Food and Agriculture Organization of the United Nations

Promoting CONSERVATION AGRICULTURE in Timor-Leste

MINISTÉRIO DA AGRICULTURA E PESCAS

USAID FROM THE AMERICAN PEOPLE

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FOREWORD

Traditional agricultural practices in our beloved country has always been largely associated, in the past and to some extent today, with land clearing, burning and soil tillage. The most widely known tool for these practices - the plough - has thus become a symbol of agriculture. Many farmers still believe that burning of biomass and soil tillage will increase soil fertility. In fact, these processes actually lead to the reduction of soil organic matter, and hence soil fertility, in the long term. Soil organic matter is one of the most important elements for soil fertility as it not only provides nutrients for the crop, but is also a crucial substance for the stabilization of soil structure. Removal of organic matter and micro-organisms (due to burning) from the top soil over years has led to reduced soil fertility in most of our arable land. This structural degradation of the soil results in the formation of crusts and compaction and leads to serious soil erosion that we are facing today. With the increased climate variabilities and climate change impacts, this process will be more intense and more destructive.

Conservation agriculture (CA) has come to our attention as an alternative to reverse the process of soil degradation and at the same time, increase productivity and resilience of crops against extreme climate conditions. Since 2013, the Ministry of Agriculture and Fisheries in collaboration with the Food and Agriculture Organization of the United Nations (FAO), has been testing the CA techniques through demonstration plots in the communities, as well as in MAF research stations. The techniques include reducing tillage and promoting the use of mulch and intercropping with legumes. Over the last five years, the CA techniques have been tested and adapted for different farm sizes, soils, crop types and climatic zones.

Farmers' reactions have been overwhelmingly positive, particularly those with large farm size on flat lands. At least 4000 farmers (of which 939 are women) across seven municipalities of Baucau, Manufahi, Manatuto, Aileu, Ermera, Dili (Atauro) and Lautem have adopted and are practising CA technologies and practices on a total of around 200 ha farm fields. Their experience has shown increased yields of up to 125% and reduced labour costs by at least 50%.

Further promotion of CA is therefore a key strategy for future development of the agriculture sector in our country mainly with the smallholders and family farming. For this purpose, we have produced this Manual as a practical guide to agricultural practitioners, researchers and most importantly, agriculture extension officers to assist farmers in the proper implementation of CA. With this Manual, the Ministry of Agriculture and Fisheries hopes that CA information will reach a wider audience and that CA will be practiced and adopted nationwide.

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1. WHAT IS CONSERVATION AGRICULTURE?

Conservation Agriculture aims to increase crop yields while reducing production costs (e.g. labour and inputs), improving and maintaining soil fertility (e.g. plant nutrients, organic matter, micro-organisms and structure) and waterholding capacities and preventing soil erosion and land degradation.

Conservation Agriculture comprises a package of crop production technologies and practices that can achieve sustainable agriculture and improve livelihoods (i.e. food security, nutrition and income generation) for Timor-Leste's vulnerable farming population. Conservation agriculture can be applied to any crop whether it be cereal, pulse, fruit or vegetable.

Conservation Agriculture is founded on three key principles:

1. Disturb the soil as little as possible (i.e. no ploughing, digging and hoeing)
2. Keep the soil covered as much as possible (i.e. cover crops and mulches - no burning and no grazing of felds)
3. Mix and rotate crops (i.e. leguminous cover crops)

Conservation Agriculture can be combined with other climate-smart agriculture technologies and practices (e.g. agro-forestry, integrated livestock farming systems (e.g. stall-feeding), integrated pest and disease management, integrated soil plant nutrient management, on-farm water management and water harvesting) to enhance its crop productivity and farm profitability benefits – all tested, validated, demonstrated/ replicated and up-scaled through a "farmer field school (FFS)" approach to demand-driven and group-based applied research and participatory extension adopted by the Ministry of Agriculture and Fisheries (MAF).

2. BENEFITS OF CONSERVATION AGRICULTURE

REDUCED CROP PRODUCTION COSTS: The use of direct seeding methods significantly reduces the labour requirements and fuel expense of digging and ploughing whole fields. The use of cover crops and mulches limits weed growth and significantly reduces the labour requirements for weeding.

INCREASED SOIL MOISTURE: The use of cover crops and mulches protects soil surfaces from: (i) rainfall impact, surface sealing and runoff – resulting in increased water infiltration into soil profiles; and (ii) the sun's heat, evaporation and burning of soil carbon, which over time will lead to increased organic matter and improved structure of the soil profile – resulting in increased water holding capacities. *See Demonstration Exercise No. 1.*

INCREASED SOIL FERTILITY: The organic matter of mulches used on soil surfaces will gradually be incorporated into soil profiles as populations of soil fauna increase (e.g. worms and beetles) and improve soil micro-biotic life (e.g. bacteria and fungus) – the basic "glues" of soil structure and soil-nutrient-plant relations. The use of leguminous crops as cover crops or rotated crops increases the nitrogen fixing capacity of the soil.

REDUCED SOIL EROSION AND LAND DEGRADATION: No burning, grazing, ploughing and digging and the use of mulches from fallow vegetation and crop residues mean that fragile soil surfaces are no longer exposed to heavy rainfall, surface sealing, runoff and soil erosion. Improved "soil health" (i.e. fertility, structure, etc) also reduces the risk of further land degradation. *See Demonstration Exercise No. 2.*

INCREASED CROP YIELDS: With improved availability of water in the soil, biodiversity in the field, soil fertility, germination and survival rates in dry spells and droughts and reduced pests and diseases, crop yields will increase over time.

MINIMISE THE EFFECTS OF DROUGHT: With increased storage capacity of water in the soil and improved "soil health", crops will be able to manage prolonged dry periods and possibly survive longer periods of drought – both increasingly evident with climate change and variability.

MINIMISE THE EFFECTS OF STRONG WINDS: With improved "soil health", crops will produce deeper and stronger roots and reduce the risk of falling plants in strong winds. – also increasingly evident with climate change and variability.

[1] See a separate FAO/MAF "farmer field school" manual

3. CONSERVATION AGRICULTURE TECHNIQUES

1. **Prevent burning and free-grazing of fallow and crop residues in the community** – as part of participatory land use planning, village regulation and legislation and enforcement of *tarabandu* customary laws for conflict resolution at suco and administrative post levels.

2. **Make a mulch across the field not more than two/three weeks before planting** – from chopped regenerated vegetation of fallow and/or legume trees' leaves, Tithonia, coffee husk and/or residue from previous crop using hand-tools on sloping land and small plots (e.g. long-handled sickles and machetes [Table 1]) and tractor-drawn roller/crimpers on flat land (ensuring sufficient decomposition of biomass for planting and enough cover for weed control).

Roots should not be dug up in order to minimise soil disturbance and increase soil organic matter. Herbicides can also be considered in early years to prevent regrowth of chopped fallow and to reduce weed growth when mulches are less dense.

3. **Plant the main crop through the mulch at the correct depth and spacing, as recommended by MAF extension services** – using minimum tillage/direct seeding practices and technologies, e.g. iron bars, hand jab planters, Li seeders and rolling injector planters on sloping or flat land (Table 1). The seed size and planting depth and spacing settings of the planters and seeders should be calibrated for the respective crop types and varieties.

4. **Plant the leguminous cover crop through the mulch and between the main crop at the correct depth and spacing** – usually by iron bars, hand jab planters, Li seeders and rolling injector planters. Again, the seed size and planting depth and spacing settings of the planters and seeders will need to be calibrated for the respective crop types and varieties. Some cover crops can be planted at the same time as the main crop but more vigorous and competing cover crops should be planted later once the main crop has germinated and is well established. Further recommendations are provided in Table 2.

5. **Weed the crops as required** – Although the use of cover crops and mulches limits or eliminate weed growth (as widely shown in FFS demonstration plots and farmers' own plots), some weeding might still be necessary when the layer of mulch does not completely cover the soil surface or is not thick enough.

Table 1. Conservation Agriculture Tools and Machinery

Long-handled sickle

Use of long-handled sickle

Iron bars

Iron bars in action

Hand jab planter

Hand jab planter in action

Rolling injector planter

Rolling injector planter in action

Li seeder planter

Li seeder planter in action

Two-wheel tractor-drawn roller

Two-wheel tractor-drawn roller in action

Four-wheel tractor-drawn roller

Four-wheel tractor-drawn roller in action

Table 2. Recommended Leguminous Cover Crops for Conservation Agriculture

Municipality	Administrative Post	Recommended Leguminous Cover Crop (s)		
		Variety	Planting Time (*vis a vis maize*)	Spacing (cm)
Baucau	Venilale	Velvet bean	4 to 5 weeks after maize	80 to 120
		Lima beans	Same time	60 to 80
		Cowpeas	Same time	30 to 50
		Pigeon peas	Same time	40 to 60
	Quelicai	Velvet bean (taboo in two sucos)	4 to 5 weeks after	80 to 120
		Lima beans	Same time	60 to 80
		Cowpeas	Same time	30 to 50
		Pigeon peas	Same time	40 to 60
		Lab-lab	Same time	80 to 100
	Baucau Vila	Velvet bean	4 to 5 weeks after	80 to 120
		Lima beans	Same time	60 to 80
		Cowpeas	Same time	30 to 50
		Pigeon peas	Same time	40 to 60
Ermera	Letefoho	Velvet bean (local variety-koto moruk)	3 to 4 weeks after	60 to 80
		Cowpeas	Same time	30 to 50
		Pigeon peas	Same time	40 to 60
		Lab-lab	Same time	80 to 100
	Atsabe	Velvet bean (local variety-koto moruk)	3 to 4 weeks after	60 to 80
		Cowpeas	Same time	30 to 50
		Pigeon peas	Same time	40 to 60
		Lab-lab	Same time	80 to 100
Manatuto	Manatuto Vila	Velvet bean	4 to 5 weeks after	80 to 120
		Cowpeas	Same time	30 to 50
		Pigeon peas	Same time	40 to 60
	Laclubar	Velvet bean (local variety-koto moruk)	3 to 4 weeks after	60 to 80
		Cowpeas	Same time	30 to 50
		Pigeon peas	Same time	40 to 60
	Soibada	Velvet bean (local variety-koto moruk)	3 to 4 weeks after	60 to 80
		Cowpeas	Same time	30 to 50
		Pigeon peas	Same time	40 to 60
	Natarbora	Velvet bean	4 to 5 weeks after	80 to 120
		Cowpeas	One week after	40 to 60
		Pigeon peas	Same time	40 to 60
		Lab-lab	Same time	80 to 120
		Winged beans	One week after	80 to 120
		Jack beans (mixed with other legumes)	Same time	50 to 80

Manufahi	Same (uplands)	Cowpeas	Same time	30 to 50
		Pigeon peas	Same time	40 to 60
		Read beans	After harvesting maize	40 to 60
	Same (lowlands)	Velvet bean	4 to 5 weeks after	80 to 120
		Cowpeas	Same time	40 to 60
		Pigeon peas	Same time	40 to 60
		Lab-lab	Same time	80 to 100
		Winged beans	Same time	80 to 100
	Alas	Velvet bean	4 to 5 weeks after	80 to 120
		Cowpeas	Same time	40 to 60
		Pigeon peas	Same time	40 to 60
		Lab-lab	same time	80 to 100
		Winged beans	Same time	80 to 100
	Fatuberlihu	Velvet bean	4 to 5 weeks after	80 to 120
		Cowpeas	Same time	40 to 60
		Pigeon peas	Same time	40 to 60
		Lab-lab	Same time	80 to 100
		Winged beans	Same time	80 to 100
Aileu	Remexio	Cowpeas	One week after	40 to 60
		Pigeon peas	Same time	40 to 60
		Lab-lab	Same time	80 to 100
Dili	Atauro	Velvet bean	4 to 5 weeks after	80 to 100
		Cowpeas	Same time	40 to 60
		Pigeon peas	Same time	40 to 60
		Lima beans	Same time	60 to 80
Lautem	Lautem	Velvet bean	4 to 5 weeks after	80 to 100
		Cowpeas	Same time	40 to 60
	Lospalos	Velvet bean (taboo in two sucos)	4 to 5 weeks after	80 to 100
		Cowpeas	Same time	40 to 60
		Lab-lab	Same time	80 to 100
		Pigeon peas are taboo in Lautem Municipality		

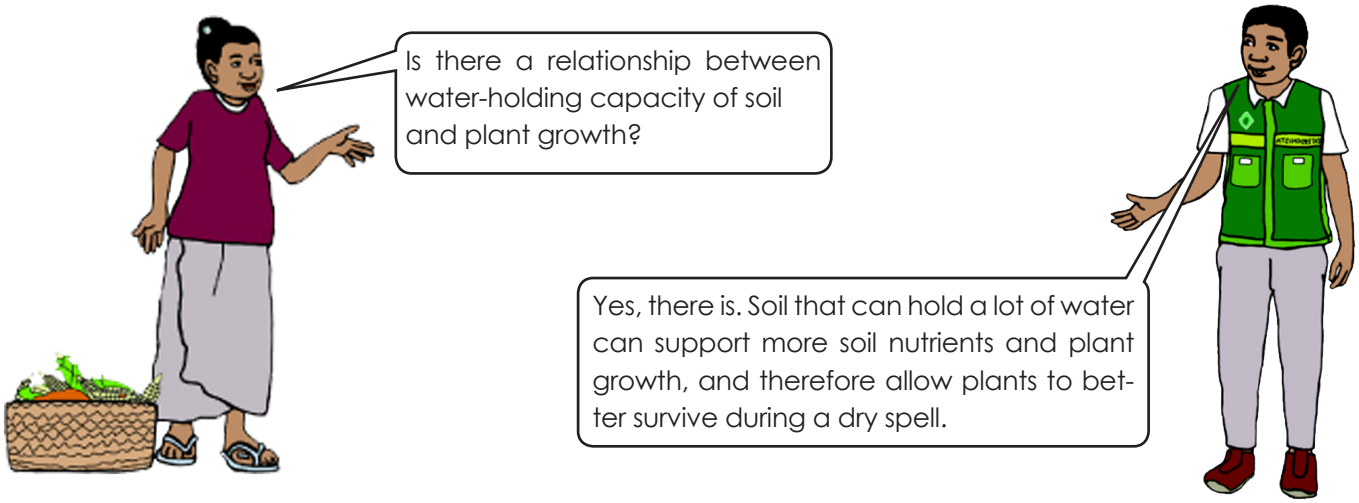
DEMONSTRATION EXERCISE NO. 1
BENEFITS OF CONSERVATION AGRICULTURE FOR IMPROVED WATER-HOLDING CAPACITY OF SOILS

Objective: to learn how the soil can conserve water.

Tools and materials: Six empty 1.5 liter plastic water bottles (three bottles with 1/4 of the upper parts cut off and three others with 1/4 of the lower parts cut off), 1.5 kg of soil for each soil type (such as soil with a lot of compost, sand, unfertile soil), five liters of water, rope and three plastic containers.

Steps:

1. FFS facilitator explains how to do the exercise and its objective.
2. Cut off 1/4 of the lower part of each bottle and hang each bottle from a pole with a rope.
3. Put each soil type into each bottle.
4. Put a plastic container under each bottle to accumulate the water dripping from each bottle.
5. Three participants take one bottle each with the same amount of water and pour slowly water into each bottle.
6. All participants observe the process and record the changes, such as how much water there is in each plastic container.
7. FFS facilitator notes the changes in each bottle containing soil compost, sand and unfertile soil.
8. FFS facilitator guides the discussion, helps the group to reach conclusions and notes all ideas from participants.



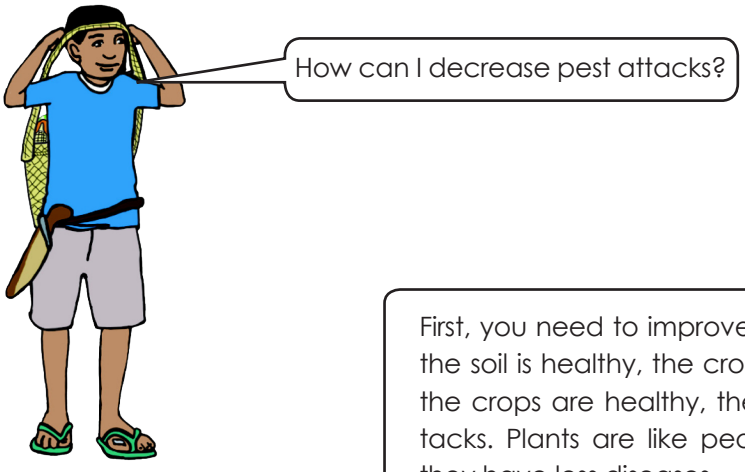
DEMONSTRATION EXERCISE NO. 2
BENEFITS OF CONSERVATION AGRICULTURE FOR SOIL EROSION CONTROL

Objective: to increase awareness among members of the group on how erosion can be minimized using organic matter as mulch.

Tools and Materials: Two empty gallon-sized plastic containers that are cut in half, dried weeds, 10 liters of water, water can and one sack of soil.

Steps:

1. FFS facilitator explains how to do the exercise and its objective.
2. Pour one sack of soil into two half gallons. (The gallons need to be inclined).
3. Cover one gallon with dried weeds and leave the other one uncovered.
4. Two participants pour water into the soil of each gallon at the same time.
5. All participants observe when water is poured.
6. FFS facilitator guides the discussion among participants regarding their observations when water is poured and asks if they see similar conditions in their own farms when it rains.
7. FFS facilitator guides the discussion, helps the group to reach conclusions and notes all ideas from participants.



4. CHALLENGES TO THE ADOPTION OF CONSERVATION AGRICULTURE IN TIMOR-LESTE

FREE GRAZING OF ANIMALS: Most farm livestock in Timor-Leste are free to graze anywhere as guided by their owners. Unless farmers go to the great expense of fencing their fields, livestock would therefore be expected to eat crop residues and the mulches that are such key ingredients for protecting the soil under conservation agriculture. The only sustainable way to overcome this challenge is to apply land use regulation through customary processes such tara bandu.

FARMERS' MIND-SET: Most farmers in Timor-Leste have practised the same traditional farming techniques for many generations (e.g. "slash and burn", grazing and burning of crop residues and ploughing/digging/hoeing of soils) and are not easily convinced to change their farming techniques – despite the obvious indicators of increased land degradation and frequency of extreme weather events. The demonstration, testing and replication of conservation agriculture techniques through their participation in FFSs is now helping farmers to see the benefits of zero/minimum tillage, cover crops/mulching and inter-cropping/crop rotation.

WILDFIRES: Most farmers traditionally clear their land by burning regenerative fallow and crop residues before ploughing/digging/hoeing. This destroys the vegetative material needed for mulching of farmers' fields. Mulching is required to conserve moisture, to increase soil organic matter/fertility, to control weeds and to prevent soil erosion.

Successful Conservation Agriculture (CA) adopters

Mr. Antonio Pereira on his farm in Betano, Manufahi. Left: traditional; and right: CA.

Ms. Natalina da Costa on her farm in Holarua, Manufahi. Left: traditional; and right: CA.

Mr. Jacinto's farm in Triloca, Baucau. He applied CA with vegetables.

Mr. Manuel Martins (MAF Extension Coordinator in Atasabe) in Mr. Fonseca Martins' farm in Ermera. Left: CA; and right: traditional.

Mr. Joaquin Caldas (right) on his farm in Natarbora, Manatuto. CA equipment allowed him to apply CA on one hectare of maize.

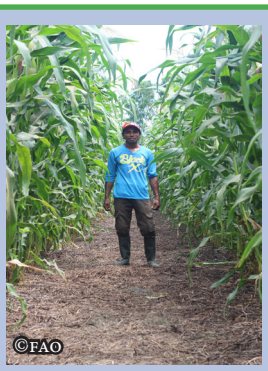
Ms. Domingas Soares on her farm in Haupu, Ermera. Left: Traditional; and right: CA.

Mr. Mariano Moniz on his farm in Betano, Manufahi. He applied CA with Mung beans and maize.

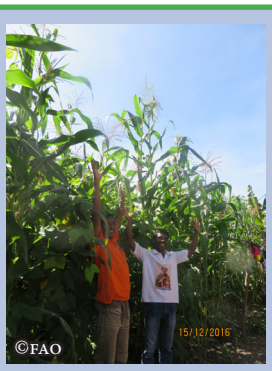
Ms. Mira da Costa Soares' farm in Maquili, Atauro. Left: CA; and right: traditional.

Ms. Madalena Soares on her farm in Atsabe, Ermera. Left: CA; and right: traditional.

Mr. Luciano Xavier on his farm in Natarbora, Manatuto, applied CA with soya beans.



Mr. Jose Soares on his farm in Natarbora, Manatutu, after two years of implementing CA with maize intercropped with velvet beans.



Mr. Jose Paulino Gomes (right) on his farm in Atsabe, Ermera. He harvested more than six tons/hectare of maize using coffee husk and Tethonia as mulch.

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