet 33), farmers can monitor and control pest levels in the fields without disturbing natural balances.

Crop rotation is especially important, as it stops infections being carried on to the next crop. Growing a monoculture (a single crop) with conservation tillage is possible, but not recommended, because - just as in conventional farming - it leads to problems with pests and disease.

Can conservation farmers keep livestock?

Yes, and the animals can help with recycling of nutrients. Farmer can grow fodder crops in the crop rotation. By growing a very different crop plant within the rotation, like a fodder tree, pests and diseases problems are reduced. Fodder crops can often double as a cover crop, helping to protect the soil. However, there may be conflicts over whether to use organic matter to feed the animals or feed the soil. These need to be resolved, especially in arid areas where plants grow slowly.

Does conservation tillage have other benefits, besides conserving the soil?

Conservation tillage is often referred to as a “win-win” situation, because it has benefits for the farmer, the community, and the environment.

For the farmer

- Less costs – no oxen or tractors and ploughs to buy, run, and maintain
- Less work – leave the tillage to soil creatures and reduce labour by up to 40%
- More crops – as the soil fertility recovers, yields increase
- More stable crop yields – more water soaks into the soil, so crops still grow well in drier years

For the community and the local environment

- More food production
- No soil erosion – conservation agriculture builds more soil!
- Less problems getting enough food and water during droughts. As more water soaks into the soil, there is more constant water flow in rivers, more water in the wells, and more water reaching underground aquifers (natural reservoirs)

After some years of conservation tillage, people find natural springs that had disappeared a long time ago starting to flow again!

- Less flooding in the rainy season as water soaks in instead of running off
- Cleaner water, as less soil washes off the land and less chemical pesticides and fertilizers have been used
- More farmland life of all kinds – soil life supports predator insects which in turn feed birds and small mammals

For the global environment

- In conventional agriculture, crop residues are usually burnt, releasing carbon dioxide. In conservation agriculture, the carbon is kept in the crop residues left on the soil. More carbon dioxide is taken in and kept in cover crops. Because people burn fossil fuels like coal, gas, oil and diesel, carbon dioxide is increasing in the atmosphere. Carbon dioxide traps heat from the sun, so the whole planet is now warming up. This global warming will change weather systems all over the world. If farmers all over the world used conservation agriculture methods, we could keep more carbon in the soil, helping to keep the earth's climate stable.
- If farms that plough with tractors switched to conservation methods, they would use 40% less fossil fuel, reducing air pollution and helping to stop global warming.

Can conservation agriculture work anywhere?

With support from experienced farmers, conservation agriculture methods can be adapted to most places. However, there are some situations when conservation tillage will be harder to introduce:

- Where people have livestock that usually eat crop residues, conservation farmers may find it hard to leave enough organic matter on the soil
- Where farmers don't have control of land-use throughout the year, they will not be able to ensure soil cover is protected from grazing animals
- Where people are used to relying on sales of a single crop (for example, maize or cotton), it may be hard to change to a system involving crop rotation. It will be easier to switch to conservation farming where there is good access to market for a variety of crops. On the other hand, by improving the soil and allowing a greater variety of crops to be grown with sustainable yields, conservation farming could lead to the development of new markets.
- Conservation tillage doesn't work well on sandy soils that tend to harden, or on soils that are at risk of water-logging

We're thinking of switching to conservation tillage! What's the first step?

Conservation tillage requires careful planning of crop rotations, new approaches to weed control and pest management, and range of new or adapted technical and management skills. You might also need to get new equipment and the know-how to use it. The first step is to make contact with farmers who have already made the switch. Join one of the Conservation Farmers clubs and unions that have been set up in many African countries. The Conservation Farmers Union of Zambia is one example. The Food and Agriculture Organization of the United Nations supports conservation farming. Your national or local office may be able to offer advice.

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FOR MORE INFORMATION

CONTACTS

AFRICAN CONSERVATION TILLAGE NETWORK – www.act.org.zw

DOCUMENTS

AFRICAN CONSERVATION TILLAGE NETWORK INFORMATION SERIES

www.act.org.zw/infoseries.html

- 1: Producing in Harmony with Nature through Conservation Tillage
- 2: The Economics of Conservation Tillage
- 3: Crop Residue Management and Cover Crops
- 4: Impact of Conservation Tillage on Soil Quality
- 5: Increasing Rainwater Productivity with Conservation Tillage
- 6: Conservation Tillage Implements for Smallholder Farming Systems
- 7: Overcoming Hardpans with Conservation Farming
- 8: Weed Management in Conservation Tillage Systems
- 9: Mitigating the Impact of HIV/AIDS by Labour Saving Technologies