MODULE 2

UNSUSTAINABLE AND SUSTAINABLE CROPPING PRACTICES

CLIMATICALLY, ENVIRONMENTALLY AND ECONOMICALLY SMART FARMING PRACTICES

Australian Aid

pacific farmer organisations

KSP
KOKO SIGA PACIFIC

Andrew McGregor

August 2022

CONTENTS

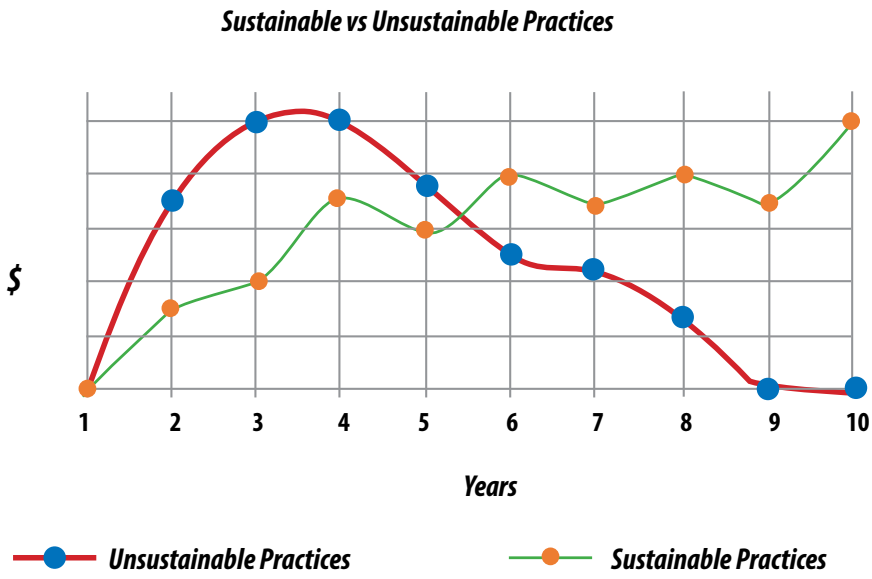
1 WHAT ARE UNSUSTAINABLE AND SUSTAINABLE CROPPING PRACTICES FOR A FARMER?

An unsustainable farming practice is one that initially yields sufficient production at a sufficiently lower cost to provide a worthwhile income for the farming household. However, over time, production falls and costs increase. This situation results in less income for the farmer and eventually insufficient income to justify the effort involved and the costs incurred. The damage to the soil and the environment resulting from these practices reduces resilience to climate variability and change and can often lead to the land no longer being used for farming, that is, it becomes obsolete for agriculture.

A sustainable cropping practice is one that yields sufficient production, at a sufficiently lower cost, so that a reasonable income for the farming household is provided over time as shown in the indicative graph below.

Often adopting unsustainable cropping practices can give a farmer a higher income in the first few years, increasing their attractiveness to farmers – particularly if they are unaware of the long-term damage that can result from the use of such practices and the impact on their family's future income and the environment in which they and their community live.

Figure 1: Sustainable vs Unsustainable Practices[1]



1 Source: Derived by Andrew McGregor from indicative information provided by Dr Rohit Lal and staff of Tutu Training Center

2 THE CONSEQUENCES OF ADOPTING UNSUSTAINABLE CROPPING PRACTICES AND WHAT CAN FARMERS DO, FOR THE BENEFIT OF THEIR FAMILY AND COMMUNITY

The consequences are:

- Farm income falls over time as production goes down and costs rise.
- Land is abandoned for farming and becomes obsolete for agriculture.
- Farming families lose their livelihood and either have to find other land to farm or migrate to urban areas.
- Land to produce food and sustain livelihoods is lost. This loss is of significant concern because land in Pacific Island countries suitable for growing food and sustaining livelihoods for current and future generations is limited; and is quickly being depleted by farmers adopting unsustainable cropping practices. Future generations will ultimately pay the biggest cost.
- The environment is damaged, including the pollution of streams and rivers, and coastal and marine environments. Unique biodiversity is lost for our children and future generations.
- Farms become less resilient to climate change, unable to cope with climate variability and extreme events, such as periods of intense rainfall. Extreme events, such as cyclones, and changes in pest and/or disease dynamics resulting from climate variability can wipe out a monoculture cropping system whereas traditional mixed cropping and agroforestry cropping systems have inherent resilience due to the mix of crops and trees

Examples are provided below of the consequences of adopting unsustainable cropping practices in four of Fiji's major agriculture industries (dalo, yaqona, ginger and sugar). These examples also provide advice as to what practices could have been implemented to ensure sustainable farming.

2.1 The experience with dalo

Fiji first started exporting small quantities of dalo to New Zealand in the 1950s but Samoa was the major taro exporter, selling their taro mainly to the large Samoan population living in New Zealand and also in Australia and the US. In 1993 this situation drastically changed when Samoa's taro was devastated by Taro Leaf Blight (TLB)[2] . As a result Fiji was able to replace Samoa as the main supplier of these overseas markets. The main taro variety exported from Samoa was *Talo Niue*. The variety *Tausala ni Samoa* that thrived on Taveuni, due to the soil conditions and high rainfall, was found to be almost identical to *Talo Niue*[3]. This pink variety met the exacting dalo taste requirements of the Samoan community overseas. Driven by this demand, dalo production on Taveuni rapidly expanded. Fiji's dalo exports peaked in 2006 – with 12,000 tonnes exported of which more than 80 per cent came from Taveuni, resulting in widely-distributed prosperity in Taveuni. Further, the very high returns that were initially available saw the rapid transformation of dalo from a subsistence garden-based agroforestry crop to one of an intensive monoculture crop.

2 Hunter et al. 1998, The Impact of Taro Leaf Blight in the Pacific Islands with special reference to Samoa https://www.researchgate.net/profile/Danny-Hunter/publication/265668376_The_Impact_of_Taro_Leaf_Blight_in_the_Pacific_Islands_with_special_reference_to_Samoa/links/551a811e0cf26cbb81a2e3dc/The-Impact-of-Taro-Leaf-Blight-in-the-Pacific-Islands-with-special-reference-to-Samoa.pdf?origin=publication_detail

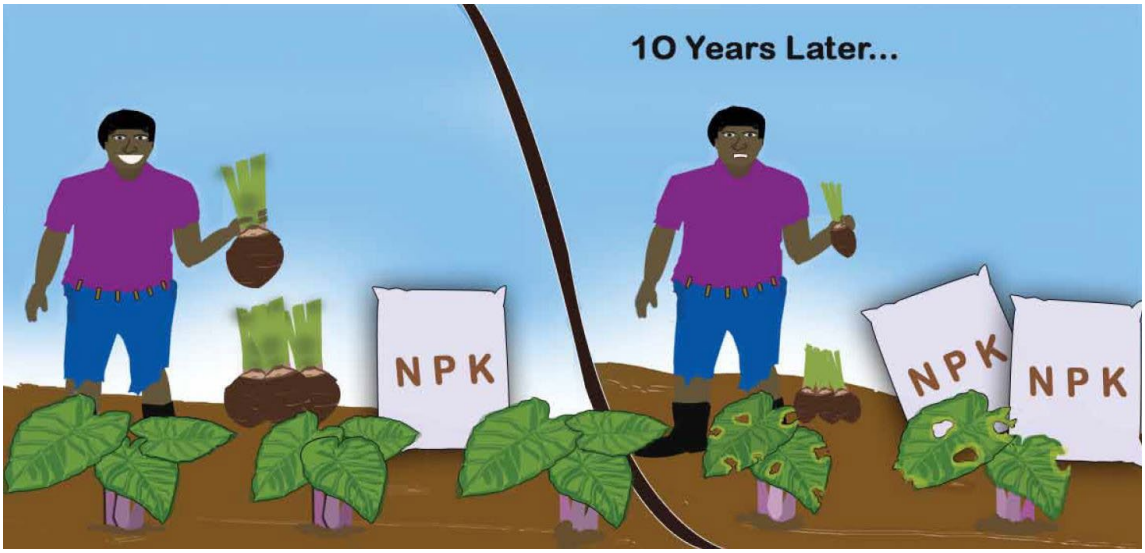
3 Mace et al. 2007, Rationalization of taro germplasm collections in the Pacific Island region using simple sequence repeat (SSR) markers Plant Genetic Resources , Vol 4 (3) 210 – 220 DOI: https://doi.org/10.1079/PGR2006125

This commercial production system that was adopted involved:

- Clearing forests for monoculture dalo planting
- Repeated planting of dalo on the same land with no fallow (rest) period to enable fertility to be restored to the soil.
- High and increasing application of chemical fertilizer (NPK) and the use of chemical herbicides.

It was incorrectly assumed that the rich volcanic soils of Taveuni would continue indefinitely to provide high yielding quality dalo provided the recommended fertilizer was applied. The reality proved to be different – to maintain production (corm size) ever increasing amounts of chemical fertilizer had to be applied and/or new land that was only available on higher elevation forested areas had to be cleared [4]. As a result dalo cultivation encroached on Taveuni's unique forest reserves. The over-cropping and the heavy application of chemical fertilizers resulted in the soils of Taveuni becoming very acidic. This increased acidity reduced the ability of the dalo to take up nutrients from the soil and from the chemical fertilizer that was being added to try and maintain yields. Welagi farmer Nicholas Naceba, in Fiji TV 'Green Pillars', talks about the Taveuni experience with unsustainable agriculture here and his experience with sustainable agriculture here.

[5]*Figure 2: A comparison of unsustainable and sustainable dalo practices.*



You might make more money in the short run if you don't follow environmentally unsustainable practices but you will be out of business in the longer term, and your farm and family will suffer and the value chain will not survive.

4 Lal, 2021, Development and evaluation of sustainable nutrient management strategies for taro growers on Taveuni Island, Fiji. A thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Soil Science. Massey University https://mro.massey.ac.nz/handle/10179/16545

5 McGregor and Stice, 2014, Agricultural Value Chain Guide for Pacific Islands https://pafpnet.spc.int/attachments/article/504/Agricultural%20Value%20Chain%20Guide%20for%20the%20Pacific%20Islands.pdf.

UNSUSTAINABLE TARO PRODUCTION PRACTICES

- Clearing forests for monoculture taro production. Use of burning for land clearing.
- Repeated planting of taro with no fallow (rest) period for the land. Continued high applications of inorganic mineral fertilizers (NPK). Overall impact of these practices over time is a loss of soil fertility resulting in higher fertilizer costs, smaller taro, higher rejects and less money for the farmer.

SUSTAINABLE TARO PRODUCTION PRACTICES

- Using traditional mixed cropping and agroforestry systems. Using soil tests to identify nutrient deficiencies.
- Using crop rotations and fallow (rest periods) on the farm. Using nitrogen fixing plants for green manuring, mucuna etc. Using soil conservation measures such as contour farming. Addition of lime and other organic inputs on to the land.
- Overall impact of these practices over time is the ability to maintain good yields, improve quality and make more money for the farmer.

Sustainable farming practices to take advantage of market opportunities

Substantial and expanding market opportunities exist for farmers growing dalo and other root crops. These include export markets but more importantly also the local market[6]. The local market demand continues to grow driven by urbanization (now 55 per cent of our population live in urban areas) and as discussed in Module 1 the impact of climate change on rice and wheat resulting in increasingly high costs and the likelihood of reduced supply. If farmers and their families are to benefit from the increasing market opportunities, now and into the future, they must adopt sustainable cropping practices. Such practices include:

- Crop rotations and fallow (rest) periods to enable soil fertility to be restored, maintained and enhanced
- The planting of green cover crops (such as mucuna beans) to fix nitrogen, enhance soil biodiversity (such as earth worms) and reduce weeds.
- Soil conservation measures such as contour planting and vetiver grass planting, when growing root crops on sloping land.
- Soil testing to identify nutrient deficiencies and accurately determine the type and quantity of fertilizer that you need to add to the soil
- Making and using compost to organically restore and enhance the fertility of your soil

Taro grown as part of a traditional agroforestry mixed cropping system on Malakula Vanuatu (photo: Andrew McGregor)

6 According to the 2009 Agricultural Census some 40,000 farmers produced approximately 57,000 tonnes of taro that was distributed to consumers as follows: |• Subsistence consumption 6,800 tonnes (12%) |• Domestic market sales 40,500 tonnes (71%) |• Export market sales 9,700 tonnes (17%

- Adding agricultural lime to acid soils. The soils in Fiji's degraded farming land have become highly acidic further reducing crop yields even if fertilizer is added. Adding agricultural lime to acid soil helps raise the soil pH (a measure of the acidity or alkalinity) to a more neutral level that will enable the nutrients in the soil, and from added fertilizer, to be fully available to your crops.
- Traditional mixed cropping and agroforestry cropping systems to restore, maintain and enhance soil fertility and minimize the spread of pest and diseases

Taveuni farmer adopting the mucuna bean cropping system (photo Fr. Isaia)

A pineapple farmer planting vetiver grass along the contours at Natovi Fiji for soil conservation (photo Andrew McGregor)

Vetiver grass planting when growing crops on sloping land is now common long term sustainable practice (photo Livai Tora)

Farmers are encouraged to plant vetiver grass to minimise soil erosion and helps reduce nutrient leaching. (photo Livai Tora)

Soil samples can be collected from your farm and sent to Koronivia for testing (photo Livai Tora)

Samples must be bagged properly and labeled with clear farm details and date (photo Kyle Stice)

Fr. Isaia Wairoga from Tutu discusses sustainable farming systems for Fiji TV 'Green Pillars' here

Adding compost material to your crops increases yield and improves soil structure (photo Livai Tora)

Adding other organic fertilizers like Alroc #3 to compost material has beneficial micro nutrients (photo Livai Tora)

2.2 The experience with yaqona

Yaqona (kava) has in recent years become Fiji's leading growth agricultural industry. Over the 5-year period (2016 -2020), annual dried kava production almost doubled to reach over 13,000 tonnes[7]. Over the same period, kava exports reached nearly 500 tonnes (4 per cent of total production). According to the 2020 Agricultural Census, yaqona was grown by almost 18,500 households – of which nearly half were in the Northern Division. This means that around 35 per cent of Fiji's rural population is at least partly, dependent on yaqona for their livelihood.[8] Market demand for kava has increased significantly with the recent lifting of the restriction of the exports to Australia.

However, there are concerns regarding Fiji's ability to maintain, let alone increase yaqona production into the future if farmers continue to adopt unsustainable cropping practices. Similar to the experience described with the expansion of dalo on Taveuni, much of Fiji's yaqona planting has involved the clearing of trees and intensive monoculture. Such unsustainable cropping systems have been particularly pronounced on Vanua Levu – where people who have lost their jobs due to the COVID pandemic have returned to their villages and started planting yaqona as a livelihood. The consequence of adopting such a cropping system is similar to that described previously for dalo. In the case of yaqona, there are severe additional risks involved when the trees are cleared to plant the crop. These are:

- the spread of the devastating virus disease, kava dieback; and,
- the loss of a farmer's entire longer term crop due to a cyclone

By minimizing these risks farmers are able to take advantage of large market opportunities

7 MoA 2020, Key Statistics for the Fiji Agricultural Sector : https://www.agriculture.gov.fj/documents/stats/2020KEYSTATISTICS.pdf

8 MoA 2020, Fiji Agriculture Census https://www.parliament.gov.fj/wp-content/uploads/2021/08/VOLUME-I_DESCRIPTIVE-ANALYSIS-AND-GENERAL-TABLE-REPORT.pdf

The common unsustainable practice of cutting of the trees for broad acre planting of yaqona (Fr. Isaia)

Taking advantage of yaqona market opportunities by minimizing the risk of kava dieback and cyclones

The international demand for high quality Fijian kava continues to grow[9]. However, if farmers are to take advantage of the excellent market opportunities, they must grow their yaqona sustainably thereby minimizing the risk of their crop being destroyed by kava dieback or cyclones.

9 Pacific Horticultural & Agricultural Market Access Program (PHAMA). Fiji Kava Quality Manual. https://pafpnet.spc.int/attachments/article/779/Fiji-Kava-Quality-Manual.pdf PIFON/CTA, 2019, Agricultural Value Chain Guide to the Pacific Islands

Figure 3: Yaqona production: the risks from unsustainable cropping practices[10]

Kava dieback has been present in Fiji and the Pacific Islands for many years. The disease is caused by a virus (Cucumber Mosaic Virus - CMV), which is spread by flying aphids. When yaqona plants are infected by dieback, the stems and rots die back to the stem base. An outbreak of dieback can completely destroy an infected block of yaqona[11].

In 1998, there was a large increase in kava prices driven particularly by demand in the US as a result of the growth of kava bars in California and New York [12]. Responding to previously unheard of prices there was large-scale clearing of land, particularly on Taveuni, for monocrop yaqona planting. An outbreak of kava dieback quickly followed which infected most of these new plantings and within months whole blocks were destroyed. Farmers who were expecting to make substantial income from their yaqona ended up making nothing.

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

11 Davis et al. 2005, Cucumber mosaic virus infection of kava (Piper methysticum) and implications for cultural control of kava dieback disease. Australasian Plant Pathology 34 (3). pp. 377-384.

12 http://pimrisregional.library.usp.ac.fj/gsdl/collect/jps/index/assoc/HASH016e/5523695a.dir/doc.pdf

The concern now is that **'history will be repeated'** with the demand and prices for yaqona continuing to increase'. On this occasion, however, the crop losses will be larger, given the scale and type of yaqona planting that is occurring, particularly on Vanua Levu. The reason for this is that large scale monoculture plantings offer no protective barriers to the aphids that spread the virus. This disease can rapidly spread through the whole block destroying the entire crop, particularly if soil fertility has declined due to the monoculture cropping system adopted. **The 'less healthy people are the more vulnerable they are to disease' - the same is true for plants.** Strong healthy plants can better resist the disease, and will recover quicker from infection.

The solution to the risk of kava dieback is to grow your yaqona as part of a cropping system that maintains the fertility of the soil and restricts the movement of the disease -spreading aphids. To achieve this, the following rules should be followed, where possible:

- **Yaqona should be planted in isolated blocks separated by trees**. This is to minimize the spread of the disease from one block to another. Andrew McGregor in Fiji TV's 'Green Pillars' discusses the role of trees in stopping the spread of kava die-back here 
- **Soil needs be fertile with high organic matter**. At the time of planting and throughout the life of the crop and be well drained. Mucuna bean can be planted as green cover crop to add nitrogen to the soil. If possible, you should add compost, made on the farm, at the time of planting.
- **Adopt an appropriate agroforestry cropping system for planting your yaqona.** The agroforestry system you adopt should be a combination of: mixed alley cropping. This involves:

  - planting nitrogen fixing trees such as *Calliandra, Leucaena (*Vaivai ni valagi), and *Glyricidia (*Bai ni cagi*)*, using existing trees in hedge rows;

  - mixed intercropping with crops, such as cassava and dalo, between the hedge rows.

  An agroforestry cropping system, in addition to improving soil fertility and moisture, encourages the virus-carrying aphids to land on other plants to feed, thereby losing the virus (or at the very least reducing it), before moving to yaqona. You need to be careful if using *Erythrina* (Drala) in your agroforestry system as it has been linked to spread of kava dieback[13]. For dalo, drala is not a problem and is an ideal agroforestry tree crop for fixing nitrogen in your soil
- **Land should be allowed to be fallow for several years before being used again to plant yaqona.** Yaqona is a heavy feeder of soil nutrients[14]. Allowing the land to remain fallow (rest) for at least two years after harvesting yaqona before replanting allows time for soil nutrients to be restored.
- **Yaqona should not be grown near plants that are hosts for aphids.** Host crops include: Cucurbits (pumpkin, squash and watermelon), Solanaceous crops (including tomato, tobacco, capsicum, chilli, eggplant), Legumes (snake bean and peanuts), passion fruit and pineapple. Also as mentioned above, drala should not be used as an agroforestry tree when planting yaqona.

13 https://www.agriculture.gov.fj/documents/leaflets/Yaqona.pdf

14 Dr Rohit Lal https://mro.massey.ac.nz/handle/10179/16545

Yaqona planted as part of sustainable agroforestry system at the Tutu Rural Training Centre on Taveuni (photo: Fr. Isaia)

Sustainable yaqona farm belonging to Tutu Rural Training Centre Young Farmer graduate (photo: Fr Isaia)

Three year yaqona harvested from agroforestry cropping system at the Tutu Rural Training Centre Taveuni (photo: Fr. Isaia)

Cyclones

The best time to harvest your yaqona is 3 to 4 years after planting. This compares with dalo which is 8 to 9 months after planting. Thus, the risk for a yaqona crop being impacted by a cyclone is much higher than that for dalo. Trees in an agroforestry system provide some protection for yaqona in the face of a cyclone and substantially reduce the risk of losing your entire crop – except in the case of a severe Category 5 cyclone.

2.3 The experience with ginger

During the early 1960s, the export of fresh ginger to the US and Canada started to become a highly remunerative industry. Fiji's location in the southern hemisphere meant it had a major marketing advantage over other producers when selling to North America. Fiji's mature ginger harvest period (July to October), is offseason to Hawaii, the main supplier to the US Mainland. Thus, Hawaii supplied ginger during the first half of the year, with Fiji supplying ginger in the second half.

Fig 4: Ginger planting on steep land [15]

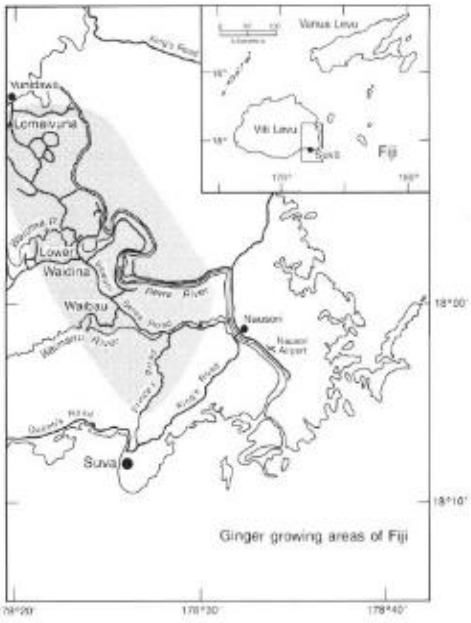


Fig. 5 Ginger growing areas of Fiji[16]

Ginger thrives in the high temperature/high rainfall environments that exist in eastern Viti Levu. However, ginger demands well-drained soils to prevent rotting in the soil. Fiji's ginger growing areas were mainly located within an 80km radius of Suva. Areas such as Waibau and Lomaivuna provided ideal agronomic conditions - better than those found in the ginger-growing areas of Hawaii and Queensland. Soils found at Waibau and Lomaivuna, in their virgin state, were particularly fertile and had excellent structural characteristics. However, in order to satisfy the **essential** requirement of good drainage, ginger was planted on steep land with the contours running up the slope. See pictures below from Waibau – tracing land degradation over a 35- year period.

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

16 McGregor, 1989, The Fiji fresh ginger industry: a case study in non-traditional export development. PIDP Hawaii https://kipdf.com/the-fiji-fresh-ginger-industry-a-case-study-in-non-traditional-export-developmen_5aaf83ca1723dd329c63331d.html

Waibau in the 1990s with the land badly eroded by the cropping practice adopted (photo: Dr. John Morrison)

The same location in Dec 2021 – the land largely abandoned and covered with African Tulip (photo: Dr Dick Watling).

Click here to see a short video of the area.

As a consequence, these soils became deeply weathered, strongly leached and highly acidic requiring increasing levels of fertilizer application to try, albeit unsuccessfully, to maintain yields. Waibau was particularly severely impacted over time by the adoption of such cropping practices. Much of the land planted to ginger has become obsolete for agriculture. Many of the farmers (of whom most had migrated from the outer islands of Lau in the 1970s) have now resettled to the Suva-Nausori corridor.

Fiji at the peak of ginger exports to the US in the 1980s was exporting between 1,800 and 2,400 tonnes of fresh ginger annually for an average fob value of nearly FJD2 million – making it the second largest agricultural export earner after sugar [17]. In recent decades, fresh ginger exports have fallen substantially. For the period 2016-2020 annual fresh ginger exports averaged 650 tonnes[18].

.

17 https://kipdf.com/the-fiji-fresh-ginger-industry-a-case-study-in-non-traditional-export-developmen_5aaf83ca1723dd329c63331d.html

18 Min Ag 2020 Key Statistics on Fiji Agricultural Sector) https://www.agriculture.gov.fj/documents/stats/2020KEYSTATISTICS.pdf

Market opportunities for ginger and the requirements to sustainably meet demand

The good news for ginger farmers, in the higher rainfall areas of Viti Levu is that ginger continues to provide an excellent income earning opportunity provided it is grown sustainably. The best opportunities now lie in growing immature ginger for processing. Significant markets have been developed by the well-established processing companies (Freshpac Ginger, Kaiming Agro Processing, and Foods Pacific Ltd). For the period 2016-2020 annual processed ginger exports averaged a little over 1,000 tonnes [19]. However, the ginger processing companies report that there is insufficient supply to meet the growing demand for their products.

Crystallized ginger being processed for export (photo: Andrew McGregor)

To take full advantage of the market opportunities available, now and into the future, ginger farmers need to adopt sustainable cropping practices. These include:

- Contour planting with vetiver grass on sloping land.
- The use of drop structures to facilitate good drainage without causing soil erosion.
- The use of two-wheel hand driven mechanical hoes for land preparation instead of large diggers.

Fig 6 Ginger planting along the contours with vetiver grass to conserve the soil [20]

A Lomaivuna farmer planting vetiver grass (photo Andrew McGregor)

19 MoA 2020 Key Statistics on Fiji Agricultural Sector https://www.agriculture.gov.fj/documents/stats/2020KEYSTATISTICS.pdf

20 PIFON/CTA, 2019, Agricultural Value Chain Guide to the Pacific Islands

Using a two-wheel tractor in land preparation and not a large digger (Photos Andrew McGregor)

2.3 The experience with sugar

During the 1950s and 60s era of the Colonial Sugar Refinery (CRS), Fiji's sugar industry had an international reputation for being a highly sustainable small holder-based industry [21]. Some of the features of the industry then were:

- Farmers were not allowed to plant cane on land with a slope > 12 ^{O};
- Burning of cane was prohibited;
- Farmers were encouraged to undertake crop rotation with food crops such as rice and legumes such as chickpeas (dhal).
- Farmers were encouraged to plant vetiver grass along the contour for soil conservation and also for use as roofing material.
- Mucuna bean was planted in rotation to help restore nitrogen (N) in the soil and for weed control.

The Colonial Sugar Refinery extension field officers actively promoting the planting of vetiver grass to Fiji sugar cane farmers in the 1950s and 60s [22]

21 https://www.vetiver.org/vetiver-and-the-pacific-islands-fiji/

22 https://info.undp.org/docs/pdc/Documents/FJI/Vetiver%20System%20Training%20Manual%20for%20Fiji%202020.pdf

However, for the last 50, or so years, unsustainable cropping practices were widely adopted in sugar cane production. These practices included:

- **Expanding cane planting to sloping talasiga (sunburnt) land.** This expansion began in the 1970s as Fiji tried to take advantage of the high sugar price available to African, Caribbean and Pacific (ACP) sugar producers under the EU's Lome Convention. Over the centuries talasiga land had been largely cleared of trees. As a result, the soil was already acidic with low fertility. High inputs of chemical fertilizer were required to achieve even modest yields. The soil erosion that resulted from ploughing the land for the monoculture cultivation of sugar cane further reduced yields, requiring even more fertilizer to be applied. By the 1990s, most of the cane farms in these areas had been abandoned and the degraded land was regarded as obsolete for agriculture.

Abandoned degraded former sugar growing land (photo Moko Productions)

- **Transition from green to burnt cane harvesting.** Whereas in the past cane was harvested green, much of cane was now burnt before harvesting. Burning cane further reduced soil fertility by removing the mulch cover that remained when green cane is harvested. With burning, more fertilizer was required to maintain yields even in the traditional flat land cane growing area. Burning also adversely impacted on sugar quality.

- **Abandoning traditional mixed cropping systems.** Practices that supported soil fertility**,** including the planting of vetiver grass along contours, and the use of mucuna beans, fallows and intercropping with food crops for the farm household, were largely abandoned

The adoption of these unsustainable cropping practices has been a major contributing factor to the continuing decline of the Fiji sugar industry. This is in addition to other major problems facing the industry, such as a shortage of labour and the ending of the EU Lome Convention Sugar Agreement, which guaranteed a price usually well above the world market price, for most of the sugar that Fiji exported.

During the first half of the 1980's sugar accounted for nearly 65 per cent of Fiji's export earnings. There were some 22,000 cane growers farming around 70,000 hectares with the four sugar mills producing around 500,000 tonnes of sugar annually[23]. Today the number of cane farmers and the area planted to cane has more than halved. The average annual exports from the three mills have fallen to around 150,000 tonnes of sugar[24]. Most of the sloping talasiga land where sugar cane used to grow has now been abandoned.

Opportunities to rehabilitate degraded sugar land

Crops (including sugar cane) can no longer be grown on most of the sloping *talasiga* land for the foreseeable future, because of the soil erosion and fertility loss resulting from sugar cane cultivation. This land could only be restored in the longer term by the planting of suitable forest trees however, within the areas where cane continues to be planted, there is scope for **'going back to the future'** if farmers return to the practices, that were successfully used in the past. These include: rotations of food crops for the use of the farm household; the reintroduction of a fallow period into the cropping system where mucuna beans are planted as green manure; and a return to only harvesting green sugar cane. In addition, opportunities exist for farmers to establish small 'food forests', which has been successfully achieved on Johnson Rd, Lautoka (see Module 3).

Fiji TV 'Green Pillar' videos discussing this can be found here:

Link 1, Link 2, Link 3

23 Ali & Narayan (1989). The Fiji Sugar industry: A brief history and overview and overview operation. Pacific Economic Bulletin Vol 4 Number 2. https://openresearch-repository.anu.edu.au/handle/1885/158013?mode=full

24 The average annual exports for the period 2016-2020 was 148,554 tonnes (MoA 2020 Key Statistics on Fiji's Agricultural Sector)

3 TRAINING MODULES THAT PROVIDE FARMERS WITH ADVICE ON FARMING PRACTICES THAT ARE CLIMATICALLY, ENVIRONMENTALLY AND ECONOMICALLY SMART

The overall impact, over time, of adopting sustainable farming practices will be to maintain good yields, improve quality and to increase the income earned by the farmer. The following modules (both printed and videos) provide practical how to do it advice to farmers on farming practices that are climatically, environmentally and economically smart.

These are:

Module 3: Sustainable agroforestry cropping systems

Photo: Vincent Lebot

Module 4: Sustainable practices to conserve your soil and protect crops from extreme events

Photos: Andrew McGregor

Module 5: Seeds and seedlings for sustainable fruit and vegetable production

Photo: PIFON

Photo: Kyle Stice

Module 6: Efficiently making and using compost

Photo: Livai Tora

Photo: Andrew McGregor

Module 7: Replanting coconuts for viable climate change adaptation

Photo: Andrew McGregor

Module 8: Sustainable farming systems as an economically viable enterprise

The estimated market for seedlings sold after a cyclone by a disaster resilient nursery

Seedling Type	Number stored in the container	Market Value per seedling (pre-cyclone) ($)	Total value (pre-cyclone) ($)	Indicative value (post-cyclone ($)
Papaya	5,000	0.5	2,500	5,000
Grafted seedless lime	1,000	15	15,000	30,000
Grafted guava	4,000	5	20,000	40,000
Tomato (in a tray)	20,000	0.25	5,000	10,000
Eggplant (in a tray)	20,000	0.25	5,000	20,000
Lettuce	25,000	0.25	6,250	20,000
		TOTAL	**53,750**	**$107,500**