

Conservation agriculture with trees:

a training manual

Produced by World Agroforestry for the Integrated Natural Resources and Environmental Management Project (INREMP)

Correct citation

Mercado A, Noza Z, and Piñon C. 2020. *Conservation agriculture with trees: a training manual*. Los Baños, Philippines: World Agroforestry (ICRAF) Philippines, Department of Environment and Natural Resources, Asian Development Bank, Green Environment Facility

Disclaimer and copyright

This training manual was prepared by World Agroforestry (ICRAF). The information appearing in this publication may be quoted or reproduced without charge, provided the source is acknowledged. No use of this publication may be made for resale or other commercial purposes.

All images remain the sole property of their source and may not be used for any purpose without written permission of the source.

The information provided by ICRAF is, to the best of our knowledge, accurate although ICRAF does not guarantee the information nor is liable for any damages arising from the use of information.

Editor: Robert Finlayson

Design and layout: Zarrel Gel Noza

Illustrations: Roy Oliver Corvera and Ma. Angela Espinosa

Integrated Natural Resources and Environmental Management Project (INREMP)
Project Number: GRANT 0325-PHI

Contents

ii	**Learning objectives**
iii	**Introduction**
1	**Soil health and land degration**
1	Soil health
2	Indicators of soil health
3	Land degradation
4	**Conservation farming**
4	Core principles
6	Key features
7	**Conservation agriculture with trees**
7	Aspects of conservation agriculture with trees
8	Benefits of conservation agriculture with trees
10	Common practices in conservation agriculture with trees
14	**Other practices in conservation farming**
14	Agronomic practices
15	Engineering practices
16	Attributes of appropriate technologies for conservation farming
18	**Equipment used in conservation farming**
18	Equipment for minimum tillage
19	Equipment for direct seeding
21	**Session Guide**
24	**Glossary**
26	**Further Reading**

Learning objectives

After reading this training manual, trainees should be able to:

- Explain soil health and its importance;
- Define conservation farming;
- List the principles of conservation farming;
- Describe at least three practices used in conservation agriculture with trees; and
- Describe at least two pieces of equipment used in conservation farming

Introduction

Several cropping practices have been found to have negative effects on soils, degrading quality and productivity. This led to the development of 'conservation farming': to conserve soils and improve farm productivity while ensuring sustainability.

What is this manual about?

Through text and technical illustrations, this manual discussed the following topics:

- soil health and its importance
- conservation farming and its principles
- conservation agriculture with trees and its related principles
- equipment used in conservation farming

Who is this manual for?

This manual is written particularly for 1) extensionists working in agroforestry and natural resources management projects; and 2) farmers, especially those who want to share their agroforestry knowledge with their fellow farmers.

The manual can be used as reference material for training sessions and other learning activities.

Soil health and land degration

Healthy soils are important to make sure that crop production will be sustainable. However, most of the time, intensive farming practices, such as plowing, frequent tillage and monocropping, degrade the soil. This calls for farming methods that address the needs and aspirations of farmers but also conserve resources, particularly, soil, water, and organic matter.

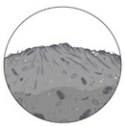
To further appreciate the importance and benefits of conservation farming, it is essential to understand soil health and concepts related to it.

Soil health

Soil health is defined as the capacity of soil to function as a living system, enough to support the life of plants and animals. A soil is considered healthy if it can store enough water and nutrients for plants to grow in it. It is deep enough to allow plant roots to penetrate deeper into the soil.

Properties of a healthy soil

A healthy soil has three main properties: physical, chemical, and biological.



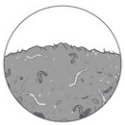
Physical

The physical properties of soil refer to the structure and texture of the soil and how air and water moves in and out of it.



Chemical

The chemical properties of soil refer to the nutrients in it and its ability to provide nutrients to plants as influenced by its acidity and alkalinity.



Biological

The biological properties of soil refer to the living organisms in it, such as earthworms, microorganisms, and insects. These organisms support plant growth through recycling nutrients, forming channels that enable water and air to move, and preventing pests and diseases in plants, among others.

Indicators of soil health

As previously mentioned, a soil is healthy if it can hold water and nutrients and supply these to the crops. Specifically, the following indicators show that a soil is healthy:

- ***Soil organic matter.*** Soil organic matter is considered the most obvious measure of soil quality. It refers to decomposed plants and animals present in the soil. It sustains organisms, enhances the stability of the soil's structure, and supplies nutrients to the plants. Therefore, the greater the organic matter present in the soil, the more fertile it is.
- ***Water-holding capacity.*** A soil's capacity to hold water is affected by various factors, such as its depth, texture, and structure. **Soil texture** refers to the share of mineral particles (that is, sand, silt, and clay) in its composition. This influences not only the water-holding capacity of the soil but also its ability to store and exchange nutrients. **Soil structure** is the arrangement of these mineral particles into lumps.

  In terms of texture, soils with high proportions of silt and clay are more productive, having a greater ability to retain water and nutrients. Sandy soils have bigger sand grains and pore spaces, so water can easily pass through. This results in low water-retention capacity and limited protection of soil organic matter. Structurally, soils that are crumbly and break easily absorb water more quickly.

  Moreover, the deeper the soil, the greater its ability to retain water. Shallow soils should be added with organic matter to increase water holding and nutrients supplying capacity.

- ***Soil pH.*** This refers to the acidity or alkalinity of a soil. It is measured on a scale of 1–14, where 7 is neutral, below 7 is acidic and above 7 is alkaline. This also determines soil solubility, which measures how easily nutrients dissolve and become available to plants. Soil pH likewise influences the activity of living organisms in the soil.

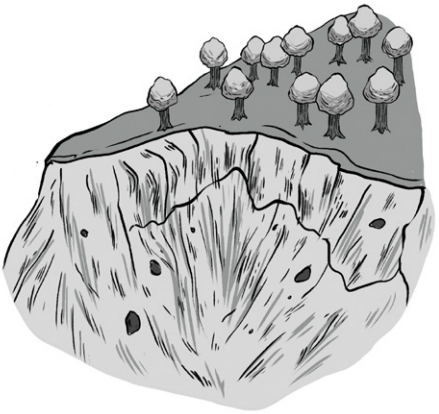
  High acidity lowers bacterial activity, therefore, slowing down decomposition and release of nutrients in the soil. High levels of alkalinity likewise lessen biological activity, resulting in soil crusting and accumulation of toxic levels of sodium and other minerals. Most soils are either acidic or alkaline, while the majority of plants require a relatively neutral pH. However, some crops have more specific pH requirements.

- ***Soil organisms.*** Soil organisms are responsible for the vital processes that maintain the health and fertility of the soil. Macrofauna, like snails and earthworms, regulate decomposition and nutrient cycling. Microorganisms, lik bacteria and algae, likewise serve as organic matter when decomposed. The presence of organisms increases the water- and nutrient-retention qualities of the soil.

Land degradation

Land degradation occurs when the quality of soil decreases owing to natural or human causes.

Soil erosion



One of the most well-known causes of land degradation, particularly on sloping land, is soil erosion. This refers to the removal of topsoil as a result of natural, animal, and/or human activity.

Natural causes of soil erosion include the removal of the topsoil by water and wind. **Human activities** resulting in soil erosion include inappropriate cultivation practices, overgrazing, deforestation, and over tillage.

Soil erosion has negative effects on the farm where the eroded soil came from (on-site) and where it goes (off-site). **On-site effects of soil erosion** include loss of nutrients in the upper layer of the soil, resulting in lower quality and reduced water-holding capacity.

Off-site impacts of soil erosion include silting of dams, contamination of water sources, movement of agricultural pollutants into water resources, flooding, and siltation of bodies of water like creeks, streams, rivers, and oceans.

Decline in soil fertility

It is important to note that erosion is not the sole source of land degradation. There are various forms of physical, chemical and biological degradation of soils, generally referred to as 'soil fertility decline'. This is commonly caused by several factors.



- Decrease in soil organic matter, resulting in lower biological activity and deterioration of soil structure and water-holding capacity.
- Changes in soil nutrients, caused by a reduction of primary nutrients and/or imbalances.
- A buildup of toxicities, commonly a result of improper use of fertilizers.

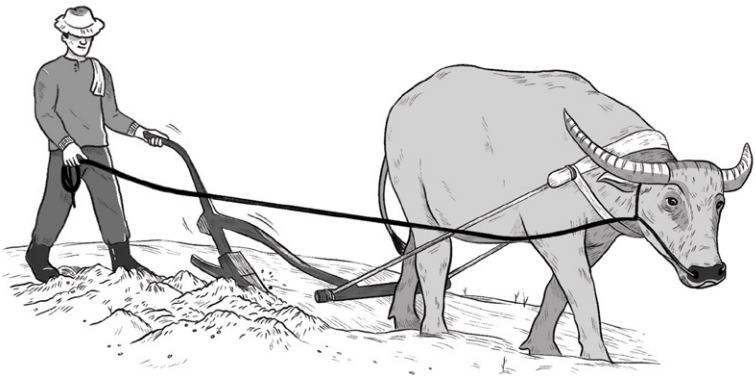
Conservation farming

Conservation farming is an increasingly common approach to sustainable agriculture. It is a combination of agricultural methods aimed at optimizing yields and profits while also preventing land degradation. It aims to minimize the decline of a soil's structure, composition, and natural biodiversity.

Core principles

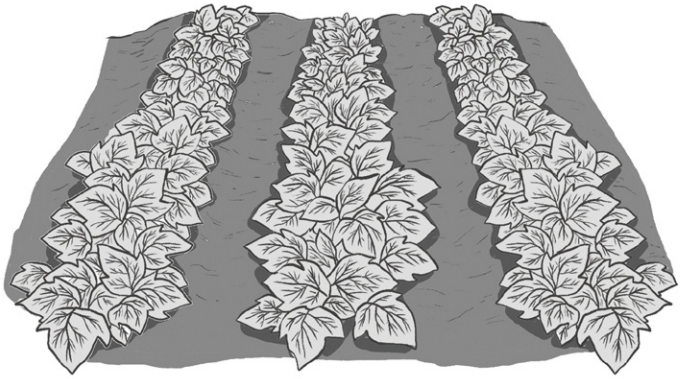
Conservation farming treats the soil as a living body, vital for sustaining life. It underscores the importance of protecting the upper 0–20 cm of soil, which is the layer with the most activity and also the most prone to erosion. Generally, agricultural methods considered as conservation farming exhibit three core principles.

1. Minimum soil disturbance



Under this principle, the soil must be minimally tilled just to allow seeding or planting of crops. Frequent and deep tillage damages a soil's structure. Continuous tillage usually results in the formation of a hardpan—a dense layer of compacted soil—which impedes the roots from growing deeper. Using a direct planter, either hand-operated or by a tractor or an animal, is one alternative to tillage.

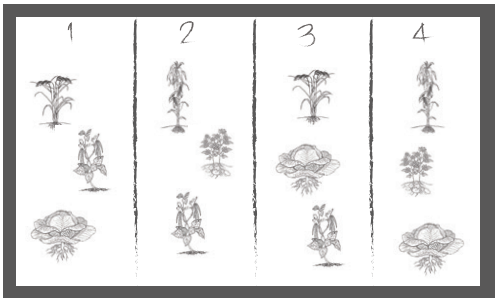
2. Maintenance of permanent or semi-permanent cover



A permanent or semi-permanent protective layer should be established above the soil's surface. This prevents erosion caused by wind and water, suppresses the growth of weeds, conserves soil moisture, thwarts soil compaction, increases soil fertility through adding soil organic matter, and protects the soil from the adverse effects of extreme weather. This can be achieved through several methods.

- Planting live cover crops such as forage legumes like *Arachis pintoi* and *Stylosanthes guianensis*;
- Spreading dead vegetative material like prunings and crop residue; and
- Inclusion of agroforestry tree species as a source of mulch and partial shade.

3. Crop rotation



This principle encourages multiple cropping in a season in the same land management unit. It advocates planting two or more dissimilar type of crops in rotation or as crop mixes. It is advised that leguminous, deep-rooted, and high-residue crops are included in the rotation to maximize benefits to the soil. This practice enhances the structure of the soil with the help of deep-rooted crops, controls weeds and pests, supports the diversity of soil organisms, and increases yields.

Key features

These three core principles of conservation farming can be summarized in the following do's and don'ts.

Do's

- Keep crops and permanent crop residues on the soil surface.
- Apply lime and sometimes fertilizer on the surface, as necessary.
- Direct seeding or planting.
- Grow multiple crops in a season.
- Use specialized equipment for seeding and mulch management.

Don'ts

- Burning of crop residue or fallow vegetation
- Ploughing or disking
- Monocropping
- Uncontrolled grazing

Conservation agriculture with trees

Conservation agriculture with trees is the combination of the principles of conservation farming with agroforestry or the integration of trees on farms.

Aspects of conservation agriculture with trees

With the three core principles of conservation farming, integrating trees to this farming system has two more principles.

Judicious integration of trees



Optimal tree integration provides better tree-crop complementarity which results in total system productivity as trees and crops have increased yields.

Tree integration should consider framework species which include: i.) fertilizer trees like nitrogen-fixing trees; ii.) ficus species which bear fruits that are edible to wildlife; iii) and premium or economic species. Adding ficus species into the farming system encourages more wildlife to converge, defecating seeds of species from other areas, thus improving local floral diversity.

Good management practices

Although farmers are usually skilled in crop management, they need knowledge on good management practices to maximize productivity. They should be equipped with information on seed quality, proper tree spacing and management, weather conditions, and control of pests, diseases, and weeds. This also includes integrated pests, nutrients, and water management.



Benefits of conservation agriculture with trees

Including trees on farms is beneficial for the soil, helping restore and protect it. The trees serve as windbreaks, therefore, protecting the soil from erosion. Aside from these benefits, agroforestry also offers other advantages such as the following.

Provision of wood and non-wood products

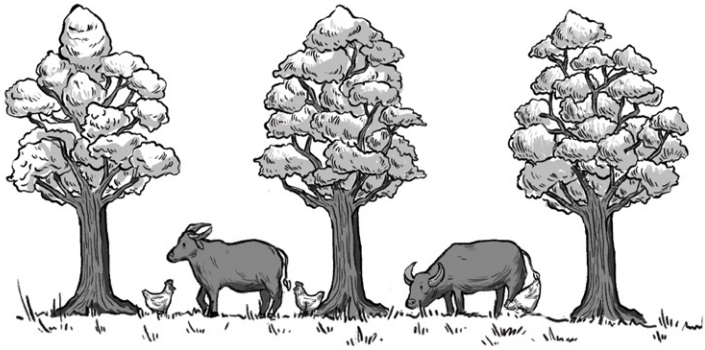
Trees produce timber that can be used for constructing houses and tools. Non-wood products include organic medicines, gums and resins, and fruit. These can serve as food and additional sources of income for the farmer and their immediate community.



Timber, fuelwood, and food are just some of the wood and non-wood prducts provided by conservation agriculture with tree

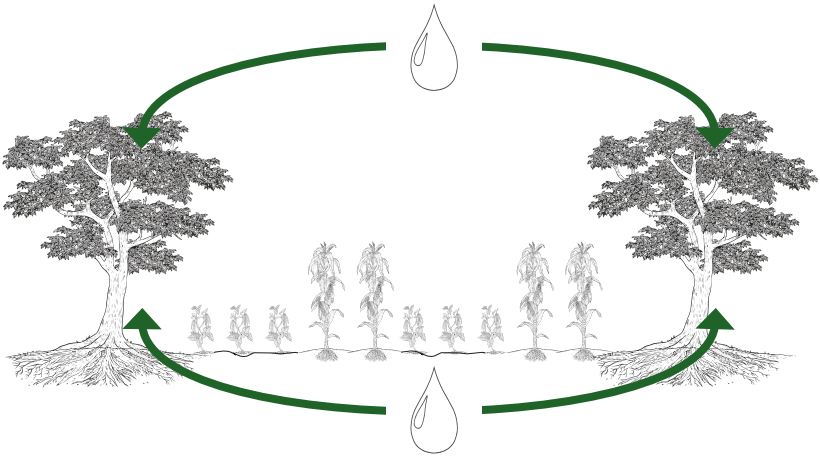
Sources of food for other components in an agroforestry system

As the trees shed their leaves, the leaves can act as organic fertilizers for the agricultural crops. Some woody and leguminous species can also act as fodder for livestock.



Water cycle

In agroforestry, tree roots capture, store and release water. By absorbing water, trees prevent flooding. They also mitigate the effects of drought by storing and releasing water.



Provision of environmental services

Trees absorb and store carbon dioxide, helping regulate the gases in the atmosphere. The carbon storage capacity of trees also helps in moderating the climate. When trees are added to upland farms, they help sustain a flow in waterways while preventing sedimentation in dams and siltation in other bodies of water.

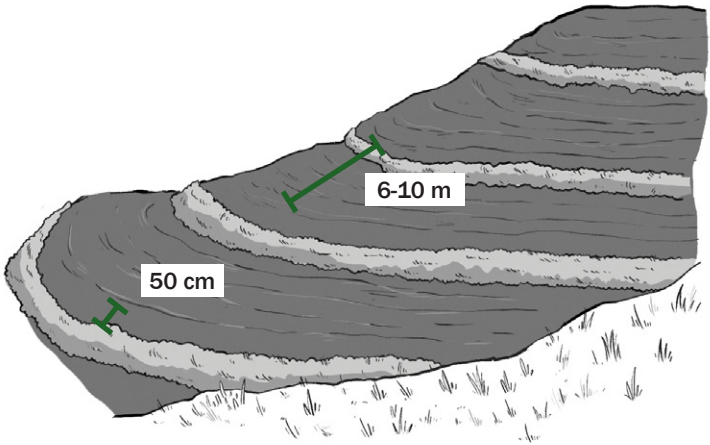
Common practices in conservation agriculture with trees

Trees can be integrated on farms in various ways.

Natural vegetative filter strips

One of the practical solutions for soil degradation, particularly on sloping lands, is establishing natural vegetative filter strips. This is done by leaving natural vegetation strips, usually unplowed, along the contours of 50-cm wide. These serve as soil and water filters.

The strips can be enriched using fodder grasses, such as Guinea grass (*Megathyrsus maximus*), Setaria grass (*Setaria sphacelata var. spendida*), and Napier grass (*Pennisetum purpureum*).



In doing this, the following measurements must be kept in mind.

- Width of the strips: 50 centimeters
- Distance between strips: 6 to 10 meters

Note that the bigger the distance between the strips, the more soil is lost in the process, as indicated in the table below.

Table 1. Annual soil loss as influenced by different strip spacing*

Spacing of natural vegetative strips	Soil loss (tons/ha)**
No strips – contour plowing and planting	38.56
24 meters (8 meters vertical drop)	14.88
12 meters (4 meters vertical drop)	11.92
6 meters (2 meters vertical drop)	6.79
3 meters (1 meter vertical drop)	2.72

*based on practices in Claveria, Misamis Oriental, **mean of two years

To ensure proper spacing between the strips, an A-frame is usually used as shown in the figure below.

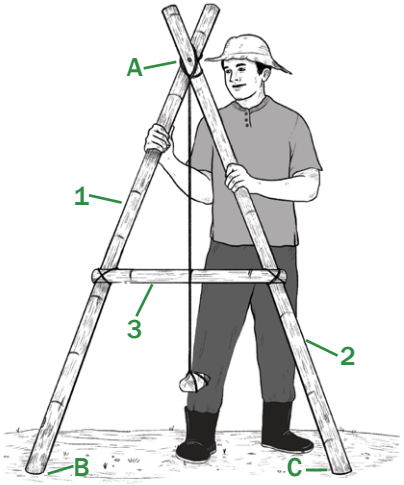
How to make an A-frame?

Materials:

- 3 sturdy wooden or bamboo poles (two pcs 1-1.5m long and one pc 0.5-1m long)
- Strings or ropes
- Nails
- A stone

Process:

1. On level ground, lay the three poles in the shape of a letter A. The two longer poles (poles 1 and 2 in the illustration) will serve as the legs of the A-frame while the shorter pole (pole 3) will be used as the cross bar of the frame.
2. While standing on level ground, spread the lower ends (points B and C in the illustration) of the legs a meter apart. Then, tie or nail the upper ends of the longer poles (point A in the illustration).
3. Place pole 3 horizontally, connecting poles 1 and 2 as shown in the illustration. Secure its place using ties or nails.
4. From the top of the A-frame, hand a thin string with a heavy stone tied at the bottom.



Another method used in establishing the strips is the cow's back method, wherein a cow or a carabao is used to walk across the slope. The carabao then tends to follow the contour, which can be confirmed when the its back looks level.

The strips bring several benefits such as the following:

- Establishment and maintenance require minimal labor.
- Strips reduce soil loss by over 90%.
- Competition with adjacent crops is minimal.
- Strips improve water infiltration into the soil.

Woodlots

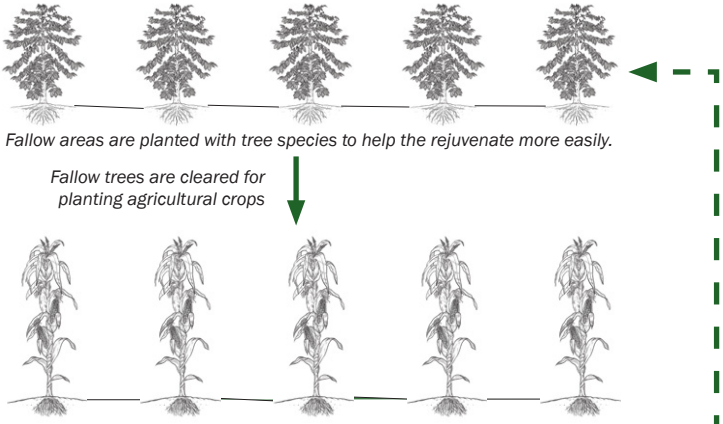
Firewood- and timber-producing trees are planted on the less fertile portion of a farm, forming woodlots. Examples of species grown include *Maesopsis eminii*, *Eucalyptus deglupta*, and *Melia dubia*. Food crops can be grown beneath the trees. To avoid excessive shading of the crops, the tree canopies can be pruned and the prunings can serve as fodder or soil



cover. Farmers only need to practice caution in selecting the appropriate tree species.

Improved fallows

'Fallow' refers to the period of regeneration allowed on a piece of land after being used for continuous cropping. Planting woody tree species, such as Tephrosia candida, *Sesbania* spp, and *Leucaena* spp, hastens regeneration of the soil. The trees are usually planted with the last crop and left to grow during the fallow period. Biomass from these trees can serve as soil cover. It can also be used by farmers to suppress the growth of weeds and as fodder for livestock.



Hedgerow planting

In this practice, food crops are grown in between hedgerows made of shrubs and trees such as *Calliandra calothyrsus* and *Gliricidia sepium*. Species to be used on such hedgerow systems must be well-adapted to acid in infertile soils, nitrogen-fixing, fast-growing, with good quality of root biomass and plant residues, producing medium-to-high-quality timber. As presented in the table below, hedgerow systems composed of trees reduce soil loss by approximately 55 times that of traditional slope cultivation.

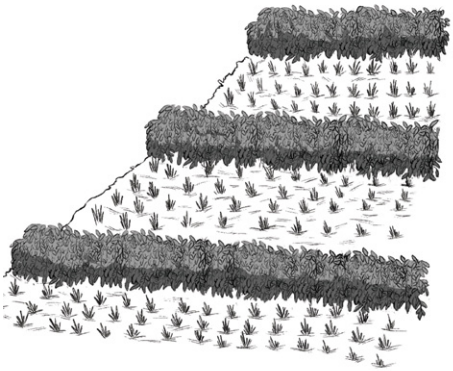


Table 2. Effect of different hedgerow types on soil loss*

Hedgerow system	Soil loss (tons/ha)
Grasses	2.20
Forage legumes	9.80
Shrubs	5.70
Trees	6.50
Contour cultivation	40.00
Traditional cultivation	350.00
Tolerable rate	**12.00**

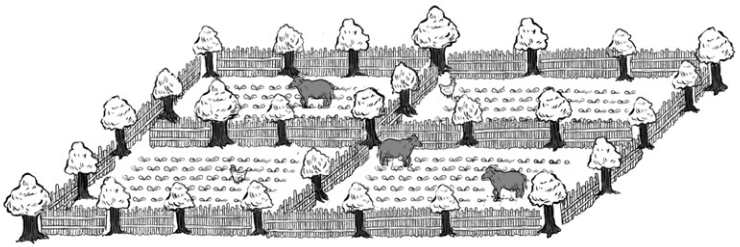
*with 3000 mm annual rainfall

Trees dispersed on croplands

Multipurpose trees, such as *Acacia* spp and *Faidherbia albida*, are grown haphazardly on cropland. Tree species should be selected appropriately to minimize competition with crops.

Boundary planting and live fences

This involves using trees and shrubs as farm boundaries or 'live fences'. Trees used include *Markhamia lutea*, *Acacia* spp, *Pithecellobium dulce,* and *Melia azedarach*. Aside from serving as boundary markers, the trees also act as windbreaks and sources of fodder.



Other practices in conservation farming

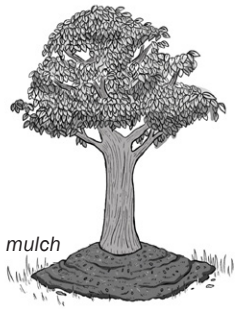
There are other agronomic practices used in conservation farming, which can also be combined with conservation agriculture with trees.

Agronomic practices

The following are some agronomic practices in conservation farming.

Mulching

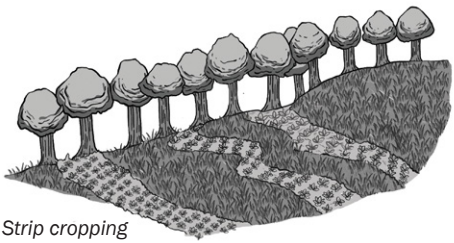
This involves using plant residues or mulch as soil cover. Adding trees in croplands also supports mulching because dried leaves can also serve as the mulch.



mulch

Strip cropping

In this method, erosion-limiting and soil-conserving crops in alternate strips are grown on the contour.



Strip cropping

Crop rotation

This is the systematic planting of different crops in succession on the same piece of land. Usually, a grain crop is followed by a legume crop.

Relay cropping

This involves planting two or more annual crops, with the second crop planted after the first crop has flowered or is nearing its harvest.

High-density planting

This involves increasing the number of crops planted per unit area of land, taking into consideration the effect on crop competition.

Multiple cropping

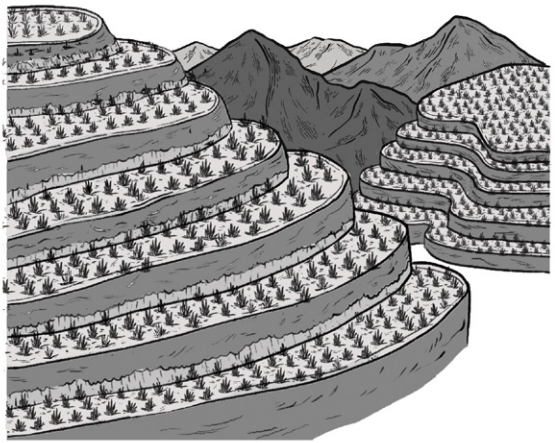
This is the practice of increasing crop varieties and productivity while protecting the soil from erosion.

Engineering practices

Engineering methods below are those that require building structures.

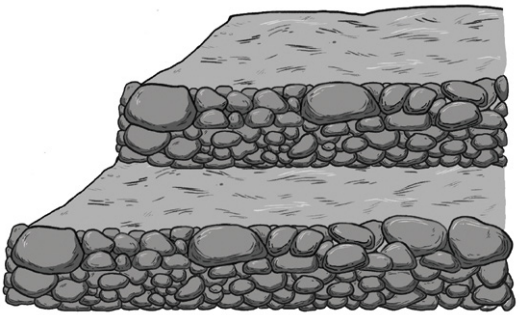
Bench terracing

Crops are planted along terraces or level steps constructed on the contour. These are separated by embankments or risers, usually made of grass strips.



Rock walls

In this method, stones are used as risers instead of grass strips.



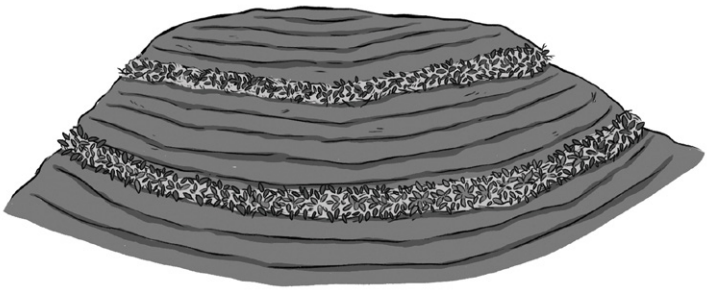
Infiltration ditches

These are ditches dug along the contours to gather water from roads and other sources of runoff. The other end of the ditch is closed so water is trapped in the ditch, allowing it to seep into the soil.



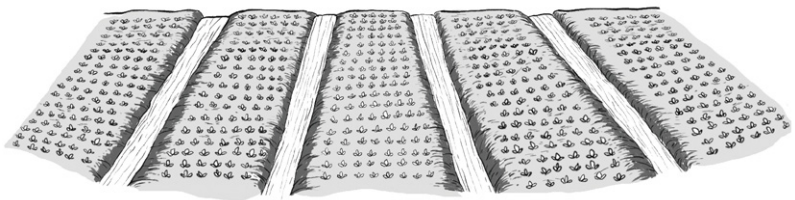
Trash bunding

This method involves lining up plant residues along the contour to slow water runoff.



Cut-off drains

Drains are dug across a slope to divert the surface runoff to a waterway. These drains are installed to prevent uncontrolled runoff from cultivated land.



These methods are commonly used in combination with agronomic methods or other engineering measures. Use depends on several factors:

- Climate
- Farm size
- Soil characteristics

Attributes of appropriate technologies for conservation farming

In selecting the appropriate technologies to use in conservation farming, the following points must be observed.

- ***Superior.*** The farming technology of choice must be better than the current practice and easy to implement.
- ***Compatible.*** The technology must match local values, experience, needs, and aspirations of the farmers.

- ***Simple.*** It must be easy enough to be understood and practiced by farmers.
- ***Affordable.*** The technology should not be too expensive both for the farmers and for any development bodies supporting it.
- ***Adaptable.*** A good conservation farming technology can be easily adjusted according to a farmer's time and available resources.
- ***Impacts.*** The technology must provide short-, medium- and long-term benefits to the soil and the farmers.

Equipment used in conservation farming

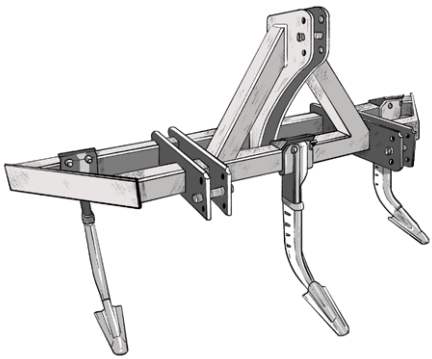
Different types of equipment are used in conservation farming.

Equipment for minimum tillage

Minimum tillage equipment is only used in an area where a crop will be planted. The rest of the area must be left undisturbed. Examples of these types of equipment follow.

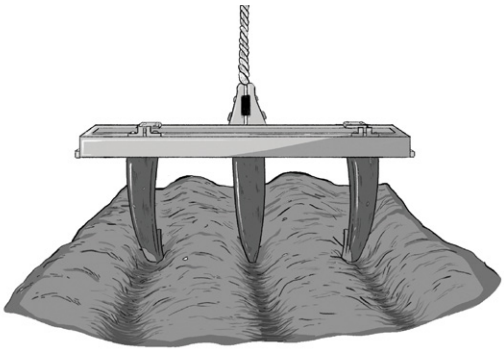
Sub-soiler or chisel plough

This is used to break or loosen compacted soils. This can be drawn by an animal or a tractor.



Ripper

This equipment is used for making planting furrows in unplowed fields.



Equipment for direct seeding

This includes types of machineries that can seed directly in unplowed land. It should also be capable to plant through trash, mulch, or cover crops. Examples of these are:

Hand hoe

This is the most common, available, and affordable equipment used to practice conservation farming. It can be used to dig planting holes. If there are already plant residues in the field, the hand hoe can be pushed directly on the soil to create planting holes.





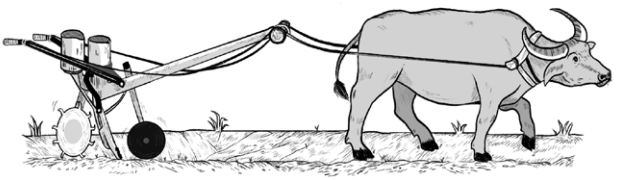
Jab planter

This equipment has sharp beaks that penetrate the soil. It can have a single hopper, which is used for seeds only, or double hoppers, which are used with fertilizer.

To use this, the seeds are placed in the seed hopper and the other hopper is filled with fertilizer. Using the handles, the equipment is carefully pushed into the soil.

Animal-drawn direct seeder

This is composed of a coulter, which cuts through the surface residue, a seed hopper, a fertilizer hopper, and a furrow opener. This should be attached to an animal trained to walk in a straight line. It should be properly adjusted so it can operate with adequate force. The operator should not apply extra force on the handles.



Conservation farming learning sites established by ICRAF for INREMP





Photos of the conservation farming learning sites at Barangay Cabaritan, Tabuk City, Kalinga. Photo credits: World Agroforestry/Mar Berry

Session Guide

Topic: Consercation agriculture with trees

Logistical Considerations:

Time allotment: 8 AM to 5 PM for two days

No. of Participants: 20 – 30 pax (ensure a ≥30% attendance of females)

Venue: Day 1 – Training Hall; Day 2 (morning) – Farmer's field; Day 2 (afternoon) – Training Hall

Purpose: Conservation agriculture with trees is a farming practice that combines the principles of conservation agriculture with agroforestry. It involves the integration of environment-friendly, high-valued, and/or nitrogen-fixing agroforestry tree species into the farm with conservation agriculture practices. Aside from conservation farming and conservation agriculture with trees, other practices promote sustainable land management. Understanding the overview of these practices is important to determine their suitability and profitability considering diverse bio-physical and socio-economic conditions.

Objectives:

The two-day training aims to capacitate the extensionists and/or farmers about the concept of conservation agriculture with trees and other related practices. Specifically, the training aims to:

- enhance their understanding and knowledge about sustainable land management from among the range of practices;
- enable them to identify practices suitable to their conditions and capacities (bio-physical, socio-economic, needs, and aspirations); and
- able to establish natural vegetative strips on the farm using different methods (A-Frame, Cow's back, hose-ring, string).

Resources:

- Powerpoint lectures on conservation farming and agroforestry
- Materials for A-Frame construction and steel tapes
- Long and thick tarpaulin (a makeshift roof in case it rains on Day 2)

Methods:

- Presentations/lectures;
- Discussions/Sharing of experiences;
- Workshop; and
- Actual demonstrations/hands-on training.

Session Plan

Key Points	Time	Learning Check
Day 1		
Introductory Introduce trainer and training team followed by the participants, training title, training objectives, flow of activities, and set of house rules. Opening remarks and leveling-off Discussion 1: Ask the participants about the common natural resource degradation they see or observe in and around their communities, followed by their understanding of conservation farming practices and some examples. Ask them for the possible reasons why some farmers are not adopting these	30 mins	Confirm that participants understood the objective of the training and the flow of activities. Check if they have any concerns or anything to add in the training program.
Theoretical Discussion ■ Soil health and land degradation (pp. 1-3): Discuss the issues and challenges in the uplands with emphasis on land degradations, for example, soil erosion as one of the major problems in sloping areas. (Conduct a short ice breaker that involves standing and movement to wake the participants up – a short game or dance.) ■ Conservation farming concepts and principles (pp. 4-6): Relate how conservation farming addresses some of the issues and challenges discussed earlier.	2.15 hours	Confirm that the participants understood each topic. Ask if CF principles and concepts are being applied in their areas and in what forms.
Open session (Q&A)	15 mins	Check for questions/clarifications regarding the lectures.
Theoretical (Presentation/discussion) ■ Conservation agriculture with trees (pp. 7-10): Discuss the important role of trees on farms – their potentials and constraints. (Conduct a short ice breaker that involves standing and movement to wake the participants up – a short game or dance.) ■ Other practices in conservation farming (pp. 14-19): Discuss other soil and water conservation measure, including those that require agronomic, engineering, and equipment.	2 hours	Confirm that the participants understood the topics discussed. Ask the applicability of these practices and the potential farmers' attitudes towards adoption of these.
Open session (Q&A)	15 mins	Check for questions/clarifications regarding the lectures.
Practical (Workshop) Enhancing farm designs: This can be individually or by group depending on the profile of participants. They will be asked to draw their existing farms, followed by another drawing of their enhanced farm design, applying some of the practices they learned. They should be able to explain their reasons for these enhancements. (The participants can continue doing this activity overnight. Inform the group that their outputs will be presented in a plenary the following day.)	30 mins	The trainer and training should make rounds and check the participants' progress during the group activity. Let them work on their own. Interfere only when there is something wrong or if the participant or group is having a hard time to start.

Key Points	Time	Learning Check
Wrap-up for Day 1 Summarize the principles and concepts that were discussed, and how these can be applied to improve their farms.	30 mins	Random participants may be asked to recall each of the principles of CF with the trainer continuing with the rest of the explanations.
Day 2		
Practical: Actual hands-on demonstration of NVS establishment The hands-on activity will be conducted on a sloping farm near the training hall. In one group, review the importance of controlling soil erosion problems and relate the hands-on activity on contouring that is about to be demonstrated. Arrange and present all the materials needed on the ground for everyone to see. Demonstrate the proper construction and calibration of an A-frame, then group the participants into three (ensure equal distribution of males and females) to do the following activities: ■ Construction of the A-frame ■ Calibration of the A-frame ■ Locating the contours using the A-frame ■ Establishing contours using a cow ■ Correcting the stakes Each group may be assigned in the upper, middle, and lower sections of the sloping farm.	2.5 hours	The trainer and training team should go around and check if the participants are following the proper steps and correct them when needed. Check for questions/clarifications.
Open session (Q&A)	30 mins	Check for questions/clarifications.
Plenary presentation of workshop outputs The workshop outputs can be presented in the plenary where the participant will present her/his current farm design and practices and the changes he/she will make based on the concepts and principles learned in the training. The other participants are encouraged to give friendly comments and/or suggestions to improve the enhanced plans. If there are few participants, the Round Robin method can be also be used in presenting the outputs, especially if many participants are uncomfortable presenting on stage. In Round Robin, the outputs are posted on the wall. The group moves from one place to another to hear and comment on the presentation.	1.45 hours	The agroforestry specialist/researcher shall provide comments and/or suggestions to the enhanced farm designs.
Wrap-up for Day 2 Synthesis and way forward (upcoming activities)	30 mins	Ask participants if they have any questions or clarifications.
Closing Impressions from the participants	30 mins	
Evaluation Use the prepared form for the evaluation	15 mins	Translate into the local language, if possible.

Glossary

Acidic soil. Soil with a pH below 7

A-frame. A piece of wooden equipment shaped like letter A used to locate the right contours of a sloping area and measure spacing in between strips or contours

Agronomic practices. Conservation farming practices that use soil and crop management

Alkaline soil. Soil with a pH of above 7

Engineering practices. Conservation farming practices that require the building of structures, for example, bench terraces and rock walls

Environmental services. Benefits provided by healthy ecosystems, for example, carbon sequestration and soil erosion prevention

Hardpan. A dense layer of compacted soil that hinders the roots of plants from growing deeper

Land degradation. The process in which the soil loses its fertility and overall quality due to natural and/or human causes

Monocropping. The practice of planting a single type of crop on a single land management unit in a season

Over tillage. Excessive and frequent tilling of the land

Siltation. A type of water pollution in which washed-off soils are deposited into bodies of water and form sediments at the bottom

Soil erosion. Removal of the topsoil as a result of natural or human activity

Soil health. The capacity of soil to function as a living system, enough to support the life of plants and animals

Soil organic matter. Decomposed plants and animals present in the soil

Soil organism. Living organisms present on the soil that help maintain its health and fertility, for example, earthworms, bacteria, and algae

Soil pH. Measures how acidic or alkaline the soil is; measured on a scale of 1-14

Soil regeneration. The soil's process of regaining its loss nutrients, helping it restore its health and fertility

Soil solubility. The soil's ability to dissolve nutrients and make it available to plants

Soil structure. Arrangement of mineral particles in the soil into lumps

Soil texture. Share of mineral particles (that is, sand, silt, and clay) in the soil

Sustainable farming practices. Farming practices that ensure the protection of natural resources, including that of soil, to provide the community and/or household's present food, fuelwood, timber, and other needs without compromising the resources' ability to meet future needs

Topsoil. The topmost layer of the soil

Water-holding capacity. The ability of the soil to absorb and retain water to sustain the needs of the soil, the crops, and other soil organisms

Further Reading

Agricultural Training Institute-Cordillera Administrative Region. n.d. *The 10 Steps of Sloping Agricultural Technology (SALT 1)*. https://ati.da.gov.ph/ati-car/sites/default/files/The_10_Steps_of_SALT1.pdf

Evans C, Rana L, Dhungana H, Lakoul M. 2001. *The Farmer's Handbook Volume 5: Forest, Soil, and other Topics*. https://www.permaculturenews.org/resources_files/farmers_handbook/volume_5/1_intro.pdf

Farooq M, Siddique KHM. 2015. *Conservation agriculture*. In: Farooq M, Siddique KHM, eds. Conservation Agriculture. Basel, Switzerland: Springer Nature. https://doi.org/10.1007/978-3-319-11620-4.

Liniger H, Critchley W. 2007. *Where the land is greener: case studies and analysis of soil and water conservation initiatives worldwide*. Wageningen, Netherlands: Technical Centre for Agricultural and Rural Cooperation; Rome, Italy: Food and Agriculture Organization of the United Nations; Nairobi, Kenya: United Nations Environment Programme; Bern, Switzerland: Centre for Development and Environment. http://www.wocat.net/fileadmin/user_upload/documents/Presentations_and_Posters/posterWOCATbook.pdf

Mutua J, Muriuki J, Gachie P, Bourne M, Capis J. 2014. *Conservation agriculture with trees: principles and practice. A simplified guide for extension staff and farmers*. Nairobi, Kenya: World Agroforestry (ICRAF). http://www.worldagroforestry.org/downloads/Publications/PDFS/TM17693.pdf.

Sustainable Agriculture Information Initiative. 2010. *Technical manual for farmers and field extension service providers: soil and water conservation*. Nairobi, Kenya: Sustainable Agriculture Information Initiative. https://foodgrainsbank.ca/uploads/Sustainable%20Agriculture%20Information%20Initiative%20%282010%29.%20Technical%20Manual%20-%20Conservation%20Agriculture.pdf.

Young A. 1989. *Agroforestry for soil conservation*. In : ICRAF. 1989. ICRAF Science and Practice of Agroforestry No. 4. Nairobi, Kenya: ICRAF, CAB International. http://apps.worldagroforestry.org/downloads/Publications/PDFS/B05682.pdf