TARO GROWING ON YAP

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Introduction

Today, and within memory of today's generation, *Cyrtosperma chamissonis* (Schott) Merr., is the main edible aroid grown on Yap. *Colocasia esculenta* (L.) Schott, while a more prestigious food, is less common. The Yapese name for *Colocasia* is not a cognate of the Polynesian names such as *talo, dalo*, and *kaho* (Jardin 1974). It is called *mal*. When the term taro was introduced, probably as a general term for edible aroids, that name became associated with *Cyrtosperma*, probably because it was the most common edible aroid. Thus, today *Cyrtosperma*, *lak*, is referred to as taro, and *Colocasia* is generally referred to by its Yapese name, *mal*. The third most common edible aroid is *Xanthosoma sagittifolium* L. Schott. Though it is native to Central America, on Yap it is commonly referred to as 'Honolulu'. *Xanthosoma* is grown in dryland situations while *Cyrtosperma* is mostly grown in wetland habitat. *Colocasia* is grown in both dry and wet habitat. This report deals only with the production of *Colocasia*.

The documentation of traditional methods of growing taro is a major objective of the Low-Input Sustainable Agriculture Taro Project. On Yap, almost all taro is grown by low-input traditional methods without the use of chemical fertilizers or machinery. A number of these taro growing systems are described in the report which follows. The systems are arranged in a rough sequence from simple to more intensive methods.

The Setting: Agricultural Zones on Yap

Almost all families on Yap live in an extended homestead situation. The main family home is located on a stone platform on a named parcel of land generally located in village agroforest near the coast. Associated with this stone platform are other parcels of land in other habitats. Agroforests generally include houses, stone platforms, paths, and tree gardens in higher areas and taro patches in low areas. Extensive depressions are generally developed into a taro patch system or zone including taro patches belonging to a number of individuals associated with different estates. In areas of better drained land located just outside the village epicenter, intermittent mixed gardens are alternated with secondary fallow. These areas represent a zone for mixed gardening, which is made up of a number of individual plots belonging to different estates. The individual plots are demarcated by ditches around their perimeter. Further inland, depending on topography and other factors, there occur forested valleys or hills, or savanna grass and fernlands. Open canopy gardening was, and to some extent still is, carried on in the latter zones of poorer soils (Falanruw 1985, Falanruw et al. 1987). Taro may be grown in all zones, though it is more common in coastal areas.

Some Methods

Growing Taro Around the House

Almost all homesteads on Yap have *Colocasia* growing somewhere around the immediate house site, most often in shallow depressions and ditches. Often this taro grown near the house is a special variety which is being cared for, observed, and multiplied prior to planting it more extensively. It may also have been planted nearby because there was not time to plant and care for it in a more distant location, or simply to take advantage of a collection of rich silt from roof and wash-water runoff.

Growing Taro in Intermittent Mixed Gardens

Colocasia is almost always present in intermittent mixed gardens. These gardens are initiated by the opening of a skylight in the canopy of forest or secondary vegetation by the ring burning or girdling of trees. The major crop is *Discorea* yams which require better drained locations. A mix of other crops are also planted, and *Colocasia* is almost always present, generally being planted in depressions and ditches. The gardens are generally initiated in the dry season, and the main yam crop is harvested about the beginning of the next dry season. Depending on the gardener's strategy and needs, the *Colocasia* may be managed for corm production or multiplied during the early stages of the garden and the daughter suckers planted to mature after the main yam harvest when there is less competition from pumpkins and shading from the trellised yam vines. If desired for presentation at a special occasion, they may be managed for tuber production from the start. This involves early removal of suckers, gentle spreading of leaves, and the mounding of soil about the base, often within a retaining mulch of coconut husks or other materials. When this is not done, the corms do not become very large, but this is not a problem as the labor investment was minor and the main purpose of the plantings may have been to maintain and multiply the planting stock for later planting in a taro patch. It is felt that the alternation of planting material between dryland gardens and taro patches assists in breaking the disease cycle. Though the corms of taro raised in dryland gardens with limited care are small, they are dense and tasty. While some varieties of *Colocasia* are better suited to either dryland or wetland cultivation, many can be grown in either habitat. Wetland situations are generally drained, and in dryland situations taro is planted in more moist micro-habitats.

Growing Taro in Shallow Soil

Some areas of Yap have shallow soil underlain by schist. Such soil is poorly drained and soggy for much of the year. In such situations, where it would be difficult to dig drainage ditches, *Colocasia* is planted either on gentle slopes which provide for drainage, or else in shallow depressions with three piles of soil placed about the planting. The piles of soil are described as providing support and security for the plant which encourages it to grow and probably provide a source of aeration for roots in the otherwise waterlogged habitat. As the plant grows, soil is heaped around it and a ring of mulch may be used to hold the soil in place.

Growing *Colocasia* with *Cyrtosperma*

In more open areas, *Colocasia* may be interplanted with *Cyrtosperma*. The *Colocasia* develops much faster and provides some shading which retards weeds and is said to encourage the *Cyrtosperma* to grow faster. The *Colocasia* matures first and is harvested, leaving the *Cyrtosperma* to finish it's development. The advantages of the system are that the two crops can be grown on the same piece of land in succession. The *Colocasia* requires better soil and full sun, while the *Cyrtosperma* is much slower growing and more tolerant of shading and poor soil. The disadvantage of the system is that the *Colocasia* cannot be mulched as heavily as it would be if grown alone as the mulch would shade out the *Cyrtosperma* and possibly contribute to the incidence of corm damaging nematodes.

Growing Taro in Dry Depressions, Surrounded by Raised Garden Dikes

In some areas with well-drained soils, *Colocasia* is grown in square depressions surrounded by dikes of soil Crops requiring well-drained soil such as yams are planted on the raised dikes, and *Colocasia* is planted in the central depression. No *Cyrtosperma* has been observed growing in such gardens. Pumpkins and sweet potatoes may be interplanted with the *Colocasia*, but it is recognized that if overdone they may compete with the taro.

Growing Taro in Ditches and Depressions around Drained Garden Beds

Most of Yap's soils are poorly drained so the inverse of the above situation is practiced: garden beds are drained by ditching around their perimeter. Depending on conditions, the ditches may be managed so that they serve as water reservoirs which maintain surface moisture during especially dry times. Ditched garden beds occur in Yap's interior savanna lands and also in areas now covered with secondary vegetation and forest. The probable origin of these ditched beds is discussed in Falanruw 1990. If the garden is to be visited fairly frequently, *Colocasia* is often planted in more shallow ditches and in the depressions into which these ditches drain.

Where ditches flow into depressions and ravines and rich silt accumulates, taro patches may be developed. If small, the water flows gently through these patches. If more extensive, the water flow through these depressions is regulated via ditches within the depression and by the size and slope of the outflow ditch.

Growing Taro in Individually Dug Taro Patches

In areas lacking natural depressions, taro patches may be formed by the excavation of soil. Often this is done in connection with some type of land fill operation such as the construction of a raised trail or house platform. The remaining depression is then used as a taro patch. The water level in the pit is controlled via the outlet ditch.

Growing Taro in Series of Taro Patches

More often, a series of depressions are connected by ditches so that an aerated flow of water moves through the whole series. Most of this type of taro patches are located in agroforest and utilized for the growing of *Cyrtosperma*, but sections, generally along the shallow margin, may be used for *Colocasia*. The culture of the two differs in that *Colocasia* requires an enriched muck, while *Cyrtosperma* taro patches are generally kept clear of organic debris. Extensive areas of taro patch habitat are generally subdivided into individual plots associated with specific estates. These plots are demarcated with stones or short piers extending into the taro pit on either side. While the per capita number of taro patches today is high, it is evident that taro patches were once in greater demand as some of the individual marked plots today measure but several square meters in size.

Growing Taro on Raised Beds in Deep Depressions

In deeper depressions, the water level during the rainy season would be too deep for *Colocasia* culture. To utilize such areas, a raised bed is built, generally during the dry season. The building of this bed involves the piling of organic debris in a long pile and then covering this debris with rich organic soil and muck dug from ditches around the raised bed. The sides of the bed are generally held in place by woven coconut fronds which are in turn supported by sticks pushed into the ground. Sites for such causeway-type taro gardens are often marshy areas adjacent to mangroves. The tall leathery *Achrosticum aureum* L. fern is common in such localities and much of the organic matter piled under the garden may consist of the leaves and especially the mass of rhizomes of this large fern. In one garden, old coconut husks which were abundant on the site were used instead of woven coconut fronds to support the sides of the raised bed. The garden is planted during the latter part of the dry season, and when the rains fill the depressions the raised bed appears to be afloat.

The Conversion of Mangroves into Taro

Stories tell of the conversion of mangroves into marshes and then taro patches in a number of localities on Yap. This is done by building a causeway across a narrow mangrove filled bay. The causeway cuts off the tidal flow of salt water, and the area eventually fills with fresh water which floats on sea water. Mangrove trees die and are replaced by *Phragmites* marsh. The marsh is in turn utilized for a taro patch. In several areas on Yap, road construction during the last ten years has resulted in the conversion of areas of mangrove into marshes.

Tall *Phragmites* and a number of other species grow very densely in such marshes. *Hibiscus tiliaceus* L. often grows around the edge of the marsh and, in some cases, into the marsh, forming a dense tangled thicket. Over time a thick layer of organic material may form. A series of taro patches made in marshes with varying thicknesses of this organic material have been observed.

Growing Taro in Marshes

In one taro patch with a very thick growth of *Phragmites* and other vegetation, there was limited buildup of organic material but a well developed substrate of deep mud and gentle flow of water. Here the tall reeds were cut down and the slash piled on the site. Some of the remaining roots sprout, but are again slashed or else pulled out and either hung on branches or piled and then either removed from the taro patch or covered with broad leaves so that they die. The flow of water through the area was enhanced by digging a shallow ditch through the mud at one side of the marsh. The *Colocasia* is planted in the soft soil amid the slash. Later more mulch may be piled about it. In areas not covered by slash, a thick growth of *Limnophila fragrans* (Forst. f.) Seem may develop. This is not generally weeded as it does not interfere with the taro crop and itself forms a weed suppressing mulch. It may be thinned, however, when collected for use as a medicine, spice, or to be braided into a fragrant garland. It is also utilized by some as a deodorant after working and washing off in the taro patch. Sometimes *Cyrtosperma* may be interplanted with the *Colocasia*. If not interplanted with the *Colocasia*, the *Cyrtosperma* may be planted after the *Colocasia* is harvested. If not tended, wild marsh vegetation will invade and the taro patch will, in effect, go into a fallow phase. Such a taro patch can be renovated as described above. Remnant *Cyrtosperma* may be cut in the process, but it will readily resprout. When renovated, *Colocasia* is generally the first crop planted, followed by *Cyrtosperma*.

Growing Taro in Ditched Beds in Deep Peat Soil in Marshes

In several prime taro growing areas on Yap there is both a seepage of fresh water and a very thick layer of organic material in the marsh. The making or renovation of a tao patch in such an area begins with the cutting down of the tall reeds. As above, the slash is piled on the site. The perimeters of the taro patch are marked by special dwarf varieties of *Cyrtosperma* or with *Cordyline* (*ti*) plants. Once the tall reeds on the site have been slashed, a ditch is dug through the thick layer of organic material. The determination of the proper depth requires experience. If too deep, the taro patch may be too dry. If not deep enough, the taro plantings may be flooded.

After the reeds have been slashed and laid on the garden and regrowth slashed or pulled up, *Colocasia* is planted in little growing chamber depressions formed in the peat soil below the mulch. Prepared suckers or, in some cases, the tops and petioles of harvested corms are gently placed in these chambers and the mulch pulled over the top. This method allows *Colocasia* to be planted even in the midst of a drought. While ambient air temperatures are very hot, the growth chambers remain cool.

The little taro plants are tended carefully. Any remains of old petioles are removed from the plant, debris is removed from the growing chambers, suckers are pricked off with the thumbnail, and leaves gently spread. The mulch of dry leaves is then replaced about the top of the growing chamber with only the tips of the one or two newly formed leaves exposed. After a number of leaves have developed, more dry mulch is added and then green mulch may be added on top of this. High levels of production of excellent taro results from such methods.

Growing Taro in Floating Taro Patches

Yet a further elaboration on the theme of growing taro in marshes are floating taro patches. Here the marsh vegetation has formed a mat which floats on gently flowing water. To renovate such a taro patch, the tall reeds and other vegetation are slashed as above, and the slash piled on the bed. Then a ditch is dug around the perimeter of the bed so that the mat is disconnected from surrounding vegetation. Any roots extending below the mat are cut and soil and silt from under the mat is gathered with feet and hands and transferred to the top of the mat to cover the cut vegetation so that it will not resprout. The taro is then planted on this floating mat. The roots of the taro extend laterally into the mat and the corm forms within and below the mat. It is possible to reach through the mat and feel the size and quality of a corm prior to harvest. Both *Colocasia* and *Cyrtosperma* are grown in such taro patches. These taro patches are especially productive, disease free, and yield taro of excellent quality.

Contemporary Problems

Insects are not a major problem in taro patches on Yap, though the taro hornworm, *Hippotion celerio*; armyworm, *Spodoptera litura*; spider mites, *Tetranychus* sp.; taro planthopper, *Tarophagus proserpina*, and aphids and ants were all observed to be present. Diseases such a corm rot are a problem if corms are not harvested promptly, especially in taro patches with impeded drainage. The biggest threat to Yap's taro patches at this time appears to be siltation resulting from runoff from road construction and other earth moving activities. Siltation is a natural process, and if not actively tended taro patches will fill in and, in effect, cease to function as a taro patch. This process has been hastened, however, by the high levels of erosion resulting from today's earth-moving activities. The landscape which Yap's ancestors drained via systems of channels is now being releveled and returned to swampy waterlogged conditions which are likely to affect the whole agroforest/taro patch system.

Especially tragic is the damage done to Yap's floating taro patches. During the Japanese occupation of the island, attempts to build a causeway through the marsh resulted in considerable siltation. More recently, the most obvious damage resulted from a flood of silt-laden water which washed through the system when a silt pond broke during road construction. The rush of water overturned some taro patches and appears to have silted in much of the system. In addition, two roads and an airstrip have been built between the marsh and its apparent watershed. The compacting of soil may affect the percolation of ground water into the system, and the ground water balance may be further stressed as a result of ground water pumping activities. While previous workers have described the aquifer as fragile and suggested increased emphasis on rainwater catchment systems to augment Yap's water system, a recent report (Shade et al. 1992) has recommended increased exploitation of the aquifer in the area of the floating taro patches.

Though the crop is different, Yap's floating taro patches are reminiscent of the hydraulic agriculture which supported the Aztec and other civilizations in Central and South America (Denevan 1982). Such systems are believed to have been especially productive, though there is debate whether some of the floating gardens or chinapas actually floated. Most of Mexico's systems are now damaged or threatened by ground water pumping, pollution and the encroachment of cities (Coe 1964). An extensive review of literature on Pacific agriculture indicates that floating taro patch systems such as those of Yap, if currently present, are quite rare. Yap's system, if it can be revived while there are still knowledgeable practitioners, offers a rare opportunity to study such a sophisticated, productive system of sustainable agriculture.

Discussion

This preliminary report on taro growing systems on Yap indicates a considerable range of techniques applied to a variety of environmental conditions. None of the systems involve the use of imported fertilizers. Nutrients for the systems seem to be derived from organic mulches and nutrients dissolved in ground water. Where enough marsh habitat is available, a shifting system may be practiced where the taro patch is allowed to go fallow and revert to wild marsh vegetation. A succession of *Colocasia* and then *Cyrtosperma* are then planted to take advantage of the initial supply of nutrients for the rapidly growing *Colocasia*, and the ability of *Cyrtosperma* to grow in less fertile conditions. *Colocasia* is shifted more frequently than *Cyrtosperma* to avoid disease problems.

In the case of the floating taro patches a well as other coastal taro patches, it appears that the periphery of coastal water lenses have been tapped. The flow of nutrient-rich water increases near the edge of such lenses, and this may create conditions especially favorable to taro production. Much remains to be learned about the nutrient flows in taro patch systems.

The technology utilized in Yap's taro patch culture consists of but a knife and digging stick, and cultivators are mostly grandmothers and mothers with young children. Past measurements indicate that the production of some of the more intensive systems can be quite high, and, given the abundance of taro patch habitat, there is considerable potential for increasing production if human inputs could be increased. Given the high ratio of dependant children to women, and the many demands on the time and energy of contemporary women, it is unlikely that they will be able to renovate silt damaged taro patches without some assistance.

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The Editor

L. Ferentinos is the Project Coordinator of the Taro Production Systems Project at the University of Hawai'i at Manoa.

Jane C. Muench, an independent editor with J.C.M. Office Services, provided technical support.

Publication was supported in part by a grant from the USDA/CSRA Sustainable Agriculture Research and Education Program (formerly called L.I.S.A.). Additional support was provided by American Samoa Community College, College of Micronesia, Northern Marianas College, University of Guam, Yap Institute of Natural Science, and the University of Hawai'i under the Agricultural Development in the American Pacific (ADAP) Project.

The Library of Congress has catalogued this serial publication as follows:

Research extension series / Hawaii Institute of Tropical Agriculture and Human Resources.—001—[Honolulu, Hawaii]: The Institute, [1980–
v. : ill. ; 22 cm.
Irregular.
Title from cover.
Separately catalogued and classified in LC before and including no. 044.
ISSN 0271-9916 = Research extension series - Hawaii Institute of Tropical Agriculture and Human Resources.
1. Agriculture—Hawaii—Collected works. 2. Agriculture—Research—Hawaii—Collected works. I. Hawaii Institute of Tropical Agriculture and Human Resources. II. Title: Research extension series - Hawaii Institute of Tropical Agriculture and Human Resources.
S52.5R47 630'.5—dc19 85-645281
AACR 2 MARC-S
Library of Congress [8506]