SUSTAINABLE TARO CULTURE: FIJI SITUATION

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Introduction

Geography

The Fiji group consists of some 364 islands, with a total land area of about 364 square kilometers. Fiji's position, 15° and 22° S and longitudes of 174° E and 177° W, places it in a strategic location for trade. Approximately one hundred of the islands are permanently inhabited. The two main islands, Viti Levu and Yanua Levu, contain 87 percent of the total land area and 93 percent of the population. As much as 25 percent of the land area is suitable for cultivation, and the rest is hilly, too mountainous, and rocky with some outcrops of coral limestone.

Climate

The climate is of the typical oceanic type with the southeast trade winds prevailing. The hot, wet months are from November to April. The windward side of the large islands is wet (3,600 mm precipitation per annum) while the leeward side receives an annual precipitation of 1,640 mm. Strong winds, hurricanes, and flooding are occasionally destructive to crops.

Soils

A total of ten soil orders exists in Fiji, and of these three are suitable for taro culture.

Flurentic Eutropet (Inceptisol) - Reva Series
- reasonably drained soils found on river planes
- fertility is only moderate and nutrient soil amendments may be required

Typic Eutropet (Inceptisol) - Waidina Series
- colluvial pockets, easy rolling to moderate slopes of S.E. Yiti Levu and Vanua Levu
- moderately fertile soil, but needs occasional application of NPK fertilizers

Typic Hydrandept (Antisols)
- comparatively young volcanic soils (Taveuni, Koro and Rotuma)
- soils are generally fertile, but require additional application of potassium fertilizer

Importance of Taro

Taro (*Colocasia esculenta*) is known to the Fijians by ten different names (Parham 1972) and is cultivated by people who lived in physically isolated communities for centuries. To the indigenous people, taro is important in their culture. Presentations of food to chiefs and at important social functions would be deemed less successful if taro or yam were absent. Taro is the most common aroid cultivated by farmers.

Taro and other root crops, together with wheat flour and rice, provide the basic carbohydrate requirements for the people of Fiji. The corm is a good source of calcium. Much of the taro produced is either sold in local markets or for export. The demand for taro, especially at the festive Christmas period, appears to be inelastic, as consumers purchase taro regardless of the high prices. Apart from the corm, taro leaves of certain varieties are particularly esteemed as a green vegetable.

Taro Market

The corms are marketed locally with petioles attached, thereby assisting in the distribution of the species since top sets are used as planting material. Quarantine requires that taro corms for export be cleaned, with approximately 5 cm of the top (petiole base) remaining. The harvested corm could be kept for some days or weeks, depending on post-harvest treatments and corm moisture content.

The area under taro for the year 1991, as reported by the Extension Division, was 1,579 hectares. The national

Table 1. Taro production and export quantities for six years.

Year	Production area (ha)	Quantity (t)	Export (000 t)	Revenue (million)
1991	1,579	8,080	866.3	0.96
1990	1,236	8,780	2,106.7	2.63
1989	1,040	7,803	1,078.0	
1988	922	8,759	619.6	
1987	1,268	12,680	131.4	
1986	1,216	12,090	559.6	

crop yield is generally low (9 t/ha). However, it should be realized that the data were field estimates.

Pest and Disease

One of the ways to sustain the interest in production of a crop is to reduce to a minimum the ravages of pest and disease. The important pests and diseases of taro are listed in Table 2.

Table 2. Major pests and diseases of taro in Fiji.

Diseases
Shothole (*Phyllosticta colocassiicola*)
Vein banding (Dasheen Mosaic Virus)
Corm rot (*Phytophthora cinnamomi/P. nicotiane* var. parasitica)
Insects
Leafhopper (*Tarophagus prosepina*)
Taro beetle (*Papuana uninodis*)

Shothole

Shothole is often confused with *Phytophthora* leaf blight which is common on wet land taro elsewhere but not known in Fiji. Cool, wet periods appear to favor the disease. Leaves have a tattered appearance when several shotholes run together. Actual loss caused by the disease has not been assessed.

Veinbanding

Experimental work conducted at Koronivia showed that growth and yield of three varieties (tissue-cultured and nontissue-cultured material), *Tausala ni Samoa*, *Tokula*, and 'Samoa Hybrid' were not adversely affected by the disease. However, the growth and yield of the local 'Samoa' variety was significantly reduced, especially when the planting was obtained from crops on hill-country farms (F. Vilsoni et al. unpublished).

Corm Rot

This is mainly a post-harvest problem. Corms from vigorously growing plants, which therefore have high moisture content, appear to be susceptible to corm rot.

Leafhopper

The insect punctures leaf stalks during egg laying. Sap exudation and mechanical injury could weaken plants. Severe local outbreaks cause stunting and wilting at the beginning of the cool season (April-May).

Taro Beetle

The insect was found in Fiji in 1981 on taro farms near the seaport Suva. Since then, it has continued to spread, but in only one island (Viti Levu).

Current and future taro breeding programs should seriously consider the selection of hybrid lines tolerant to important pests and diseases.

Taro Varieties

A total of 72 local varieties have been collected, classified, and evaluated (Sivan 1981). Corm yield of varieties obtained from single plots at Koronivia is given in Table 3.

Table 3. The corm yield of local varieties grouped into four categories.

No. of varieties	Yield (t/ha)
10	over 25
29	20-25
29	10-20
4	below 10

The ten high-yielding varieties were then further evaluated (Sivan 1981) for yield and sucker number under three environments (Table 4).

Table 4. Fresh corm yield (t/ha) and sucker numbers (mean of two trials) of ten taro varieties at three sites.

Variety	Waidradra (wet, hilly land)	Koronivia (wet, alluvial flatland)	Dobuilevu (neither dry nor very wet)	Sucker number
Samoa Oriori	22.2	17.1	17.0	1-3
'Samoa'	20.3	14.8	19.6	2-4
Tausala ni Samoa	19.9	13.3	14.3	5-6
Tausala ni mumu	17.1	15.3	19.4	10-16
Toakula	19.3	15.1	14.7	6-8
Vaivai Dina	17.9	11.9	13.0	4-5
Volo	22.4	14.6	18.1	7-8
Kaboa	19.0	13.9	13.0	6-9
Qawa ni Urau	19.5	13.2	13.2	6-7
'Hawaii'	12.6	10.2	8.0	8-9
Mean	18.9	13.9	15.0	
SE	1.4	0.76	1.2	

The maintenance of production and culture of the crop may depend upon the suitability of the variety to the environment. The varieties *Tausala ni Samoa*, 'Samoa', and *Toekula* have relatively few suckers, however, they are

the most popular taro cultivated by farmers. Farmers, therefore, appear to propagate and maintain a variety that is acceptable to consumers or the market.

Sustainability of taro culture may also be influenced by the genetic potential of hybrid varieties. High yield, disease, or insect tolerance are selection criteria necessary to promote the future expansion of the crop.

In Fiji, nine clones of the original 2,500 developed in 1984 were evaluated in 1989, and corm yield ranged from 20.7 t to 30.3 t/ha as shown in Table 5.

Table 5. The corm yield of hybrid taro tested at Koronivia (Tavaiqia 1989).

Cross variety	Clone No.	Yield (t/ha)
R16 x *Tausala ni mumu*	160/32	30.3
Vaivai dina x 'Samoa hybrid'	123/70	29.7
R16 x *Tausala ni mumu*	160/31	29.0
'Samoa hybrid' x *Toakula*	110/6	28.4
Tausala ni mumu x *Tausala ni Samoa*	191/37	25.6
Vaivai dina x 'Samoa hybrid'	123/102	25.0
R9 x 'Samoa hybrid'	115/133	24.5
Vavai dina x 'Samoa hybrid'	123/98	24.2
'Samoa hybrid'	check	22.1
Tausala ni Samoa x 'Samoa hybrid'	106/5	20.7

From these nine clones, six were selected and are in final evaluation trials. Yield increases of these clones have been as high as 38 percent compared to local parent varieties.

Through a regional Root Crop Improvement Project, more than fifty varieties were introduced as meristem tissue cultures. The varieties were evaluated and the promising ones set aside for further testing or improvement.

Traditional Taro Culture

With dryland taro, the practice of shifting cultivation is still being followed. Normally, virgin forest would be cleared and planting holes made in the ground using a selected stick about 1.5 m long. In the first year, taro would be the main crop, but by the second and third years an intercropping pattern would have developed. The land would be fallowed after two to three years of cropping.

In some areas if the climate and vegetation allow, regeneration of forest species could proceed at a rapid rate. Soil nutrient replenishment by natural means could be achieved in a few years, and the same piece of land could then be replanted. There are, however, certain areas where forest species are either slow to regenerate or never recover at all. In such areas, grasses and mixed weed species would normally cover the fallowed land. Soil nutrient replacement in this situation would be comparatively slow.

Fertilizers are not normally used in traditional subsistence taro cultivation. A number of taro varieties could be found growing in any one farm. In this situation, outbreak of pest and disease do not normally occur. Because of the simple cultivation and planting tools used in this system, topsoil is little disturbed and soil erosion is minimal.

A small amount of Fiji taro is grown on wetland. Often, the area would be subdivided into small plots by drains that allow for removal of excess water. The wet conditions do not support the growth of most other crops, and taro as a monocrop is planted for about two years and the land left to a grass fallow. Since the soil is wet, there would be little nutrient loss through excess aeration. The application of fertilizers or manure to wetland taro is not a common practice.

Traditional systems could sustain the cultivation of taro provided the land was rested sufficiently to allow for nutrient replacement.

Intensive Taro Culture

With the increase in demand for food as a result of population pressure, the practice of shifting cultivation is giving way to intensive taro culture.

In this system, taro is planted in rotation with other crops, each as a monocrop. The system favors a single variety of taro for a specialized market. Cultivation is often done with the use of machinery. Fertilizer and pest control inputs are required. Weed control by use of chemicals would not be uncommon.

With the frequent cultivation, nutrient loss through crop harvest, soil aeration, and top soil erosion, if ignored, could lead to a non-sustainable production system.

In Fiji, intensive taro culture is either semi-mechanized on flat land or conducted manually on hilly land.

A large proportion of the taro (2,000 t/yr) produced on the island of Yiti Levu is grown in rotation with ginger. Much of the ginger land is rolling hills (10°-25° slope) to steep slopes (25°-35°). This crop rotation (Table 6) is recommended primarily to control diseases of ginger. The taro crop planted after ginger also captures the unutilized nutrients from the heavily manured ginger crop.

Table 6. Taro and ginger (Waidina Series) crop rotation practice on island of Yiti Levu.

Ginger	Nine months' duration; application of poultry manure prior to planting. Mineral fertilizer use - optional.
Taro	Ten-11 months; crop grows vigorously; remnant of nutrients from ginger crop. Poor host of nematodes.
Cassava	Ten months. Non-host of nematodes (or fallow) attacking ginger. Can thrive reasonably well without additional fertilizer.
Fallow	Twelve-24 months, then ginger again.

Production of taro is sustained because of the manure and fertilizer inputs. Unfortunately the continuous soil loss through erosion might not, in the long term, support the system.

Clark and Morrison (1987) found soil losses, in the ginger area, amounting to 85 t/ha/annum. The losses were accompanied by consequent reductions in carbon, calcium, and magnesium and increases in aluminum to toxic levels. Soil loss through ginger crop removal was estimated at 26 kg per tonne of rhizome (F. Vilsoni et al. unpublished).

Two research projects (IBSRAM and German Agroforestry) have been implemented and aim to reduce soil erosion by establishment of *Calliandra*, pineapple, and vetivar grass on the contour.

Fertilizers for Taro

In all intensively cropped soils, the use of fertilizers is imperative. The three soil types recommended for taro in Fiji, although relatively fertile, still require additional nutrient amendments if production is to be sustained. Fertilizer recommendations are as follows:

N	100 kg N/ha (22 kg Urea or 475 kg sulphate of ammonia) in split applications at 5, 10, and 15 weeks.
P & K	If levels are low in soil.
P	25 kg/ha (300 kg superphosphate) at planting 100 kg/ha (250 potassium sulphate or 169 kg/ha muriate of potash) in split applications at planting and at ten weeks.
K	100 kg/ha (250 potassium sulphate or 169 kg/ha muriate of potash) in split applications at planting and at ten weeks.
NPK	Compound (13:13:21), 400 kg/ha at planting and at ten weeks plus N 50 kg/ha at five and 15 weeks.
Poultry Manure	10 t/ha before planting plus NPK compound 200 k/ha at ten weeks or N 50 kg/ha.

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The Editor

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