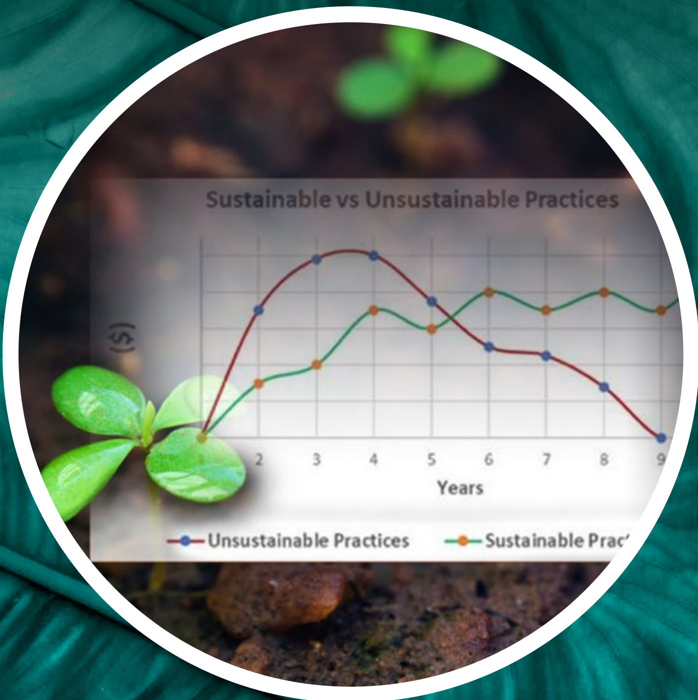
MODULE 8

SUSTAINABLE FARMING SYSTEMS AS AN ECONOMICALLY VIABLE ENTERPRISE



CLIMATICALLY, ENVIRONMENTALLY AND ECONOMICALLY SMART FARMING PRACTICES

Australian Aid

pacific farmer organisations

KSP KOKO SIGA PACIFIC

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FOREWORD

The previous seven modules have described the expected impacts of climate change on farming in the Pacific Islands with a focus on Fiji. The need for change in current farming practices is emphasized to enhance the sustainability and climate resilience of farming systems. The farming practices recommended in the modules are climatically, environmentally and economically smart – all three pillars must be addressed to ensure that a farm's productivity is maintained, outputs are achieved and livelihoods are supported. The modules have focused on several key crops but the recommended practices can be and should be adopted for other crops. This final module builds on the findings of the previous seven modules and focuses on the economic component of farming practices

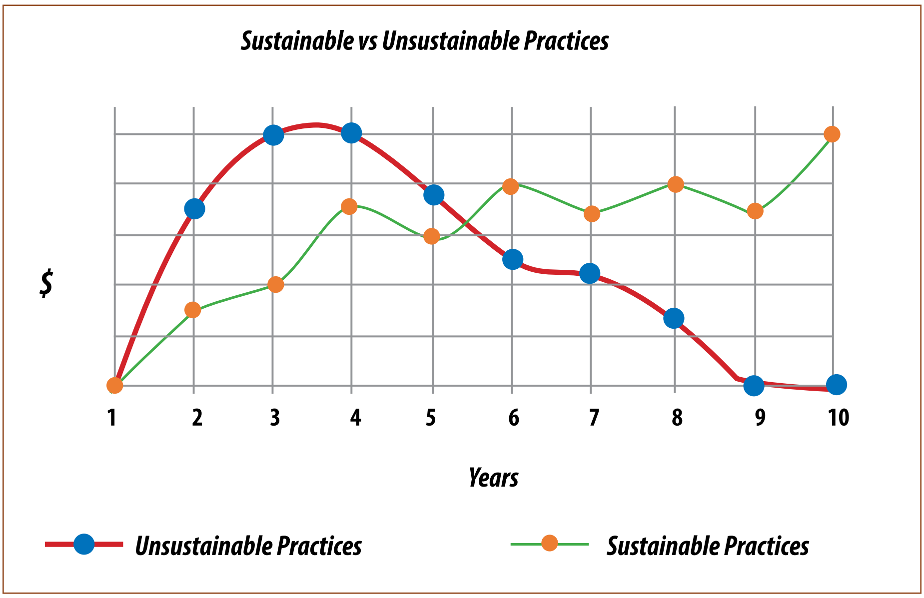
1 WHAT ARE UNSUSTAINABLE AND SUSTAINABLE FARMING PRACTICES?

1.1 Unsustainable farming practices

As discussed in some detail in Module 2, an unsustainable cropping practice is one that initially yields sufficient production at a low enough cost to provide a worthwhile income considering the amount of effort put into the farm. However, over time, because of the farming practices adopted, production falls and costs increase, resulting in less income for the farmer – an income which no longer justifies the effort involved and the costs incurred. The damage resulting from poor practices to the soil and the environment often means that the land can no longer be used for farming (that is, it becomes obsolete for agriculture).

Modules 2 and 4 provided a number of examples from important agricultural industries in Fiji (sugar, dalo, yaqona, ginger and pineapples). Unsustainable practices can often provide the farmer with a higher income for the first few years before income falls away (as illustrated by the indicative graph below; Fig 1). The primary reason for the decline in crop yields to non-viable levels is due to soil loss (both quantity and quality).

Fig 1 Sustainable vs Unsustainable Practices



The reason for farmers adopting unsustainable cropping practices is due to a combination of factors, including:

- Farmers being unaware of the consequences of their actions.
- Provision of insufficient or inappropriate advice.
- A focus on immediate income rather than income that can be earned and sustained over time – which can be linked to insecurity with regards to land access

1.2 Sustainable farming practices

A sustainable cropping practice is one that yields sufficient production, at a low enough cost, to continue to provide a reasonable income for the farming household over time. This is illustrated in Fig 1.

By working with nature rather than against it, farmers can manage their farms in ways that avoid damaging the environment and at the same time improve the income they can earn. Farmers in the Pacific have an advantage in working with nature because of traditional knowledge and the inherent resilience of most of the traditional Pacific Island food crops to climate change (Module 1).

2 THE CONSEQUENCES OF FARMERS ADOPTING UNSUSTAINABLE CROPPING PRACTICES

The overall consequences are:

- Farm income falls over time as production goes down and costs rise.
- Farmers are less able to adapt to climate change.
- Farms are abandoned and the land often becomes obsolete for agriculture.
- Farming families lose their livelihood and either have to find other land to farm or migrate to urban areas. Remember, the land that is suitable to provide food and livelihoods for current and future generations is limited and is being quickly depleted by farmers adopting unsustainable cropping practices. Future generations will pay the biggest cost with declining access to land and an increase in environmental damage - particularly with the increasing impact of climate change.
- The environment is damaged, including the pollution of streams and rivers and coastal marine environments. Unique biodiversity being lost for our children and future generations.

3 IDENTIFIED SUSTAINABLE FARMING PRACTICES THAT ARE CLIMATICALLY, ENVIRONMENTALLY AND ECONOMICALLY SMART

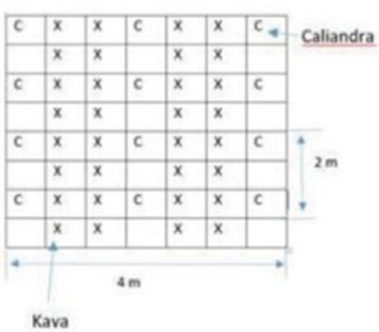
In the previous modules, a range of sustainable farming practices, identified as climatically, environmentally and economically smart, were discussed. The selection of sustainable practices that some farmers had adopted was based on a combination of: traditional knowledge; the practical experience of lead farmers and nursery operators; and, the results of applied research undertaken throughout the Pacific Islands.

Some of the examples of such practices that were identified and discussed in the previous modules included:

- ***Alley cropping (Module 3)***

Planting dalo with the micro climatic conditions provided by alley cropping (photo: Vincent Lebot)

- ***Isolation/hedge row planting (Module 3)***



Harvesting yaqona from an isolated block that is protected by trees from kava dieback (photo Fr. Isaia)

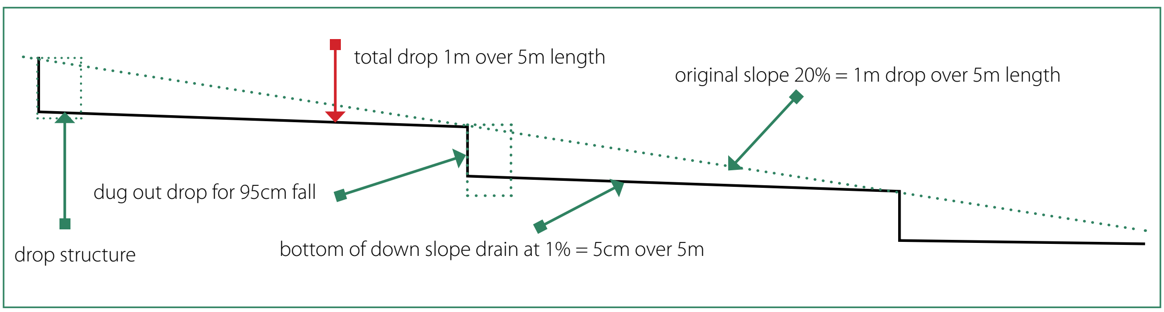
- ***Mixed intercropping (Module 3)***

Planting a variety of crops, with multi-year crop rotations results in healthier soil and improved pest control. The example presented here is Prakash's 'food forest' outside Lautoka where degraded, largely abandoned, sugar cane land has been transformed into productive and remunerative food production (photo: Moko Productions).

- ***Using green manure cover crops: the mucuna bean cropping system (Module 3)***
- ***Planting vetiver grass along the contours (Module 4)***

The benefits from planting crops between rows of vetiver grass planted along the contours include: minimizing soil erosion; slowing down fertilizer leaching; and trapping beneficial nutrients in the form of mulch. This was the traditional sugar cane farming system in Fiji. There is now a need to look at "going back to the future" and resurrecting this system.

- ***Establishing drains to reduce soil erosion (Module 4)***



After heavy rain to avoid soil erosion, 'step-wise' drains can be built to allow for a non-damaging gentle flow of the excess water that can't be absorbed by the soil and thereby substantially reduce soil erosion.

- ***Protecting your nursery and seedlings from the devastating impact of cyclones and floods. (Module 5)***

It is important for nursery owners to invest in protecting their nurseries and seedlings from the damaging effects of cyclones which are projected to increase in intensity due to climate change (photo: Kyle Stice and Moko Productions)

- ***Planting fruit trees in drums to reduce the impact of cyclones (Module 5)***

The growing of fruit trees in drums containing compost offers a number of important advantages to farmers including: fruiting patterns and yields can be similar to those of trees grown in the field but less space is needed; and, in the event of a cyclone, the drums are tipped on the ground to reduce wind damage (photo: Moko Productions)

- ***Making and using compost to improve crop yield (Module 6)***

Good composting provides soil health and moisture conservation in a stable organic way. The improvement in crop yields and quality through healthier soil is maintained into the future (photo: Fr. Isaia)

- ***Fruit tree pruning to maximize yields and minimize the damage cause by cyclones (Module 5)***

The radical pruning of commercial fruit trees is standard practice to enhance productivity and to improve harvesting efficiency. It also minimizes the damage caused by cyclones which are expected to increase in intensity due to climate change (photo: Andrew McGregor)

- ***Replanting coconuts as a climate change adaption strategy (Module 7).***

Coconuts were identified as one of the most climate change resilient crops in the Pacific Islands. However, if they are senile (> 60 years old) they become one of the most vulnerable due to their brittleness in the face of cyclones that will become increasingly intense. Thus, for this reason the replanting of coconuts has been identified as a particularly good climate change adaption strategy for the Pacific Islands

4 THE ECONOMIC RETURNS TO FARMERS FROM INVESTING IN SUSTAINABLE AGRICULTURAL PRACTICES

For most farmers to invest (both time and money) in sustainable agricultural practices, it must be economically worthwhile. This means that the practices must be financially rewarding to them and their family for the money spent and the effort put in.

In this module, farm management budgets are presented comparing sustainable and unsustainable cropping practices. These examples are:

- A sugar cane farmer growing a conventional monoculture crop, with a long ratoon cycle and cane burning to make harvesting easier, is compared with a farmer who has adopted the traditional rotational cropping system which involves short ratoon cycles with harvesting of green cane and food crop production.
- A yaqona/dalo farmer adopting an agroforestry/mucuna bean-based cropping system is compared with a broad acre system involving the clear felling of trees.
- A pineapple farmer planting along the contours, using vetiver grass and drop structures, and crop rotations is compared with a farmer using the common monoculture system with planting up the slope to try and improve drainage.
- A papaya farmer adopting the recommended sustainable production practices is compared with a farmer who is not adopting these practices.
- A climate resilient seedling nursery and a container to store seedlings when a cyclone is approaching

4.1 Comparison of a small sugar cane farmer adopting the now conventional long ratoon monoculture system, with a farmer adopting the traditional rotational cropping system

4.1.1 The now conventional long ratoon monoculture system

The assumptions for this model are:

- 2 ha of land are farmed, all of which is planted to cane
- The ratoon cycle is 15 years
- The cane is burnt for ease of harvesting
- Annual yield starts at 75t/ha and falls to 35 t/ha over the 15-year period due to soil erosion and declining soil fertility. The yield of cane falls despite the same quantity of fertilizer being applied over the entire period.
- The cane price remains constant at FJD 70/tonne – as does the harvesting and transport costs per tonne.
- No food is grown for the household – this all has to be purchased.

The returns to the farmer: Gross Margin

The detailed cropping budget from this conventional monoculture system over a 15-year period can be found here (Sugar Cane Budget)[1]

The annual revenue (gross income) from the 2 ha of cane falls from FJD10,500 initially to FJD4,900 by year 15 (the end of the ratoon cycle). The falling annual revenue is due to steadily declining cane yields. In year 1, the gross margin (GM) which is revenue minus cost is estimated at FJD1,800 and reaches a maximum of FJD3,790 in Years 2 and 3. From then on, the GM falls annually and stands at only an estimated FJD920 by year 15. This is assuming that the land continues to be farmed and is not abandoned which has often occurred when cane farms are established on sloping *talasiga* land (see Module 2)

4.1.2 "Traditional" rotational cropping system

- Assumptions for the model
- 2 ha farm; 1 ha planted to cane; ½ ha to rotational cropping (vegetables and root crops); and ½ ha left fallow.
- The ratoon cycle is only for 5 years. The cane is then planted on the other ha.
- The farm has been established on land not already badly degraded from previous cropping systems and not situated in a very isolated location for the marketing of the vegetables and root crops.
- Vegetables and root crops grown are either sold or consumed at home - the money saved is factored into the budget.
- The vegetables grown are eggplant and tomatoes (including off-season) plus cassava.
- Rows of vetiver grass are planted along the contours for soil conservation.
- Mucuna beans are planted as a green cover crop before the crops are planted for weed control and soil fertility.
- Cane is not burnt - the trash is left for mulch after harvesting the cane.
- A higher cane yield is achieved which doesn't decline over the ratoon cycle.

Returns to the farmer

Gross Margin (Revenue – Costs)

The detailed cropping budget from this traditional system over a 15 year period (can be found here (Sugar Cane Budget B) [2]. The estimated gross income from the 2-ha rotational cropping farm remains constant at around FJD10,000 throughout the entire period because yields do not fall. The GM from the farm in the first year is FJD3,600 due to the relatively high costs involved in establishing the system. It then remains steady for the next 4-years, at around FJD7,000. In year 5, the GM falls to around FJD5,200 when the 1 ha of cane needs to replanted on another location on the farm.

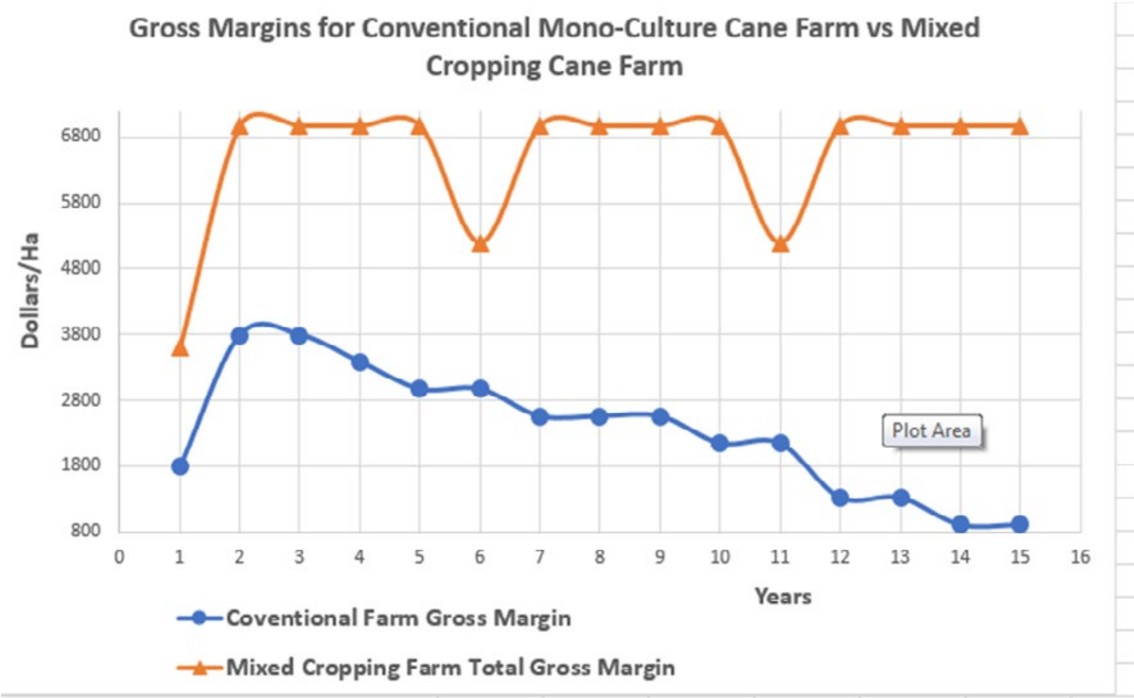
1 For any suggested adjustment please contact Livai Tora (livaitora@gmail.com) or Andrew McGregor (andrew@kokosiga.com)

2 Please contract Livai Tora or Andrew McGregor with any suggestions

Comparing the returns to the farmer from the two cropping systems

The estimated gross margin per hectare for the two cropping systems is compared in Fig 2

Fig: 2 Gross Margins for two sugar cane cropping systems



4.2 A kava (yaqona) farmer adopting an agroforestry/mucuna bean-based system

Fig 3 Unsustainable and sustainable yaqona production[3]

3 PIFON, 2015, Agricultural Value Chain Guide for the Pacific Islands https://pacificfarmers.com/agricultural-value-chain-guide-for-the-pacific-islands-2/

The assumptions of the model are:

- The farmer has long term access to 2 ha of their mataqali (clan or family) land and wants to plant 2 ha of yaqona inter-cropped with dalo. This land had already been cleared of most of the forest trees and previously cropped to yaqona and dalo and thus its fertility had declined.
- No direct payment is made for the use of this land.
- Approximately ½ ha of kava per year is planted over a 4-year period. This is in order to spread production and to phase in the costs.
- An alley cropping system is adopted to rehabilitate the land so it can be used sustainably into the future. This involves using nitrogen fixing and other nutrient enhancing trees such as Glyricidia *sepium* (Bai ni cagi), *Calliandra, Erythrina* (Drala), and *Leucaena* (Vaivai ni valagi). Where possible, any existing trees of these varieties have been retained and pruned to allow sufficient light to enter the cropping system. The spacing for any new trees planted (species listed above) is approximately 2 m x 4 m, thus leaving alleys for the planting of yaqona and dalo.
- Where possible, all trees around the boundary are retained, and additional trees planted to isolate the block as much as possible from the spread of kava dieback.
- The cropping alleys were established 4 months before the yaqona and dalo are planted.
- After a year of growth, all trees are pruned back to allow for more sunlight to reach the now well-established yaqona plants. The chopped leaves and branches are placed for mulch around the yaqona plants to suppress the weeds and conserve moisture. From then on, these trees are regularly pruned.
- The dried yaqona yield achieved after 4 years is 1,750 kg for each ½ ha planted.
- The yaqona is sold to traders at a price of FJD45/kg dried.
- The land is left fallow for at least two years before being planted again with yaqona and the cropping timetable is repeated.
- Mucuna bean is planted as a green manure crop six months before the yaqona is planted or replanted to add nitrogen to the soil and for weed control.
- Agricultural lime is also added as initially the soil is quite acidic because of the previous cropping system.
- The labour inputs are shared equally between the farming household and hired labour (paid FJD45 a day). This relatively high wage rate is due to the shortage of labour in the yaqona growing areas.
- Approximately 100 days of labour are hired annually to work on the yaqona. The tasks undertaken include: establishing the agroforestry alley and planting mucuna beans; maintaining the agroforestry alleys; weeding; planting; harvesting; and washing/drying the yaqona.
- A brush cutter is purchased to facilitate yaqona weeding

Returns to the farmer: Gross Margin (Revenue – Costs)

Table 1: Summary of the returns from 2 ha yaqona farm adopting and agroforestry/mucuna bean-based cropping system

	1	2	3	4	5	6	7	8	9	10	11	12	Total	Annual average over 12 years
Total revenue @ $45/kg				78,750	78,750	78,750	78,750		78,750	78,750	78,750	78,750	630,000	52,500
Total cost ($)	7,500	6,525	4,275	9,013	4,988	5,338	5,438	4.050	5,338	6,488	8,438	5,338	72,727	6,061
GM (Revenue-costs) ($)	- 7,500	- 6,525	- 4,275	68,738	73,763	73,313	73,412	- 4.050	73,412	72,262	70,312	73,412	557,273	46,439
GM per day of effort from the farming household ($)	- 107	- 77	-45	581	776	698	699	- 45	699	761	670	699	5,310	442

A detailed cropping budget for can be found at the following link[4].

To the income earned from yaqona the income earned from dalo has to be added – to which the cost of developing the agroforestry system for growing yaqona has contributed. However, it can be expected that in some years, the projected income will not be realized due to the impact of cyclones – although the impact of cyclones is expected to be reduced because of the cropping system (protective trees and phased planting over an extended period of time) that has been adopted.

The difference between the sustainable agroforestry cropping system and a conventional broad acre monoculture kava production system

The sustainable agroforestry cropping system proposed for farmers offers on-going yaqona production over several planting cycles. This compares with a farmer clearing and planting the entire 2 ha with yaqona who runs the risk of losing the entire crop due to a cyclone. Also, the risk of the incursion of kava dieback is far greater with this approach as there are no tree barriers to constrain the movement of aphids that spread the virus. In addition, the loss of soil fertility, due to the cropping system adopted, will mean another suitable area will have to be acquired for further planting. With the current yaqona boom, and the unsustainability of the cropping practices being adopted by farmers generally, the availability of such land is becoming increasingly scarce.

4 For any suggested adjustments please contact Livai Tora (livaitora@gmail.com) or Andrew McGregor (andrew@kokosiga.com).

4.3 A pineapple farmer planting along the contours (with vetiver grass) and using drop structures



Assumptions for the model:

- The farm is 2-ha with 1 ha planted to pineapples at any one time. The rest of the farm is left fallow with a cover crop of mucuna beans or is rotated with cassava followed by watermelon.
- The pineapples are planted intensively (50,000/ha). The average yield is assumed to be 50 tonnes/ha which is well above average but is seen to be realistic given the cropping practices that have been adopted. Maximum pineapple production is achieved by year 3, and from then on is maintained over a number of cropping cycles.
- The cropping cycle involves one plant crop (18 months from planting to harvesting) followed by two ratoon crops (12 months from ratooning to harvesting). After harvesting the 2nd ratoon crop, the land is left fallow for 6 months, during which time the suckers for replanting are collected. After this fallow period cassava is planted, followed by mucuna bean and then watermelon. The watermelons are followed again by mucuna beans before the pineapples are replanted. The whole cropping cycles takes approximately 6 ½ years to complete.
- Initially planting material has to be purchased (tops for 25c/each and suckers for 35c/each). Following the initial planting tops and suckers are then sourced from the farm itself - taken from the blocks after they have been harvested.
- The farm is on moderately sloping land (< 10o). To minimize soil erosion, rows of vetiver grass are planted along the contours with the pineapples planted between the rows of vetiver grass. An A frame is used to mark the contours. A two-wheel tractor is used to prepare the land for planting.
- Drop structures are installed on the drains to improve drainage and to reduce soil erosion. This will be particularly important during periods of intense rainfall and flooding that can be expected to increase with climate change.
- The average price received during the off-season is FJD1/kg farm gate and 50c/kg during the main season. Because of the cropping system adopted, the farmer is able to spread production equally between the main and the off -season. Thus, the average price received is assumed to be FJD75/kg.
- The fertilizers applied are NPK, Urea and Muriate of Potash (MoP). The Urea and MoP are sprayed on.
- The pre-emergent weedicide Diuron is applied at the time of planting. A bush cutter, hand weeding and mucuna bean ground cover are the main way in which weeds are managed at other times.

- The leguminous green manure cover crop is planted before the planting of the pineapples and watermelons. This is done to restore the nitrogen in the soil and for weed control.
- Labour is hired mainly for planting, weeding and fertilizer application and is paid a rate of FJD 30/day. Off-season pineapple production is facilitated by the planting schedule (April. June and January) and through the use of a flower inducing spray.

The returns to the farmer: Gross Margin

A detailed cropping budget for a 10-year period for this sustainable pineapple cropping system can be found at the following link[5] . It will be 18 months before any income is earned from pineapples with around FJD8,200 invested in setting up the cropping system. By the end of 2nd year around 35,000 kg of pineapples will have been sold for FJD26,000. In the 2nd year a GM of approximately FJD16,000 will be earned. By the end of year 3 a maximum annual production of 50,000 kg of pineapples will have been reached with the cropping system fully in place. This will allow for an annual gross margin of FJD27,000 from the 1 ha planted to pineapples. This will remain steady for the next 6 years as summarized in Table 2 below:

Table 2 Estimated GM of 1 ha of pineapples following the package of practices recommended by Aad van Santen

	Gross Margin from 1 ha planted to pineapples grown under a sustainable productions system									
Year	1	2	3	4	5	6	7	8	9	10
Revenue (FJD)	-	26,250.0	37,500.0	37,500.0	37,500.0	37,500.0	37,500.0	37,500.0	37,500.0	37,500.0
Cost (FJD)	8,210	9,900	11,050	10,350	11,250	10,350	10,350	10,350	10,350	10,350
	- 8,210	16,350	26,450	27,150	26,250	27,150	27,150	27,150	27,150	27,150

In addition to the GM earned from the core pineapple business, significant income will be earned from the two intercrops (cassava and watermelons). The sustainable yields achieved from these crops will have been significantly enhanced by the cropping system adopted for the pineapples. In addition, the estimated GM from pineapples will increase if some of the cost involved in setting up the contour and drainage system is shared with cassava and watermelons. Had the farmer not adopted this sustainable cropping system there would be a significant fall in crop yield and income earned from year 3 onwards due to soil erosion and the loss of soil fertility.

4.4 A profitable sustainable papaya farm growing 'Fiji Red 'for both the export and domestic market

Areas of western Viti Levu and the Sigatoka Valley offer ideal growing conditions for papaya. Over the last twenty (20) years, Fiji has developed its own unique papaya variety (the 'Fiji Red') – the result of research and development undertaken by Nature's Way Cooperative (NWC). 'Fiji Red' is exported to New Zealand and Australia where there is a large and growing market. There are also substantial market opportunities for export to the United States once market access has finally been obtained. There is an even larger local market, selling to hotels and local consumers.

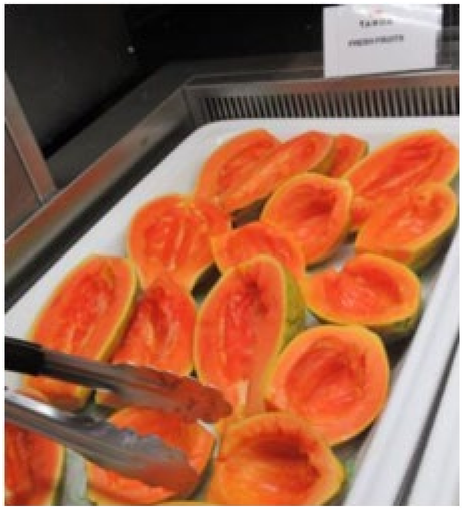
5 For any suggested adjustments please contact Aad van Santen <aadandlice@gmail.com>) or Andrew McGregor (andrew@kokosiga.com

'Fiji Red' papaya seed developed by NWC, available on sale. (photo: Kyle Stice)

'Fiji Red' papaya seed developed by NWC, available on sale. (photo: Kyle Stice)

The necessary conditions for a farmer to be able to sustainably take advantage of these remunerative market opportunities are:

- Investment in an irrigation system to enable the full production of high-quality 'Fiji Red' papaya during extended dry periods - which can be expected to increase with climate change.
- Investment in a drainage system to minimize soil erosion and to ensure that the papaya trees are not left standing in water in for a few hours – especially as longer periods of extreme rainfall are expected as a result of climate change.



'Fiji Red' papaya for breakfast in a hotel.(photo: Kyle Stice)

Assumptions for the model:

- The farmer adopts the practices recommended by the NWC Research and Extension (R&E) Service. The farm budget prepared is based on the data supplied by the NWC R&E.
- There are 1,250 papaya trees planted on 1ha – with 2.5 m x 2.2 m spacing. Initially 3 seeds or seedlings are planted in each planting mound. The best hermaphrodite (bell shaped fruit) seedling is selected from each mound when flowering commences (66 per cent of the trees will have hermaphrodite flowers and 33 per cent will have female flowers). One tree being maintained per mound results in approximately 90 per cent of the fruit being the bell shaped fruit suitable for export. The remaining 10 per cent are round and can only be sold on the local market.

- The seedlings planted are from certified 'Fiji Red' seed which has been sourced from NWC.
- The papaya cropping cycle is for 4 years. The first fruit for sale is harvested 9 to 10 months after planting.
- Planting is undertaken after land preparation and the installation of a drip irrigation and drainage system to eliminate waterlogging. The papaya trees are removed at the end of 4 years and the block is then planted to vegetable crops (eggplant, tomato, English cabbage, long bean) and replanted with papaya again after another year. Ideally the land should be left fallow for at least 1 year before replanting. However, the shortage of suitable land for papaya means that this is usually not possible and the minimum fallow period of 1 year has to be accepted.
- The fertilizers applied are NPK, Urea, Ag Lime, Urea, Ag Lime, animal manure, and Borax.
- Papaya yields are maximized in year 2 – falling away in years 3 and 4. Overall 70 per cent of the fruit sold is of exportable grade with the quantity of exportable fruit maximized in year 2.
- The price received for exported fruit is FJD1.20/kg and FJD1/kg for fruit sold on the local market. The cost of transport to the buyer is 10c/kg.
- The wage rate for hired labour is FJD25/day.

The returns to the papaya farmer

The detailed 4 year cropping budget for the papaya farmer adopting the NWC R&E recommendations for sustainable remunerative cropping can be found here[6] . The summary is presented in Table 3 below.

Table 3: Estimated GM of 1 ha of papaya following the NWC recommended package of practices

GM for a papaya farmer adopting the NWC recommendations for a sustainable remunerative production					
Year	1	2	3	4	Annual average
Total Revenue (FJD)	17,000	63,000	51,000	34,000	41,250
Total Cost (FJD)	43,437	21,362	13,882	9,382	22,015
Revenue - Cost (GM	-26,437	41,638	37,118	24,618	19,235

In the first year, there are significant initial costs incurred in establishing the sustainable remunerative cropping system. These include land preparation and installing a drip irrigation system and drainage system to prevent waterlogging. If the irrigation and drainage systems are well maintained, they can last beyond 1 papaya cropping cycle and thus future investment in the cropping system will be reduced.

Production and thus revenue are highest in year 2. Revenue then falls in year 3 and 4 as the production of export grade fruit declines. It can be expected that the farmer will have several blocks planted to papaya, and these will be at different stages in the 4-year production cycle. Thus, the total GM from papaya for the whole farm will be more evenly spread through time. Having several blocks at different stages of the production cycle also helps minimize the impact of cyclones. Other measures (irrigation, drainage, pruning and covering the fruit) recommended by the NWC R&E assist the farmer to adapt to climate extremes.

6 For any suggested adjustment please contact Livai Tora (livaitora@gmail.com) or Andrew McGregor (andrew@kokosiga.com)

Papaya yield and quality (particularly for export), will be substantially lower for those farmers who don't adopt the recommended sustainable cropping practices. The specific reasons for this include:

- A higher percentage of round fruit that is not suitable for export as a result of poor sourcing of seed and planting practices.
- Without irrigation papaya yield will be much lower.
- The impact of cyclones and flooding will be more severe on those farmers who have not adopted the recommended practices particularly those relating to drainage to avoid waterlogging.

4.5 Investing in a climate resilient seedling nursery and a container to store seedlings when a cyclone is approaching

As discussed in Module 5: 'Sustainable Seed, Seedling and Vegetable Production', Sant Kumar of Bula Agro, in 2011, built a seedling nursery that is resilient to both cyclones and floods. The Bula Agro nursery, located at Votualevu, Nadi, is in an area particularly prone to both events.

The resilient nursery system has two components:

- A nursery that can be quickly disassembled with the imminent arrival of a cyclone (Category 2 or above) – the design is such that the nursery can be reassembled within 48 hours of a cyclone passing. The nursery poles are not cemented into the ground and it is built out of basic, locally sourced materials so that it can be built at a somewhat lower cost than a conventional nursery with poles cemented into the ground. The total cost of the Bula Agro nursery was around FJD45,000.
- Prior to dissembling the nursery, the seedlings are removed and placed where they will be protected from cyclonic winds and floods. Bula Agro has provided this protection with a renovated, 24ft sea freight container. The container has removable shelves on which the seedlings can be placed. It has an air circulation system that enables the seedlings to be stored for at least 48 hours without damage.


Sant Kumar with his dismantled shade house and his seedlings stored in shipping container (photos: Kyle Stice and Andrew McGregor)

The figures presented in the table below are indicative of the seedling capacity of the container. The estimated market of these seedlings pre-cyclone is around FJD54,000. However, the cyclone will cause severe damage to fruit and vegetable crops which will generate a high demand for seedlings. Thus, it would be reasonable to expect a more than a doubling of the market value of the seedlings that have been saved by storage in the container. Therefore, once Bula Agro's nursery becomes operational again after a few days, it is ideally placed to take full advantage of the sudden high demand for fruit and vegetables seedlings that have been produced from open pollinated seed (such as eggplant, okra, tomato, chillies, cow peas, pigeon pea and papaya).

Given that over the last decade there have been some three major cyclone and flood events in Fiji, the investment in a climate resilient nursery system has been more than financially justified. With climate change, the frequency of major cyclone and flood events is expected to increase. Bula Agro's investment is a clear example of a sustainable **farming practice that is climatically, environmentally and economically smart** and is an area where the support of financial institutions would be well justified.

Table 4: Indicative estimate of the market value of the seedlings, saved by the Bula Agro disaster resilient nursery system.

Seedling type	Number stored in the container	Market value per seedling (pre-cyclone) (FJD)	Total value (pre-cyclone) (FJD)	Indicative value (post-cyclone) (FJD)
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**