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Controlling weeds

Weeds are any plants that grow where they are not wanted. They compete with the cultivated crops for nutrients, moisture, sunlight, and space. They shelter pests and diseases that attack the crop. They reduce crop yields and farmers' incomes. Controlling weeds can be a lot of work.

In conventional farming, tillage (turning the soil over) is a major way to control weeds. Farmers plough repeatedly in order to suppress weeds and have a clean field when they plan their crop. Ploughing buries many weed seeds, but it also brings other seeds back to the surface, where they can germinate. Burning crop residues may also stimulate the growth of some types of weeds.

Conservation agriculture reduces weed numbers in several ways:

- **It disturbs the soil less**, so brings fewer buried weed seeds to the surface where they can germinate.
- **The cover on the soil** (intercrops, cover crops or mulch) smothers weeds and prevents them from growing.
- **Rotating crops** prevents certain types of weeds from multiplying.

How to manage weeds

Controlling weeds is vital in conservation agriculture. If you do not control weeds properly, they may take over your field, and you will be left with little or no yield! It is important to control weeds at the right time, before they become a problem. Do not allow them to compete with the crops, and do not let them grow long enough to produce seeds. You may have to slash weeds even after harvesting the crop in order to prevent them from producing seeds.

Weeds are thieves

- They take light, water and food away from your crops.
- They push the crops out of their living space.
- They shelter pests and diseases that attack the crop.

The longer you leave them, the harder they are to control. Control them before they steal your yield!

Weeds can be a big problem when you first start using conservation agriculture. You may have to work hard in the first couple of years to control weeds. Be patient! If you do it properly, weeds will become less of a problem later on.

You can manage weeds in many different ways (see also Photos 28–34):

- Using crops and other forms of **soil cover.**
- By **hand weeding** or using **equipment** to cut or crush the weeds.
- Using **herbicides**.

We will discuss each of them in turn.

You will probably need to use a **combination** of these methods to control weeds. It is best to prevent weeds from growing by using various forms of soil cover. These methods are cheap and avoid disturbing the soil. You can then kill any weeds that do grow by using a hand hoe or machete, or with herbicides.

Managing weeds with soil cover and crops

There are various ways to control weeds using crops and other forms of soil cover. They include planting the main crop and intercrops at the right spacings, planting cover crops, using mulch, rotating crops, and intercropping.

Crop spacing

You can plant crops closer together to shade weeds that try to grow in between. The best crop spacing suppresses weeds but avoids competition between individual crop plants. The ideal spacing depends on:

- **Soil moisture and temperature** Weeds grow quickly in hot, wet areas, so closer spacing is needed to smother them.
- **Soil fertility** Weeds grow fast in fertile soil, so closer crop spacing is recommended.

Cover crops

Good cover crops spread over the soil quickly and suppress weeds before they can grow.

Select cover crops that have several uses (food, fodder, fuelwood, etc.), and that produce a lot of green matter that covers the surface rapidly. Cover crops such as lablab can cover the soil completely 2 months after planting.

You may have to weed once to give the cover crop a chance to get established. You can also use a pre-emergence herbicide after planting maize and lablab to stop weed seedlings from emerging.

If the rainy season is long enough, consider planting the cover crop as a relay crop. It will spread over the soil and smother weeds after you harvest the main crop.

Some cover crops (such as black oats) control weeds by producing chemicals that prevent weeds from growing.

See Chapter 5 for more information on cover crops.

Mulch

Weed seeds germinate easily if the soil is bare. Leaving the crop residue on the surface as mulch makes it hard for weeds to grow because they do not have enough space or light. Take care that the mulch does not smother emerging crop seedlings. See Chapter 5 for more information on mulch.

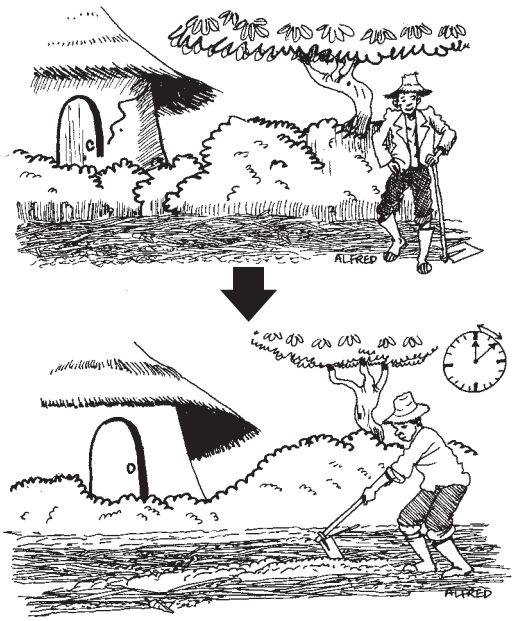
In some cases (such as in semi-arid areas) it is difficult to get enough mulch to cover the soil. Consider bringing in mulch from other fields. This takes more work, but is probably worthwhile. The mulch will not only manage weeds; it will also reduce the soil temperatures, conserve moisture, encourage water to sink into the soil, and add organic matter.

Take care not to bring in mulch that can spread weed seeds! Do not use as mulch plants that have flowered and produced seeds.

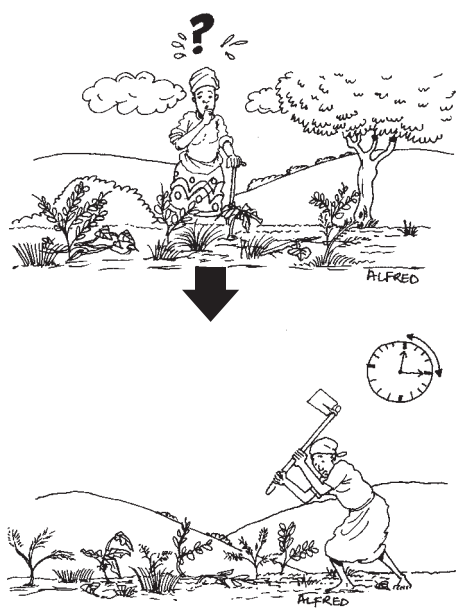
Crop rotation

Planting a different crop on each field breaks the life cycle of weeds. There are fewer weeds, and they are easier to control. A good crop rotation prevents the buildup of weed populations. If you cannot rotate your main crop, try to plant a different cover crop or intercrop each season.

See Chapter 6 for more information on crop rotations.



Mulch suppresses weeds, so saves time when you prepare the field for planting



No mulch? Get ready to spend a lot of time preparing the field and fighting weeds!

Intercropping

Intercropping helps cover the soil and smother weeds that grow between the rows of the main crop. Choose a crop that spreads quickly and produces a lot of vegetation. Legumes, pumpkins and sweet potatoes are a good choice.

Weeding by hand or with equipment

Hand weeding

You can pull out weeds by hand, or slash them with a machete, sickle, slasher or billhook. You can also use a hoe for weeding, but this disturbs the soil surface. Hand weeding is often the job of women and children.

Here are some advantages of hand weeding:

- Uprooting weeds by hand disturbs the soil less than using most types of equipment. Try not to disturb the soil too much if you use a hoe or other implements.
- Hand tools are cheap and can be bought in most markets.

Hand weeding has several disadvantages:

- It is hard work and takes a long time.
- The weeds may regrow easily.
- The stalks may not be crushed well, making it difficult to plant crops through the residue.

Animal- and tractor-drawn weeders

To use an animal- or tractor-drawn weeder, plant the crops in rows with the same spacing as the cultivator blades.

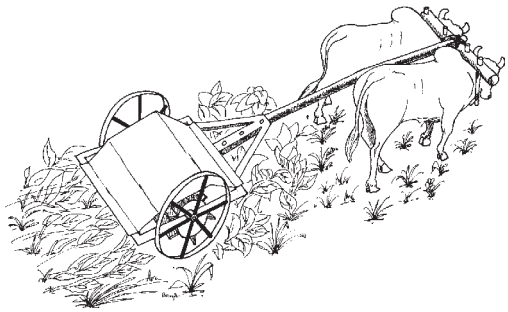
Weeding by draught animal or tractor power is quicker and easier than by hand. Using an animal-drawn weeder can take less than one-fifth of the time needed for hand hoeing.

However, weeders have several disadvantages:

- They can damage crop roots. This may be a problem especially in arid and semi-arid areas.
- They disturb the soil. They bring up weed seeds to the surface and let them germinate more easily. That means more weeding later on.
- They may carry weed seeds from place to place.
- They do not work properly if the field has crop residues or mulch from cover crops.

Knife-rollers

A knife-roller kills the cover crop and weeds by bending them over and crushing them. It is used before planting the main crop. It can be pulled by draught animals or by a tractor. Knife-rollers are fairly simple, and can be designed and made locally.



Animal-drawn knife-roller

Knife-rollers and black oats

Farmers in Brazil plant black oats (*Avena strigosa*) as a cover crop. They use a knife-roller or roller-chopper to kill the oats after flowering but before the seeds have matured. The best time to do this is when the oats have reached the milk stage (squeeze the grains and a white liquid like milk comes out). This has two advantages: when the oats are this old, the dead leaves and stalks stay on the ground as mulch for longer. And the oats do not have a chance to produce seeds, which would be difficult to control.

The knife-roller crushes the cover crop, but does not cut it up. That means the residues are not dragged along by the roller and do not get tangled in equipment.

Herbicides

In some places, there are not enough people to do the weeding. If this is the case, consider using herbicides.

Herbicides are quick and easy to apply, and do not disturb the soil. Some herbicides kill only certain types of weeds.

Not many smallholder farmers use herbicides because they are expensive and hard to find. They also need special equipment, such as sprayers or wipers. It is important to use the right amounts of chemicals, mix them with clean water, and handle them safely. If you are considering using herbicides, get training on how to use them the right way.

Herbicides can be applied in different ways:

- **Weed wiper** (such as a Zamwipe)
- **Knapsack sprayer**
- **Hand-pulled sprayer**
- **Animal-drawn sprayer**
- **Tractor-mounted boom sprayer**.

Weed wipers

A weed wiper looks like a broom with a sponge on one end and a bottle on the handle

A weed wiper looks like a broom with a sponge on its head. A small tank on the handle holds the herbicide, which flows down into the sponge. The best-known type of weed wiper is the "Zamwipe", used in Zambia.

Wipers are ideal for small farms. Use them to apply herbicide on weeds between crop rows, or to kill cover crops before planting the main crop.

Their advantages include:

- They are light and easy to use, and ideal for women farmers.
- They are fairly cheap (about US$ 17) and easy to maintain.
- They have low application rates (only 20–25 litres/ha), so use little water.
- There is no risk of wasting herbicide or damaging the crop because of spray drifting in the wind.

Wipers have some disadvantages:

- They are useful only for small plots of land.
- Farmers need to know how to use the wiper properly.
- Wiping weeds on uneven ground is difficult.

The Zamwipe works best just before planting the main crop. Use it to kill weeds that have started to regrow after they are slashed, when they are 10–12 cm tall. Use it also to deal with individual weeds. It can also be used to control weeds in between rows of maize or sorghum, when the crop is knee-high – i.e., at the same time as when farmers normally weed their fields.

Never use dirty water, and clean the wiper immediately after use.

Knapsack sprayers

Many small-scale farmers already have a knapsack sprayer. These sprayers may be manual or powered by a petrol engine. They are reasonably cheap and easily available. Mounting a shield prevents the spray from drifting onto crops, so the sprayer can be used after the crop has emerged. Knapsack sprayers are not suitable for large farms.

Knapsack sprayer

Hand-pulled sprayers

Hand-pulled herbicide sprayers are like a knapsack sprayer mounted on wheels. When the wheels turn, they pump the herbicide into a boom with four or six spray nozzles. The height of the boom can be adjusted to deal with plants of different heights.

Hand-pulled sprayer

These sprayers are sometimes called "pedestrian-pulled" sprayers.

They have more nozzles and a larger tank than a knapsack sprayer, so can cover a larger areas more evenly. They are suitable for treating a whole field; they cannot be used to spot-spray individual patches of weeds. Because the spray is behind the operator (unlike with knapsack sprayers), there is much less risk of breathing in the spray or getting it on your skin other clothing.

Animal-pulled sprayers

Animal-powered sprayers may have up to 10 nozzles (spaced about 50 cm apart). They can be pulled by one or two animals. They have a larger capacity than hand sprayers, so are suitable for larger areas.

Tractor-powered sprayers

Tractor-powered sprayers can be very sophisticated. They are suited for large farms. It may be possible to hire someone to spray your farm with a tractor sprayer, rather than investing in one yourself.

When and how to weed

After changing to conservation agriculture

When you first adopt conservation agriculture, weeds may be a big problem. Conservation agriculture improves the soil fertility, so encourages weeds to grow. African couch grass (*Digitaria abyssinica*) and yellow nutsedge (*Cyperus esculentus*) may be a particular problem because they are difficult to uproot.

There are a lot of weed seeds in the soil, and if you let them grow, they will destroy your yield!

Here are some steps in controlling weeds. Adapt them to suit your own situation.

1 It is a good idea to slash weeds immediately after the harvest and during the dry season to prevent them from producing seeds.
2 Before you plant, slash any plants (weeds, cover crop, stalks left over from the previous crop) in the field. (A disadvantage with this is that it may encourage grasses and certain other weeds to grow if it is wet.)
3 Dig planting pits with a hoe, or open planting furrows with a ripper or subsoiler.
4 After the first rains have fallen, allow weeds to regrow or new weeds to emerge. Wait about 2 weeks until they are growing vigorously, then apply a post-emergence herbicide such as glyphosate using a Zamwipe or a sprayer. This will kill all emerged weeds before you plant.
5 Immediately afterwards, plant the main crop.
6 Plant a cover crop between the rows of the main crop.
7 Check for weeds every week and control them by pulling them out by hand, scraping the soil surface with a hoe, using an animal-drawn weeder, or using a selective herbicides.
8 Harvest the main crop and allow the cover crop to grow.
9 Continue checking for weeds and pull them out before they can flower and seed.
10 Harvest the cover crop seeds.
11 Manage (bend over and crush) the mixture of crop residues and cover crops using a sickle, machete, knife-roller or another implement some 3 weeks before you expect the first rains to begin.

In later years

If you control weeds diligently, they should be easier to control in later seasons. It can take 3–5 years for the number of weeds in the soil to be reduced so much that very few new weeds grow.

Leave the soil undisturbed, and keep the soil covered so that weed seeds do not have a chance to germinate. Any weeds that are lucky to germinate have no space or light, so they die.

You should still check for weeds regularly and pull out any you find. You may also need to use herbicides to control weeds. But overall, weed control will be a lot less work.

Challenges in managing weeds

- The switch from conventional farming to conservation agriculture is the most challenging time. Many farmers do not realize the importance of controlling weeds, or they may not know how to do it without disturbing the soil.
- Weeding with hoes or with equipment pulled by animals or tractors is more difficult because of the crop residues or mulch on the ground.
- Farmers may be reluctant to use herbicides because of the expense, or because they do not have the right equipment.
- Some critics of herbicides say they damage the environment or make people ill. (Herbicides are safe as long as they are used and stored properly.)
- Farmers may not know how to use sprayers properly, or how to spray the right amount of herbicide. (See the guidelines below.)

Using the right amount of herbicide

If you use herbicides, it is important to make sure you apply the right amount. If you do not, you risk either using too much (which is wasteful and expensive) or too little (which will not control weeds properly).

Zamwipe

The Zamwipe manufacturer estimates that wiping the weeds or cover crop on one hectare of land will use about 20 litres of liquid. The actual amount used depends on the number of weeds (or cover crop) and how thorough the operator is.

Here's how to make sure you use the right amount of herbicide in a Zamwipe:

1 Fill the Zamwipe container with clean water. Do not put herbicide into the tank.

2 Use the Zamwipe to wipe the weeds in a field until the container is empty.

3 Calculate the area you have wiped:

$$\text{Area wiped with 1 container } (m^2) = \text{Width of area wiped (m)} \times \text{Length of area wiped (m)}$$

4 Calculate the number of containerfuls needed to wipe one hectare:

$$\text{Containers of liquid needed to wipe 1 ha} = \frac{10{,}000\ (m^2)}{\text{Area wiped with 1 tank } (m^2)}$$

5 Check the label of the herbicide you want to use. What is the recommended application rate?

6 Calculate how much herbicide to add to each containerful to get the right application rate:

$$\text{Amount of herbicide per tank (millilitres)} = \frac{\text{Recommended application rate (litres/ha) x 1000}}{\text{Tankfuls of liquid needed to wipe 1 ha}}$$

Example

You do a test-wipe of cover crops in a maize field, with rows 0.75 m apart. You find that you can wipe an area of **0.75 m x 650 m** with one containerful.

- Area wiped with 1 containerful = 0.75 m x 650 m = **488 m²**
- To wipe 1 ha, you will need 10,000 / 488 = about **20 containerfuls of liquid**.

The glyphosate label recommends an application rate of **3 litres** of glyphosate per hectare.

- Amount of glyphosate per container = 3 x 1000 / 20 tanks = **150 ml**
- You will need to put **150 ml** of glyphosate into each Zamwipe container.

Sprayer

You can use the same approach to make sure you use the right amount of herbicide in a sprayer.

1 Fill the sprayer tank with clean water (do not add herbicide).

2 Spray a field until the tank is empty. Walk at the same speed as if you were spraying weeds in a field, moving the nozzle for side to side as you normally do.

3 Calculate the area you have sprayed, the number of tankfuls needed per hectare, and the amount of herbicide to add to each thankful, using the equations above.

Example

In your test-spray, you use a tankful of water to spray an area **20 m x 100 m**. The herbicide label recommends an application rate of **3 litres** per hectare.

- Area sprayed with 1 tankful = 20 m x 100 m = **2000 m²**
- To spray 1 ha, you will need 10,000 / 2000 = **5 tankfuls**
- Amount of herbicide per tank = 3 x 1000 / 5 tanks = **600 ml**
- You should put **600 ml** of the herbicide in each sprayer tank.

Sums with herbicide

For more information on working out how much herbicide to use, see the following websites:

- www.arc.agric.za/institutes/sgi/main/howdo/calibrate.htm
- www.knowledgebank.irri.org/ppfm/cropProtection/WebHelp/Crop11.htm

Hand-pulled or animal-drawn sprayers

You can use a similar method to the one above to work out how much herbicide to apply using a hand-pulled or animal-drawn sprayer.

During your test run, make sure that the sprayer boom is set to the right height so the sprays overlap with no wastage of liquid. Pull the sprayer (or lead the animals) at the same speed as you would when normally spraying.

Using herbicides correctly and safely

Using herbicides correctly

- Check the amount of herbicide the sprayer applies to make sure you are using the right amount (see text above).
- Spray from the right height. This depends on the height of the weeds and the type of nozzle. If you are using a hand-pulled or animal-drawn sprayer, adjust the height of the boom so the spray from the nozzles covers the weeds evenly – not too much overlap, and no gaps.
- Mix the herbicide with clean drinking water.
- Always read the label carefully before using any herbicide.
- Make sure you know how to use the herbicide properly. Get training if you need it. If you are not sure about any herbicide or equipment, ask a specialist for help.
- Some dealers sell fake or outdated herbicides. Buy only from a certified dealer. Check the date on the label to make sure the herbicide you buy is still effective.
- Do not use the same herbicide year after year, because weeds may become resistant to it. Switch herbicides each year or every few years.

Using herbicides safely

- Use protective clothing to protect yourself from harmful effects of the herbicides.

Weed control in Laikipia

Farmers who practise conservation agriculture in Laikipia district, a semi-arid area in Kenya, use herbicide to control weeds.

Immediately after harvest, when the soil is not too hard and dry, they rip their fields using an animal-drawn ripper. This allows dew and the first rains to sink into the soil.

It also allows weeds to grow. So the farmers check which type of weeds have germinated, then buy a herbicide that will kill these weeds. In the short rainy season, broadleaved weeds are normally more common, so the farmers buy 2,4-D herbicide (a very toxic chemical!). In the long rains they buy Roundup (a herbicide that contains glyphosate), which controls grass weeds.

They check on weeds regularly and apply another round of herbicide after the crop has started to grow.

The farmers save on herbicide by spraying early in the season when the weeds are small, and by spraying early in the morning. They need only 400–800 ml per acre.

They have found the number of weeds has fallen since they introduced conservation agriculture in 2000. Farmers who cannot buy herbicide use an animal-drawn cultivator, ridger or plough for the first weeding.

- Wash your hands, face, body and equipment immediately after handling or using any herbicide.
- Rinse and clean spray equipment well away from water sources such as wells, ponds or rivers.
- Always store herbicides in their original containers, well out of reach of children and animals.
- Dispose of containers in a deep pit, or as indicated by the manufacturer.

Care of sprayers

- Ensure that the equipment is in good working condition (no leaks or blockages). Check that the valves and switches are working properly and that the spray nozzles and filters are not worn or clogged. Replace worn-out or defective parts.
- Clean the equipment immediately after use.
- Grease and oil moving parts.
- Tighten loose bolts and nuts.

How a Tanzanian farmer controls weeds

"When I was practising traditional agriculture, I had to hand-hoe intensively twice, and do one lighter weeding. It took three labourers 6 or 7 days to weed one acre under normal conditions, or 10 days if the soil was wet.

When I switched to conservation agriculture, I was able to reduce the workload and save time and money. It took fewer people and less time to do the weeding.

The first season when I started conservation agriculture, I had to spend extra on lablab seed and Roundup herbicide. But in the following seasons and years, the costs went down because I had to weed less. I left half of the residues from the previous crop on the field to cover the soil. So the work was easier: only one person could weed an acre in just 2 days by pulling the weeds.

This has given me more time for other work, such as planting trees, gardening, controlling erosion, and making honey. I have three beehives, which produce enough honey for my family and to sell."

Thomas Loronyo, Ngorbob village, Arusha

Controlling *Striga* with agroforestry

Striga hermonthica is a weed that attaches itself to the roots of maize and sorghum plants. It is a parasite – like a flea or leech. It takes nutrients away from the maize or sorghum plant, and reduces the crop yields. It is especially a problem on infertile soils.

Striga is a serious problem in parts of western Kenya. An ICRAF project in this area promotes crop rotation as part of conservation agriculture. It recommends planting leguminous shrubs in rotation with the main crop. These shrubs include *Crotalaria grahamiana*, *Crotalaria paulina*, *Tephrosia candida*, *Tephrosia vogelii*, and *Sesbania sesban*.

The shrubs encourage *Striga* seeds to germinate, but the *Striga* plants cannot attach themselves to the shrub roots, so they soon die. They can completely remove Striga from a field after only two years of rotations.

The shrubs have other benefits too. Because they are legumes, they improve the soil fertility and raise the yield of the main crop. They also provide soil cover, reduce runoff, and control erosion.

More information: Anja Boye