

SUSTAINABLE MANAGEMENT PRACTICES OF TARO (*Colocasia esculenta*) PRODUCTION IN WESTERN SAMOA

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Abstract

A Rapid Rural Appraisal (RRA) survey was conducted in 30 farms in ten villages in different parts of Upolu Island of Western Samoa to ascertain the traditional sustainable methods of cultivation of taro (*Colocasia esculenta*).

It was the major crop in a mixed cropping system under coconut. It was also grown extensively as a monocrop, mainly in areas where forests and abandoned bush land were cleared for planting.

Few farmers used insecticides, but none used fungicides to control pests and diseases, respectively. Cluster caterpillar *Spodoptera litura* was the most serious pest. It was controlled by crushing the caterpillars and their egg masses and cutting and burning severely infected leaves. Corm rot by *Pythium* spp. caused considerable damage in the wet areas. It was controlled by uprooting the plants and destroying the infected corms and also by not planting in poorly drained soils.

Several major species of monocotyledonous and dicotyledonous weeds were present. Herbicides were widely used. Most applied them two to three times after planting, while some removed weeds manually and used them as a mulch.

Farmers owning large holdings fallow the land for 12-18 months, while many others used short fallows of six to eight months. A few carried out continuous cropping. *Erythrina subumbrans* was extensively used, mainly in areas where taro was grown as a monocrop, and the loppings were used as a mulch. The cation exchange capacity (CEC), calculated from the organic carbon content, was over 20 me/100 g soil. This indicated that the soil fertility is good. Inorganic fertilizers were not used by many farmers.

Soil erosion was prevented by mulching and allowing tree trunks and branches to remain on the ground.

Introduction

Taro (*Colocasia esculenta* (L.) Schott) is the most important staple food crop in Western Samoa. It is grown

throughout the year and much of it is locally consumed. However, recently it has gained significance as an important export commodity.

The farmers in this country have for centuries used indigenous farming practices in taro production. However, rapid changes in economic, technological, and demographic conditions in many developing countries have caused alterations to their traditional methods of farming, often with negative environmental and social impacts. To arrest the degradation of natural resources, considerable emphasis is now being placed on sustainable agriculture, especially in the developing countries, using traditional methods. Such practices in the Pacific Islands associated with the Land Grant program have been investigated (Fatuesi et al. 1991, Vargo 1992).

This paper describes the traditional sustainable practices of taro production in Western Samoa, with emphasis on farming systems, choice of cultivars, disease, pest and weed management, methods of soil conservation, and maintenance of soil fertility.

Methodology

A Rapid Rural Appraisal (RRA) survey was conducted in 30 farms in ten villages in different parts of Upolu Island in Western Samoa. The questionnaire was completed after discussion with the farmer while walking along with him in the plantation to examine various practices he had adopted. The weed species present in the farms visited were collected and identified using the descriptions of Whistler (1983). Soil samples were collected from the top 15-cm layer, using a soil auger from eight farms in different parts of the country. The organic carbon content was determined by the Walkley and Black (1934) method, and cation exchange capacity (CEC) was calculated using the formula of Wright (1963).

Results

Land Tenure System

Generally, the farmers owned their land either as a

large contiguous block or in several small blocks. Usually large extents of land were owned by farmers who cleared forests, which were often located far from their homes. They cultivated their land with family labor, and only a few used hired labor. There was also a unique system in one farm, where a group of people belonging to a club helped each other in cultivation practices, without any wages.

Some farmers did not cultivate their own land due to various difficulties and constantly obtained their food supplies (banana, taro, *tamu* (*Alocasia macrorhiza*)) and cash loans from other farmers around them. In one such instance, a farmer opted to lease his land in return for a regular supply of food crops.

Farming Systems

Most coconut plantations in Western Samoa are in a state of neglect with senile palms having sparse canopies resulting from the damage caused by two cyclones that devastated the country in 1990 and 1991 within a space of 22 months. Taro was commonly intercropped (20 percent) with coconut singly or in a mixed cropping system with cocoa, banana, and *tamu*. It was also a common practice to intercrop taro with banana. Usually, taro was extensively grown as a monocrop (80 percent) in areas where the farmers have cleared the forests or abandoned bush land. In these areas, *Erythrina subumbrans* (Hassk.) Merrill was established in a systematic manner to utilize the loppings as a mulch to sustain the yield of taro.

Many farmers grew vegetables (cucumber, tomato, Chinese cabbage, squash, and bean), fruits (papaw, watermelon, pineapple, and citrus), other root crops (*tamu*, cassava, sweet potato, and yam), cash crops (kava, peanut, pandanus, sugarcane, and breadfruit) mainly around their homesteads and less commonly in the plantations for domestic use and to be sold in the local market. Some farmers reared pigs and poultry.

Cultivars

It was observed that many farms had a mixture of cultivars dominated by unimproved cultivars, *Talo Niue* and *Manua*. The other predominant cultivars were *Paepae*, *Pute Muu*, *Faelele*, and *Pula*. Cultivars like *Tusitusi*, *Manua Tusitusi*, *Taro Palagi*, *Tuseitusi Paepae*, *Magasiva*, *Matalea*, and *Pueta* were less popular. The cultivar *Vale* was grown in a few farms essentially for leaf production. There were several unknown local selections, which the farmers claimed were high yielding, having resistance to pests and diseases, with corm quality acceptable for the local market but not for export. The cultivar *Talo Niue* had a high demand in the local and export markets. Farmers thought that *Manua* was

unsuitable for the export market as the corms have a tendency to dry up quickly during transit and storage. The local cultivars yielded well, but many were suitable only for domestic use and not for export because of the poor corm quality.

The improved cultivars, 'Alafua Sunrise' and 'Samoa Hybrid', were also grown by a few farmers. They have collected their planting material from the farms in which the University of the South Pacific (USP) conducted on-farm trials and through student relatives in the campus.

Tamu was also grown in separate blocks in many farms, around the home garden, and as an intercrop in coconut, cocoa, or banana plantations. In some areas, *Tamu* was used as a shade plant for cocoa seedlings. *Tamu* was sold in the local market and had a great demand for various traditional ceremonies in the village.

In the wet areas, taro was planted throughout the year. The number of suckers planted depended on the amount of plants uprooted for sale and the availability of land to replant taro. It ranged from 500-10,000 plants per week. However, in most areas planting was mainly confined to the wet season, but it was also done during rainy weather in the dry season.

Taro was generally harvested in about six months after planting, and only a few farmers left it for seven to nine months. The corm weight varied between 0.5-1 kg at harvest in six months. At present, about 10-12 taro corms were sold for ten *tala* in the local market. For export, a bag of taro weighing 35 kg was sold for 55 *tala* at the farm-gate.

Pests

The major pest in taro was the cluster caterpillar (armyworm) *Spodoptera litura* F. It caused serious damage by feeding on the leaves. Farmers claimed that severe outbreaks often occurred soon after cyclones, during dry weather periods, and in plantations close to forests, resulting in widespread defoliation and sometimes total destruction of the plantation. Many cultivars were attacked, but *Pute Muu* and *Faelele* were claimed to be tolerant and highly susceptible, respectively.

Many farmers did not use insecticides to combat the cluster caterpillar. Those who used them claimed that Ambush and Orthene were effective but uneconomical to use. Though Mortein was not recommended, one farmer claimed that it successfully controlled the caterpillar. The most common methods of control were to squeeze the egg masses and young worms with the fingers and crush them by rubbing the pest infested leaves. Hand picking was done only if a few plants were affected. Shaking the leaves to dislodge the caterpillars was also a common

practice in plantations around homesteads by farmers who reared chickens. The chickens picked the worms from the ground and also directly fed on them by pecking on the leaves.

Severely damaged leaves with large caterpillars were usually cut and burnt. Allowing the weeds to grow around taro plants reportedly acted as a physical barrier and prevented an attack by cluster caterpillars. Sprinkling wood ash also helped to reduce the caterpillar population. It was alleged that smoke from burning logs in taro plantations prevented the moths from laying eggs. Heavy rain caused a reduction in the larval population by washing them off the leaves. Planting *Coleus blumei* Beuth (pate) in between taro or in the boundary of the plantation was thought to be effective in repelling cluster caterpillars because of the strong smell of *Coleus* plants. When the infestation was severe, the farmers uprooted the plants and harvested the corms if they were formed.

The taro planthopper (*Tarophagus proserpina* Kirkaldy) was not a serious pest in many farms, except in one, where taro plants showed severe symptoms of Dasheen Mosaic Virus (DMV). A large number of planthoppers were present on the infected plants.

Farmers believed that *Coleus* was more effective in controlling planthoppers than the cluster caterpillars and that its effectiveness was attributed to the smell of *Coleus* and to the build up of other predatory insects which presumably attacked the planthoppers.

It was evident that pest attacks were greater under monoculture than in mixed cropping systems.

Diseases

There were no major disease problems, and none of the farmers used any fungicides. However, corm rot caused by *Pythium* species was found mainly in wet areas with poor soil drainage. In some farms, it caused considerable damage sometimes, resulting in significant yield losses. Brown leaf spot and orange leaf spot diseases caused by *Cladosporium colocasia* (Sawada) and *Neojohnstonia colocasiae* (M.B. Ellis), respectively, caused no serious damage and control measures were not warranted.

Mild symptoms of DMV were also observed in a few farms, but severe symptoms were seen in only one farm. The cultivar *Paepae* was highly susceptible to DMV. The only remedy for this disease was to uproot the infected plants and destroy them.

Farmers believed that continuous cropping helped to perpetuate *Pythium* rot and fallowing land for periods ranging from 6-18 months or more and growing taro in well-drained soil helped to reduce the incidence of the disease. The improved cultivar 'Alafua Sunrise' was highly

susceptible to *Pythium* rot, but some unimproved cultivars such as *Tusitusi* and *Pute Muu* were said to be tolerant. Removal of infected plants and destroying them was the only practical method of control of *Pythium* rot.

Farmers were careful in selecting planting material. They used vigorously growing suckers which were apparently free of diseases.

Weeds

The most predominant dicotyledons weeds were *Mikania micrantha* HBK., *Stachytarpheta utricifolia* Sims, *Blechnum brownii* Juss., *Crassocephalum crepidioides* (Benth.) A. Moore, *Passiflora foetida* L., *Peperomia pellucida* (L.) HBK., and *Ageratum conyzoides* L. *Paspalum paniculatum* L., *Digitaria horizontalis* Willd., *Eleusine indica* (L.) Gaertn., *Cynodon dactylon* (L.) Pers., *Brachiaria mutica* (Forsk.) Stapf, *Paspalum conjugatum* Berg., and *Echinochloa colona* (L.) Link were the most common monocotyledonous weeds found on the farms.

Farmers considered *M. micrantha* and *B. mutica* the most beneficial weeds. These helped to retain moisture and enrich the soil fertility during the fallow period. They claimed that *B. mutica* was particularly useful as it suppressed the growth of all other weeds and provided an excellent mulch after spraying with herbicides. *M. micrantha*, on the other hand, was an easy weed to pull out.

Weed control practices varied, and these broadly fell into four categories (Fig. 3): (i) The most widely practiced method was to slash the weeds prior to planting taro, followed by the application of three rounds of herbicides around 2-3, 6-7, and 15-17 weeks after planting. Some farmers used herbicides (Paraquat) only once or twice, followed by hand weeding. One farmer used herbicides before planting, followed by hand weeding. Farmers always slashed the weeds before spraying the second and third rounds. The removal of weeds round the base of the plant during the last weeding round was a standard practice in many farms. These different combinations of herbicide use were practiced by about 47 percent of the farmers. (ii) Some farmers preferred to spray herbicides (Sting) before planting taro, especially when there was a thick growth of weeds. Application of Sting was followed by one to two rounds of spraying with Paraquat or hand weeding. Farmers claimed that the second round of herbicide application could be delayed by about 2-3 weeks if Sting was used instead of Paraquat for the first round. (iii) About 23 percent of the farmers did not use herbicides at all. They hand weeded the plantation and left the weeds as a mulch to prevent the soil from being eroded. (iv) One farmer (3 percent) first hand weeded

the plantation, then planted taro, followed by application of one round of herbicides and two rounds of hand weeding.

Soil Fertility

Only two farmers (7 percent) applied fertilizers (150 g of NPK mixture 12:5:20) to the planting hole. One other (3 percent) sprinkled a handful of the same mixture around each plant about 4-5 weeks after planting.

Fallowing land to allow it to be colonized by weeds to rebuild the soil fertility was a common practice adopted by many farmers. Those who owned large extents of land fallow their land for about 12-24 months, while others with relatively small holdings used a fallow period of 6-8 months. Those who were constrained by land had a shorter fallow of 2-3 months.

The nitrogen-fixing legume tree *Erythrina* was widely planted, especially in areas where taro was grown as a monocrop. It was observed that taro plantations in recently cleared forest areas were systematically planted with *Erythrina*. It was also planted in areas where taro was intercropped with coconut. The trees were pruned at least once a year, and the prunings were used as a mulch.

The cation exchange capacity (CEC) calculated based on the organic carbon content in soil, using the method of Wright (1963), indicated that the soil fertility level was good in most farms, while a few were closer to the threshold level of 20 me/100 g (Table 1).

Table 1. Cation exchange capacity of soils in eight farms.

Farm site	Cation exchange capacity of organic carbon (me/100 g)
Faleseela Lefaga	30.38
Siumu	23.89
Aleisa	-
Uafato Fagaloa	1.38
Falelati	32.89
Satui	24.52
Lalomanu	27.73
Saleilua	26.82

Soil Conservation

None of the farmers used any special method of soil conservation. The mulch provided by decaying weeds after spraying with herbicides or hand weeding helped to prevent soil erosion. Leaving blocks of uncultivated land as fallow areas, in between cultivated plots also helped in arresting soil erosion, especially in sloping lands.

In undulating and hilly terrain, especially in newly cleared areas, tree trunks, large branches, and tree stumps were allowed to remain on the ground to act as barriers to prevent erosion. Similarly, rocks in hilly areas prevented wash-off of soil.

Discussion

The farmers in Western Samoa kept the damage caused by pests within acceptable bounds by employing a wide array of traditional practices. At present, pest damage is not a constraint to taro production. Pests were more abundant and caused relatively greater damage when taro was grown as a monocrop, especially around forests, compared to taro in a mixed cropping system. Species diversification in crop mixtures frequently results in reduced pest and disease incidence. These complex systems affect insect populations by either interfering with the movement and colonization or increased mortality caused by natural enemies (Root 1973). Spread of cluster caterpillar was controlled by using weeds to create a physical barrier that interfered with insect movement. *Coleus* was thought to repel the pests and also help in breeding predators and parasites which can attack planthoppers, but concrete evidence for this hypothesis is lacking.

Herbicides were extensively used because farmers cultivated larger areas with limited family labor. The mulch formed after spraying herbicides, hand weeding, or slashing arrested soil erosion, conserved moisture and enriched the soil fertility by recycling the nutrients.

Erythrina was widely planted as farmers were fully aware of its beneficial effects (Rogers and Rosecrance 1992). *Erythrina* loppings improved the soil physical properties (Anathacumarasamy et al. 1988), enrich fallow periods (Rogers 1992), increase yields (Weeraratna and Asghar 1992) and reduce weed growth (Rogers and Rosecrance 1992). This sustainable practice is particularly important as a negligible number of farmers applied inorganic fertilizers.

Fallowing land is another practice widely adopted by farmers to improve soil fertility. The fallow period depends on the availability of land. Farmers preferred to have *Brachiaria mutica* and *Mikania micrantha* growing during the fallow period as they rapidly covered the ground and provided a thick mulch at planting. Fallowing results in temporal diversity that interrupts pest life cycles by eliminating suitable habitats for the pests at certain times (Root 1973).

Cation exchange capacity in most soils had a value well over 20 me/100 g soil, indicating the high sustainability of the farming systems. Several soil physical properties are

closely related to organic carbon (Wright 1963) and depletion of organic matter results in lowering the soil fertility (Reynolds 1972, 1976). The maintenance of high soil fertility on most farms can be attributed to the use of traditional practices of fallowing and mulching.

Many farmers still use unimproved indigenous cultivars which show high tolerance to diseases and pests. They gave good yields under low-input farming systems. Only a few farmers grew improved cultivars such as 'Alafua Sunrise' and 'Samoa Hybrid'. Although they were good yielders, high susceptibility of the former to *Pythium* rot may not make it very attractive for large-scale planting, especially in wet areas of Western Samoa. It is unlikely that farmers will readily accept new cultivars unless they have the same level of tolerance as local cultivars and good taste characteristics.

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