MODULE 4

# SUSTAINABLE PRACTICES TO CONSERVE SOIL AND PROTECT CROPS FROM EXTREME EVENTS

## CLIMATICALLY, ENVIRONMENTALLY AND ECONOMICALLY SMART FARMING PRACTICES

Australian Aid

pacific farmer organisations

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# 1 SUSTAINABLE CROPPING PRACTICES TO STOP SOIL EROSION, ENHANCE SOIL FERTILITY AND IMPROVE DRAINAGE

Fiji, over the last 50 years or so, has lost large areas of farming land due to soil erosion and poor drainage. This was the result of the unsustainable and damaging cropping practices that have been adopted. In Module 2, some prime examples of such practices were discussed. These were:

- **The major expansion of sugar cane planting on sloping talasiga ('sunburnt') land which took place in the 1970s.** This was in response to the favorable price available from the EU under the Sugar Protocol of the Lome Convention between EU and African Caribbean and Pacific (ACP) Countries. The traditional sugar cane farming system of crop rotations, fallow periods and the planting of vetiver grass along the contours was replaced by monoculture cane production with exceptionally long ratoon cycles. As a result crop yields became so low that most of this land is no longer farmed and has been abandoned.

*Now abandoned talasiga cane land in Sabeto Valley Nadi (photo Moko Productions)*

- **The planting of ginger at Waibau in the 1980s,** This was the area farmed to meet Fiji's booming ginger export market, is another example of the consequences of unsustainable cropping practices. To improve drainage the planting ridges were dug up and down the slope instead of along the contours. As result, soil has been eroded and soapstone exposed – the end result is that the land is no longer farmed.

In other locations valuable agricultural land continues to be lost due to the adoption of similar unsustainable cropping practices. A good example of this is the planting of pineapples on Viti Levu (see photo below).


***Fig 1:*** *Ginger planting on steep land* [1]

*Badly eroded pineapple farm land at Natovi, Tailevu (photo Andrew McGregor)*

The continuation of such cropping practices will make it increasingly difficult for us to cope with the challenges of climate change – which include more severe climatic events. Erosion degrades land, which means it can support fewer plants that can take in climate-warming carbon dioxide. Soils themselves can also sequester enough greenhouse gases. Eroded soil offers no resistance to extreme events, such as increasingly heavy rainfall and more intense cyclones, becoming more eroded and degraded and in coastal locations, damaging marine environments.

Fortunately, however, there are proven cropping practices available that enable farmers to address these climate change challenges now and into the future. These practices include:

- Adopting agroforestry and other intercropping systems;
- Planting crops along the contours;
- Planting of vetiver grass along the contours to stop erosion; and,
- Building of drop structures to reduce erosion force and improve drainage.

Module 3 covered agroforestry and intercropping systems. This module covers the other 3 areas to address soil erosion.

1 PIFON/CTA , 2019, Agricultural Value Chain Guide to the Pacific Islands https://pacificfarmers.com/resource/agricultural-value-chain-guide-for-the-pacific-islands/

# 2 THE PLANTING OF VETIVER GRASS ALONG THE CONTOURS

## 2.1 What is vetiver grass?

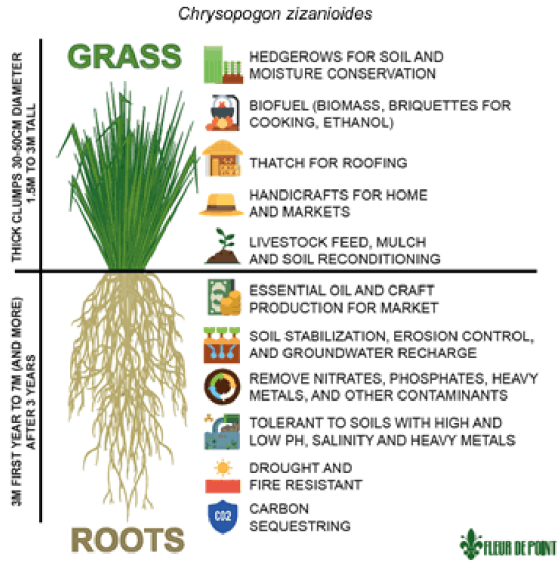
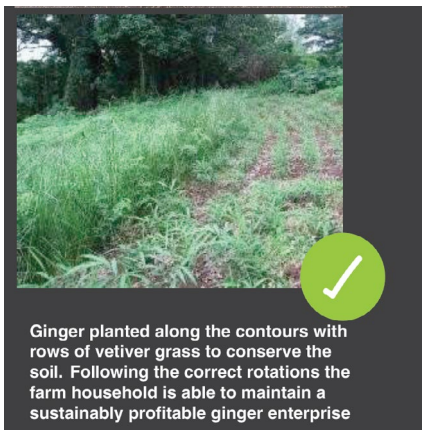



***Fig 2 :*** *The characteristics of vetiver grass*

*A bunch of vetiver grass with its deep vertical rooting system (photo Livai Tora)*




*Lomaivuna ginger and dalo farmer installing a row of vetiver grass along a contour (photo Andrew McGregor)*

Vetiver is a large tufted bunch grass that can eventually reach up to 1.5 m in height and whose roots can achieve depths of more than 3 m. Vetiver grass is drought tolerant and now has an international reputation for conserving soil through the trapping of sediment and preserving moisture[2]. As such it has a particularly important role to play in climate change adaptation[3].

2 Oshunsanya and Aliku, 2017 Vetiver Grass: A Tool for Sustainable Agriculture https://www.intechopen.com/chapters/55730

3 Smyle, 2011, Confronting Climate Change: Vetiver System Applications Conference: Vetiver and Climate Change -- The Fifth International Conference on Vetiver (ICV-5) DOI:10.13140/RG.2.2.18937.16489

Vetiver grass is native to India and Sri Lanka and was first brought to Fiji over a century ago by people from South India for medicinal and house thatching purposes. However, it was not until the 1950s that the Colonial Sugar Refining Company (CSR) undertook pioneering research into using vetiver grass for soil conservation.

As a result of the findings of this research, farmers, contracted by CSR were required by the CSR extension service to plant vetiver grass as part of their crop rotations. Records kept at the time show that a vetiver grass system, if properly implemented, was able to improve sugar cane yield up to 55 percent[4]. John Greenfield, who led the CSR's vetiver program in Fiji, went on to work with the World Bank, where he helped develop vetiver grass cropping systems world-wide. With CSR's departure from Fiji in the early 1970s, the use of vetiver grass was largely abandoned in the cane areas as well as the subsequent scaling back of the farmer extension service. The impact of vetiver grass, planted many decades ago, for soil conservation is still highly visible today in the form of 1 to 1.5 m high terraces built up from trapped sediment around cane fields in Lautoka and Ba.

*CSR Field Officers supervising the planting of vetiver grass in the 1950s (photo CSR)*

*Cane fields outside Lautoka: A terrace of captured eroded soil with vegetables growing behind a row of vetiver grass planted 20 years before (photo Paul Truong and Jai Gawaander)*

Despite vetiver grass being a proven highly effective means of soil conservation and fertility enhancement, Fijian cane farmers were reluctant to implement the vetiver system. Some of the reasons given were; the extra work initially required in planting the vetiver grass, the blocking of field access roads and the taking up of too much space. Fortunately, the Ministry of Agriculture (MoA) has recently been promoting the use of vetiver grass and as a result this reluctance is now starting to be reversed as farmers are again realizing the benefits of a correctly implemented vetiver grass cropping system [5].

*MoA providing farmer training on vetiver grass contour planting for pineapples at Seaqaqa Research Station (photo Andrew McGregor)*

4 Truong and Gawanderb Back From The Future: Do's and Don'ts After 50 years of Vetiver Utilization in Fiji https://www.vetiver.org/FIJI_15.htm

5 https://pasifika.news/2021/03/communities along-major-rivers-in-fiji-urged-to-plant-vetiver-grass-to-prevent-riverbank-erosion/; https://www.fijitimes.com/vetiver-grass-nursery-will-help-mitigate-climate-change-factors/

## 2.2 What are the benefits of planting vetiver grass along the contours?

As a farmer using sloping land you will gain substantial benefits from correctly planting vetiver grass along the contours. These benefits include:

- Minimizing soil erosion
- Slowing down leaching of fertilizer
- Trapping beneficial nutrients in the form of mulch
- Absorbing water runoff during heavy rain

## 2.3 How do I plant my vetiver grass?

You must ensure that you plant fresh vetiver grass clumps with healthy roots. The soil for planting needs to be moist and, if possible, the plants should be watered for the first couple of weeks after planting.

If you don't have ready access to vetiver grass planting material - please check with your local MoA Office. Within two years of commencing your vetiver grass cropping system you will have more than a sufficient supply of your own planting material.

The photos below show cassava farmers in Sabeto valley, Nadi, and pineapple farmers in Natovi, Tailevu, planting small fresh clumps of fresh rooted vetiver grass, approximately 0.5 m apart.

*Planting vetiver grass in Sabeto valley, Nadi and Natovi Tailevu (photos: Moko Productions and Andrew McGregor)*

## 2.4 Using an A-frame to mark the contours for planting

- To reduce risk of erosion on sloping fields you should plant your crops along contour lines between rows of vetiver grass which are also planted along contour lines. Contour lines are imaginary lines running horizontally along the width of the slope, with all points at the same height level. You can prepare the beds and ridges for planting your crops, between the rows of vetiver grass, along the contour, once the contours have been marked. The planting beds and ridges are prepared by hand or a two-wheel tractor (or by a bullock plough), depending on the size of the field to be planted.

*Preparing the beds, with a two-wheel tractor, for planting pineapples with vetiver grass at Natovi Viti Levu (photo Andrew McGregor)*

- By planting along the contour lines, you avoid or reduce the downward runoff flow of water during heavy rain. The direction of the contour should follow a drop of 1 to 3 per cent over the length of the bed. With this drop, the water is able to gradually flow to the end of the bed or ridge run. From here it should be guided down the slope in a controlled way, through a step-wise constructed down slope drain with drop-structures to break the force of the water flow.
- You mark out the basic contour lines with the use of an A-frame. This is done to assure that all marked points on this contour line are situated on the same level or height. These contour lines are used as guides to prepare the planting beds or ridges along the contours of a sloping field.
- An A-frame is a simple structure consisting of legs of exactly the same length and a cross bar fixed horizontally on the same height at the two legs. Exactly in the middle of the cross bar is a clear marking, and a string with a weight (e.g. a water bottle) hanging from the top joint of the two legs. By placing one leg on a fixed point, the other is moved up or down slope, until the string weight is hanging free at the centre mark of the cross bar. See Moko Productions video of Livai building an A frame in Sabeto Valley here
- The next step is to place the first leg of the A-frame on the newly marked level and in the same way the next level spot is surveyed by checking the weight on the centre mark of the cross bar. Each surveyed spot is marked with a peg and the process is continued until the other side of the sloping field is reached. here
- Depending on the size of prepared field, and on steepness of the slope, one contour line is marked every 5 to 15 m down the slope.

- Between the rows of vetiver grass the beds or ridges are prepared for planting your crop (pineapples, ginger etc) using these contour lines as the guiding markers.
- In practice, slopes on a certain field are not always the same over the total area. Thus separate contour lines are not always parallel to each other. As such if slopes suddenly become steeper, contour lines come closer to each other and rows or beds for crops become narrower. Thus, your planting might not look as orderly as you might like. However, you can be assured that your soil has been protected by the contour planting.
- The contour lines for planting may have to stop when they meet/come together – indicating that the land is just too steep for planting.

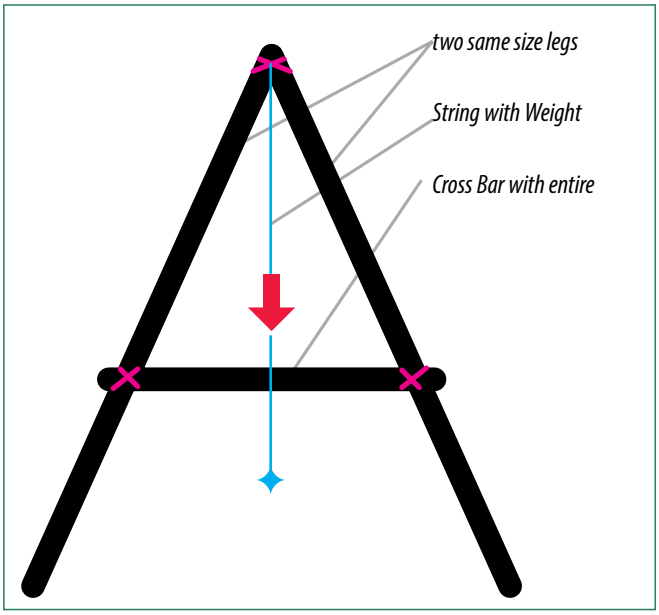



***Fig 3 :*** *An A frame used to mark contours.*

*MoA staff providing training in the use of the A frame to identifying contours (photo Andrew McGregor)*

*Natovi pineapple farmers using the A-frame to mark the contours before planting (photo Andrew McGregor)*

# 3 ESTABLISHING DRAINS TO IMPROVE YOUR DRAINAGE AND REDUCE SOIL EROSION

- If planting is done along the contour lines of a slope with ridges retaining rain water over the total length of the ridge/bed, the water will collect at the end of the ridge. The water that has collected then needs to be guided down the slope without causing erosion damage. To achieve this, you need to construct a down slope drain, every 30 to 50 m. This drain guides the collected excess water, that can't be absorbed fast enough by the soil, down the slope in a gentle way. To achieve a non-damaging gentle water flow as shown below the drain must be a step-wise one.

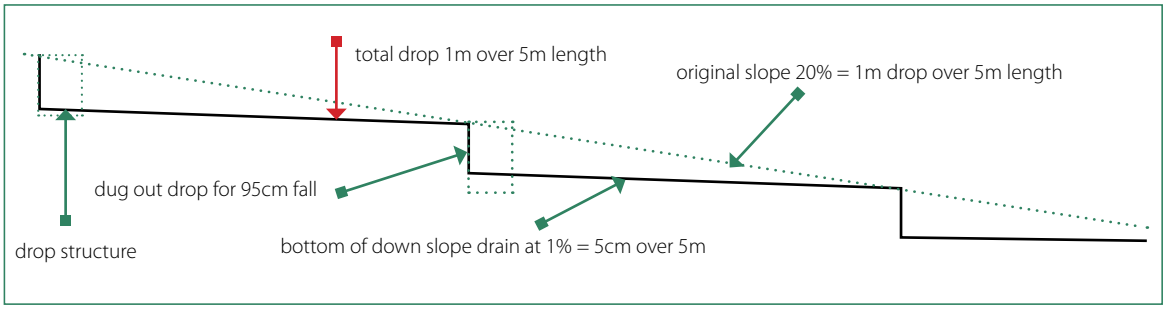



***Fig 4 :*** *A step-wise downward drain to allow a gradual non-damaging flow of water*[6]

- This step wise digging of the drain is continued until the level of the natural existing water ways is reached. These step-wise down slope drains will need extra protection at each step, where the run-off water will fall down to the next level with quite some force. This protection and depletion of water force is done with drop structures or stilling basins.

## 3.1 What are drop structures?

- In order to break the force of water flow several types of drain structures can be made; these are commonly called drop structures, ranging from small retaining dams from sticks and twigs to huge concrete stilling basins, with all sorts of possibilities in between.
- Probably the best choice for most farmers in in the Pacific Islands is to build a simple timber structure using offcuts of timber pieces about 1.25 m long.
- These planks are placed along the three sides of the dug-out step and jammed into the ground along the walls of base of the step/drop structure of the down slope drain. The sides of the structure are a few cm wide. The rear wall is covered with the offcut timber, reaching about 25 cm above the base of the top of the step, and jammed into the soil at the lower base of the step.
- The middle portion of the back wall of the step is also covered with the offcut timber, but in order to allow the collected water to flow down and fall into the bottom of the structure, the top end of the timber has to be at the same level as the top base of the step drain.

6 van Santen, 2020, Crop Nutrition and Fertilization
https://drive.google.com/file/d/1Fr9hXOUlb7DvzdeJmhu-zROx4TtDNOGM/view?invite=CKe47o0J&ts=62cbdf56

- The bottom of the structure is dug a few cm deeper and filled up with rocks and stones to the level of the bottom step of the drain to break the force of the falling water. At the bottom outlet of the structure, stones are built up slightly to form a force-breaking wall. A few metres after the structure, the wall of the drain should be protected with stones dug into the sides. See here the Moko Productions video of Livai Tora and his team building a simple drop structure in Sabeto Valley Nadi here

*A simple wooden drop structures built at "Hill Side" farm Ba (photo Livai Tora)*

*A drop structure four years after it was built at Tui's breadfruit orchard farm Nadi (photo Livai Tora)*

## 3.2 The use of structures is particularly important for horticulture crops

The use of drop structures to improve drainage is particularly important for horticultural crops such as papaya, even when the crop is grown on fairly flat land. Papaya is very susceptible to standing water; even 6-8 hours of exposure to puddle water will kill a papaya tree. Thus, good drainage is a critical and necessary requirement for ensuring adaptation to climate change when growing commercial papaya.

*Papaya is very susceptible to standing water; even 6–8 hours of exposure to puddle water will kill a papaya tree (photo: Kyle Stice)*