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THE PAST, PRESENT AND FUTURE OF TRADITIONAL TARO IRRIGATION IN THE PACIFIC: AN EXAMPLE OF TRADITIONAL ECOLOGICAL KNOWLEDGE. –

South Pacific Commission
Noumea, New Caledonia

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SUMMARY

Three main varieties of traditional irrigation can be found in the Pacific: swampland, pit cultivation and true (canal) irrigation. The advantages which made irrigation an attractive agricultural technique for Pacific peoples are discussed in this paper. Since European contact, use of irrigated gardens has declined in many parts of the Region, but a recent trend in some places (Solomons, Vanuatu, Hawaii) has been the revival of traditional irrigation technologies. The paper examines why traditional irrigation remains viable today and may remain so in the future.

> *There is a need to understand more about the social, economic and agronomic features of the remnants of indigenous intensive root crop systems where they still exist. This may be a matter of some urgency, as the remaining examples are relatively few and in many cases difficult of access. A process of re-intensification along lines to which the societies concerned had been adapted in the past may well cause less stress and disruption than change devised in ignorance of this background. Research in this field, including that being undertaken by the Prehistorians, may thus prove exceptionally valuable. (Fisk 1979:370)*

During several thousand years of adapting to and changing their environments to provide food for themselves, Pacific societies have evolved systems of agriculture of great sophistication and skill. The countless varieties of useful plants and their particular properties, their yields, return for labour, practices to control pests and diseases, methods of fertilizing and enriching the soil and preventing erosion, crop storage techniques: all of these need to be investigated not as relics of past ways, but for their future contribution to the increasing problems of feeding the people of the Pacific region. I will discuss here only one example of the sophistication of traditional Pacific agriculture - the techniques associated with the irrigation of taro (*Colocasia esculenta*).

THE PAST

Much of the Pacific, from Island Melanesia to Polynesia and eastern Micronesia, may have been initially settled by the bearers of the **Lapita Culture** between 3000 and 4000 years ago (See Spriggs 1984a for a summary of the archaeological evidence). These colonists carried with them their crops and domestic animals, and their agricultural science clearly included various irrigation methods for the propagation of taro. Thus we find similar methods for growing this water-loving plant from New Guinea and the Solomon Islands through to the Tuamotus and Hawaii. Linguistic comparisons give further clues to this shared science - an irrigated field is called **roki** on Rapa in the Austral Islands while it is the similar word **lo'i** in Hawaii, and other examples link East Futuna (Horne Island) with Fiji and the Cook Islands.

In the New Guinea area, the immediate ancestral home of the **Lapita Culture**, taro and its cultivation may have an even longer history. Taro is usually considered to be a plant of Southeast Asian origin, but its natural distribution may well have included New Guinea. Independent domestication of the plant there is a distinct possibility and indeed evidence of swampland agriculture in the New Guinea Highlands goes back 9000 years, some of the earliest dates for agriculture in the world. While we do not know which crops were being grown in New Guinea at this time, taro is certainly a reasonable suggestion. Identification of taro pollen has been claimed from the Markham Valley of Papua New Guinea at about 8500 years ago which would support this inference (Spriggs 1982 summarizes the archaeological evidence for the antiquity of taro in the Pacific).

Irrigation is a term which has often been loosely applied to describe a range of wetland agricultural techniques. It is used here in a general sense to mean water manipulation for agricultural production where the aim is to maintain a high soil moisture content, rather than to create a 'dryland' environment. The term thus embraces all forms of 'wetland' agriculture from the use of naturally swampy areas to systems whose water supply comes from long supply canals.

When the first European 'explorers' ventured into the Pacific, some thousands of years after its discovery and settlement, three main varieties of irrigation were in use: swampland, pit cultivation and true irrigation. Swampland cultivation techniques generally consist of the management by ditching of freshwater swamps where the aim is not complete drainage to create a dry land environment for planting but is only to control the water table within required limits. These techniques are very widely distributed in the Pacific. Pit cultivation is found mainly on coral atolls and other low islands where pits are dug to tap the freshwater lens beneath the ground surface. It is also found in the coastal margins on some high islands, particularly in Micronesia.

True irrigation refers to diversion of water from source to fields. Variants of this method are widespread in the Pacific. There are two basic parts to this technique: a water delivery system of canals or pipes, and a system of water application to the crop. Sometimes water is led almost directly from a stream into the garden area but often unlined (or stone-lined) canals up to several kilometres in length are necessary. In parts of the Pacific canals are found up to 5 km in length, with one exceptional example in New Caledonia 12 km long. Found in association with such canals or in place of them are pipes usually of bamboo, pandanus or tree fern which again may be some kilometres long.

The methods of water application to the crop include (1) simple flooding, (2) 'paddies' or pondfields, (3) island beds, and (4) furrow irrigation.

In **simple flooding** water is led to the upper edge of the garden and then circulates down, often with simple wood or stone barriers to slow down the flow, thus helping to trap sediment and control erosion. Simple flooding is essentially a Highlands New Guinea practice. A variant is when rough terraces are constructed directly in small stream beds which is a widespread practice.

Pondfield systems have a planted area which is an artificial pond through which water is kept constantly flowing, to feed other usually terraced pondfields downslope. These systems resemble closely some of the wet-rice paddy systems of Southeast Asia, and indeed taro is sometimes interplanted with rice in S.E. Asian paddies or found as a monocrop in paddies adjacent to ones used to grow rice. Pondfield taro systems are found widely distributed in Melanesia and Polynesia and occur also on Palau in Micronesia (for details of the distribution of this and other irrigation techniques in the Pacific, see Spriggs 1981a, Chapter 7).

The **island bed** system consists of water led round the perimeter of usually rectangular beds and it thus resembles the island bed systems found in swamplands. Island bed irrigation systems occur in Papua New Guinea, New Caledonia, Fiji and the Cook Islands. In

some parts of the region there is a garden succession from pondfield to island bed as fertility declines, followed by a fallow period and then reactivation of the pondfield.

In furrow irrigation, water is applied to the ground in small, shallow furrows from which it soaks laterally through the soil wetting the area between the furrows. I have seen this system in use only on Aneityum in Vanuatu.

Occasionally plants other than aroids (the different genera of taro) are grown in irrigated gardens. In New Guinea irrigation of *Coix gigantea*, a plant used in salt manufacture, has been reported while in Vanuatu I observed the narcotic Kava (*Piper methysticum*) interplanted with taro in irrigated gardens. In leeward areas of Hawaii, the sweet potato (*Ipomoea batatas*) was sometimes grown using intermittent irrigation by methods most approximating simple flooding whenever surplus water was available.

What were (and are) the advantages of irrigation over dry land agriculture as perceived by traditional Oceanic subsistence farmers? All Pacific irrigation systems share certain advantages:

1. They produce a higher yield/hectare than dry land crops (particularly taro) grown in equivalent soils even when rainfall is adequate for good crop growth (details of yields are given in Spriggs 1984b).
2. With constant water supply risk of crop failure is reduced and year round production is possible, thus preventing yield fluctuations and crop shortfalls. This may allow more permanent occupation in an area, and the need for crop storage is often obviated.
3. It is possible with irrigation to use land not otherwise agriculturally productive, either because it is too wet and water level is uncontrolled (some unmanaged swamps) or it is too dry (some leeward or rainshadow areas).
4. Production certainty in irrigated land allows 'speculative' use of rain-fed land. The production system is buffered against crop failure in the rainfed sector in particularly dry years.

5. Irrigated taro varieties have different flavours and cooking properties than dry land varieties. Variety is the spice of life!

Various other advantages accrue to a range of irrigation systems although not all -

6. Once built most irrigation systems form a permanent or semi-permanent infrastructure which can be brought back into use at any time. Thus there is often a better return for labour once built than in dry land gardens where usually the garden has to be completely recreated at every use: an exception would be the New Caledonian yam mounds which are also semi-permanent structures. There are implications here in terms of the potential for privatization of land.
7. Irrigation often allows extension of the number of cropping-cycles before fallowing is necessary, sometimes allowing nearly permanent production from a piece of land. The swampland systems of Aneityum can be re-used every year if the subsurface leaf mulch is replaced. In pondfield systems there is wide variation in the number of cropping cycles dependent on soil type, nutrient supply, availability of land and the labour involved in clearing out the pondfields. On Maewo (Vanuatu) on the best soils 8-10 years cropping (6 cycles) is normal, followed by 3-4 years fallow. On less fertile soils 3-8 years cropping (2-4 cycles) with five years fallow is typical. Dry land gardens on that island can only be put through a single cropping cycle before fallowing.
8. Linked to point 7 is the potential (often present) for further intensification, increased labour inputs to the economic limit, to allow either increased yields or increased number of cropping cycles: practices such as tillage, fertilizing and mulching are important in this regard. While such potential exists too in dryland systems it is not usually as great.
9. In all true irrigation systems nutrients are carried in the water to the garden site allowing natural fertilization tapping the nutrients of a wider catchment than the garden site itself.
10. In some swampland, pit and true irrigation systems conditions are suitable for blue-green algae to grow on wet surfaces and

in the water, considerably increasing nitrogen availability to the plants.

11. By flooding the gardens (as in pondfield agriculture) some pests and diseases may be prevented. Taro beetles (*Papuana* spp.) and rats cannot reach the corms if they are submerged and the purple swamphen (*Porphyrio porphyrio*) is discouraged from attacking the corms if sufficient water depth is maintained. While taro grown in wetland conditions is more susceptible to corm rots than dry land taro, it has been suggested that wetland taro is not so susceptible to leaf and petiole diseases. The water in flooded fields acts as a weed-suppressing mulch for weeds intolerant of low oxygen levels.
12. Water control devices in true irrigation often incorporate slope retention measures such as terracing which help to prevent washouts and lessen erosion. Slope retention is not usually as developed or effective in dry land systems.
13. True irrigation systems can considerably extend the habitats of fish, eels, shellfish, crustacea and water birds, and allow such resources to be harvested more easily than in their natural habitats. As well as higher root crop yields, animal protein availability becomes more certain. The creation of large pondfield systems in the Hawaiian islands may have allowed coots, ducks and gallinules to establish permanent colonies there for the first time. These systems may have played a similar role elsewhere in the Pacific.
14. Certain kinds of soil are easier to dig when saturated. This is clearly recognized by the irrigation farmers of Col de la Pirogue, New Caledonia, who soak the ground before pondfield preparation. Similar practices are found elsewhere.
15. Constant irrigation can allow long periods of field storage after maturity without corm rot. On Maewo field storage for periods of up to 18 months was claimed for some pondfield systems. Variation in field storage potential is accounted for by soil and water conditions and taro varietal differences.

These advantages can be summarized as:

1. A greater control over environmental factors.
2. A higher yield/ha. than dry land crops grown in equivalent conditions.

3. A greater potential for further intensification.

If water supply from springs and rivers can be assured, soil moisture content and other growth factors can be controlled. Thus continuous production throughout the year is possible, yield fluctuations/year are reduced and labour inputs may be regulated to avoid a marked seasonal demand. This allows relatively exact planning, with implications too for dry land gardening operations in that speculative use of rain-fed land becomes less risky. This may allow crops to be obtained from land which otherwise might not be used.

Absolute yield of taro is higher with irrigation and in some cases relative yield/person-hour increases. The highest yields recorded for taro in both traditional subsistence gardening and commercial production come from irrigated plots.

THE PRESENT

Despite these advantages, in many parts of the Pacific traditional agricultural techniques such as irrigation have markedly declined or even been completely abandoned in the last hundred years.

The forces for change have been well-documented, for instance by Brookfield (1972) and more recently by Ward (1982; 1984). They include factors such as new forms of labour mobilization and reward attendant on European penetration and colonization of the region, forced or voluntary relocation of population, absolute population decline, new crops and animals, and the general change in the region to an increasing reliance on cash crops such as coconuts, cocoa and tea which have competed directly with traditional agricultural pursuits for land and labour. In some areas land was sold to or seized by Europeans, the latter being a major factor in the abandonment of large areas of taro irrigation in New Caledonia. The breakdown of social systems which demanded food surpluses for exchange and prestation and the attendant transformation of traditional patterns of leadership, which may have had a role in organizing agricultural production, have also

been important factors. In some areas taro blight and other problems have become significant, especially since World War II.

In some places this decline appears now to have been arrested and taro irrigation systems are being reactivated or expanded. On Kolombangara in the Solomons, pondfield systems unused since World War II have been brought back into commission (Miller 1979:149). In New Caledonia taro production picked up again after a low during the nickel boom of the early 1970s when labour was transferred to mining-related activities (Bourret 1978). There have been calls for greater irrigated and swamp taro production in the Cook Islands (Ward and Proctor 1980:373-4, 376) to supply urban and possibly export markets. The first government-sponsored plan to revive traditional taro irrigation in the Pacific was started in 1980 on the island of Aneityum in Vanuatu (Spriggs 1981b).

In 1978 and 1979 the author was engaged in field research examining prehistoric remains and traditional irrigation systems on Aneityum. Many now uninhabited valleys on the island are covered with the remains of stone-lined terraces for dryland and irrigated gardens. At the time of fieldwork, however, the irrigation techniques were only known to the older inhabitants of the island, and although several swampland island bed systems were in use in 1979, only one very small canal-fed system was in operation, and so there was a very real danger of these highly productive techniques being lost. Following European contact about 150 years ago, the population was decimated by a series of introduced diseases and decreased from nearly 4000 people recorded in a census of 1854 (after two previous epidemics of unknown effect) to around 200 people by the late 1930s. The population has risen since this low point and had recovered to 464 at the time of the January 1979 Census.

The work was discussed with officials of the Agriculture Department of Vanuatu and the possibility of encouraging taro growing on the island for urban and export markets was raised. All of these officials were very positive in their attitudes to

traditional agricultural knowledge and its role in the future development of the country.

Such attitudes were evident in the election policy of the Vanuaaku Party, prepared for the November 1979 election. In their Natural Resources policy the VP identified one of the problem areas as 'the disruption and imbalance between the cash crop economy and the subsistence economy in the rural areas' (Vanuaaku Pati 1979), and one of the aims of the policy was to ensure a balance in these sectors. There were four proposals towards achieving this:

(a) Recognition of the vital role of custom and subsistence agriculture in the rural areas and far from denying this role, it must be recognized as the basis for the development of the cash economy;
(b) Responsibility of Government to ensure that cohesion of community structures based on custom links is maintained;
(c) The encouragement and revival of traditional techniques in root crop farming; and
(d) The introduction of traditional agricultural techniques in the Agricultural school.

Following consultation with the people of Aneityum, the Ministry of Natural Resources and the Central Planning Office in Vanuatu, a project was put forward which would operationalize at least one of these proposals, proposal (c). The project was supported fully by the Vanuatu Government and aid money was obtained from the British Government. The author returned to Vanuatu in July 1980 on secondment to the Agriculture Department to initiate the project.

The aim of the pilot project was to give the initial 'push' to the development of taro as a cash crop on Aneityum and ensure that the younger generation had a chance to learn the traditional techniques for its production. Taro irrigation offers (along with Forestry) one of the more promising avenues for the development of the island. Coconuts and cocoa yield poorly, and the soils (unless irrigated) are generally of low fertility. The Government recognizes that unless some sources of cash income are developed

on the outer islands such as Aneityum, increasing rates of rural-urban migration with its attendant problems will result.

The infrastructure for the development of taro irrigation on the island was already there in the form of the canals, terraces, and ditched swamp beds. The labour involved in bringing them back into commission is not very great in most cases, while the skills involved in irrigation are already present on the island and so would not need to be taught or introduced from outside. The yields are high (especially in the swampland island beds where yields of 30 mt/ha./year and above have been recorded) and irrigation makes year round production possible and hence regular supply rather than seasonal gluts.

Project funding was available to provide money for paying people to undertake the major initial tasks, such as dam and canal reconstruction, forest clearance and the cleaning of swamp ditches. Tools such as crowbars, spades, forks and pickaxes were provided and the Government undertook to arrange the marketing of the taro. Why did people need this initial 'push' and cash incentive? One important reason was the decline in the power of the traditional leaders as organizers of the labour force. They can no longer command people to turn out for communal labour as in the past. Although the people were genuinely interested in growing taro as a cash crop, they would not invest time and effort in such labour-intensive tasks as digging canals, for two main reasons: first, most people on the island had never made the canals before and were skeptical that they could complete the task. When paid, they would at least attempt the task and thus realize the comparative ease with which such work could be accomplished. Secondly, without help in finding a market, they felt that they might be producing taro which they would not be able to sell. There was thus a vicious circle to be broken. Many people had no faith that the canals could be brought back into operation, and the leaders and old men who had made such canals in the past no longer had the power to coerce the community to help them in redigging them. Paying for the initial heavy reconstruction tasks broke this circle. Government help in marketing was also perceived as crucial in getting the work going.

The project was initiated in August 1980 at the first of the three population centers on the island, and regularly up to 30 men, women and children turned out to work. A canal over half a kilometer long was repaired and the first 50 m of its course and the take-off dam were rebuilt having been completely washed away. There is no-one now living who has ever seen this particular canal-fed system in use and it has lain dormant for the last 100 years. Under the dense forest, however, the subsidiary stone-lined channels, terraces and beds remained. A large area of forest was cut and left to dry for a few months before being burnt off and planted. Elsewhere on the island, other canal-fed garden systems and previously ditched swamps were also brought back into production. One aim of the project was soon accomplished: the irrigation techniques had been passed on to another generation, who now have the choice whether to use them or not. Had Government encouragement not been given, all element of choice in the matter would have disappeared.

In commercial terms, however, the project was not a success. Agricultural reports reveal that although the project was generally going well a year after its inception and some taro had been shipped for sale, by October 1982 all work had been abandoned. Technical problems included lack of sufficient planting material at some sites and extensive damage to one of the canal take-offs in a flood, but the major problems were those of lack of respect for garden taboos by younger workers, inability of the villagers to cooperate in gardening and management tasks, and uncertainty about marketing opportunities. While questions of land tenure had been worked out at two of the three villages, this issue surfaced late in the project at the other village when the traditional owner of one of the garden locations demanded 50 percent of the proceeds. This turned out to be occasion for final abandonment of the project at that location.

The garden taboos involve not eating certain foods and abstaining from sexual intercourse for a certain period prior to going to work in the gardens. The problem is a common one of generational (and to an extent religious) conflict. Taro-growing

skills belong to older men but the labour force consists primarily of younger school-educated individuals who tend to be skeptical of traditional practices. A recent history of disputes over village councils, Co-operatives, land matters and political and religious divisions has left a legacy of distrust both within and between the different communities on the island. This problem is well-recognized by the Aneityumese but is not easily solved. The success of the Forestry replanting program has been precisely that it is organized from outside the community: a government Forestry Officer is stationed permanently on the island and it is he who organizes and pays labour and is in charge of overall management of the project. In the taro project, it was at the point where outside organization and payment gave way to a phase of development requiring communal and unpaid labour organization in anticipation of returns from marketing that the project broke down. In discussing the failure of the project, Aneityumese suggested that production from private gardens (i.e. by small family groups) would work better because those outside the family could not be trusted to keep the taboos, and also there would be no disputes over the proceeds from selling the taro or over the organization of communal labour. An alternative might be centralized direction by a Government Agricultural officer, but this would not ensure enforcement of garden taboos.

In Hawaii taro (*kalo* in Hawaiian) is produced commercially using semi-mechanized methods. In some areas, however, traditional methods are used by native Hawaiians as an expression of cultural identity. Commercial plantings have been declining but reactivation of long-abandoned irrigated terraces by community groups and individual farmers with a desire to 'get back to the land' have become common in recent years. This is part of the 'Hawaiian Renaissance', a revival of pride in their culture by native Hawaiians. Taro and the work involved in its cultivation form powerful symbols in this movement - various rehabilitation programs for youthful offenders in Hawaii involve work in refurbished irrigated taro patches, and community groups do volunteer work on weekends to learn irrigation techniques from kupuna (elders), usually elderly taro farmers from rural areas. The feelings and hopes which taro farming inspires among native

Hawaiians searching for identity in a world changing too fast are expressed well by Kepa Maly (in Hess 1982:55):

> Perhaps through a renewal of cultivating the *kalo* we might relearn the value of family and the humbleness of our **kupuna**. In the process we might also regain the simple understanding that earth and man are tied together. If man respects his surroundings and himself, the earth will respect him - and his needs also.

A recent issue of *Pacific Magazine* (Linker 1984) contained a news item on Keoki Naki, a Hawaiian farmer on the island of Moloka'i who has returned some long abandoned irrigated taro fields to production. The techniques are traditional but adaptation has had to be made to modern economic realities: 'It is not far different from how Naki's ancestors worked the land 1,000 years ago - except of course Naki has to watch his cash flow and spread sheets as closely as he does his taro'. How long such a melding of traditional techniques and a market economy can coexist remains to be seen in Hawaii because of competing demands for water and land. Given the cultural value of taro, however, if traditional irrigation ceased to exist then the end of native Hawaiian culture would also have been signaled. Luckily both appear to be undergoing a revitalization at present.

CONCLUSION: THE FUTURE

Productive traditional agricultural techniques such as irrigation are usually ignored by the agriculture departments of Pacific countries. In the colonial past the agricultural officers were usually trained outside the region and that training often actively devalued the agricultural knowledge of the colonized, the non-literate subsistence farmers. Sadly, many indigenous agricultural officers and government planners have inherited a colonial attitude to their own people's traditional agricultural science. It is indeed arrogant to believe that peoples who have been farming their own lands continuously for many thousands of years know nothing about agriculture worth investigating and thus have nothing to contribute to agricultural development. While

many of the countries of the Pacific have been de-colonized politically, this process has not often reached the minds of the new Pacific elites in government offices. The farmers can produce the food, but government help is needed in transport and marketing. Whether traditional village agriculture has a viable future is really the same question as whether traditional village life has a future and has to do with the adequate provision of socioeconomic benefits and services to the non-urban populations of Pacific nations.

A paper on 'Papua New Guinea's Food Problems' discusses these questions and its optimistic conclusion conveys well my own feelings about the challenge of the future, not just for Papua New Guinea but for the Pacific in general (Carrad *et al.* 1979:22)

> Papua New Guinea is in a position to build on traditional technology, crops and institutions to feed the non-subsistence sector. It is not necessary to replace the traditional ways with large-scale, energy and capital dependent technology. Nor is the choice only between cheap, convenient food from overseas and expensive locally grown food. To a large extent the technology is already available in Papua New Guinea to produce staples at reasonable prices.
>
> Priorities must be reassessed and more resources devoted to food production. At the same time the social and economic climate must be made more favourable to local food producers.

Priorities must be reassessed, and this process must start now. The old agricultural scientists are fast dying out, their knowledge is not being passed on, and their laboratories are returning to forest.

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