AN OVERVIEW OF THE KEY PACIFIC FOOD SYSTEMS

2.0 KEY PACIFIC FARMING SYSTEMS

There are a variety of traditional and modern farming systems used in the South Pacific for crop and livestock production. While traditional farming systems (TFSs) still dominate agricultural production in most PICTs, they are being increasingly undermined by monoculture-based agriculture practices, urbanization, and lifestyle and dietary changes that are combining to make PIC communities more and more reliant on cash cropping and imported foods such as flour, rice and chicken meat.

Traditional farming systems can be defined as "*sets of interconnected customary practices of producing crops and animals for food, socio-cultural uses and export which conserve resources, protect the environment and are passed down from generation to generation*" (Tofinga in USP/IRETA, 2001: See TOOL 34). Traditional farming systems range from low-input shifting agricultural (swidden) systems, which can be found throughout the Pacific region, to high-input permanently cultivated systems. In contrast to modern, conventional farming systems, most TFSs are characterised by the integrated use of trees, mixed cropping, extended fallow periods and natural rainfed irrigation.

Many Pacific Island countries have embraced commercial crop and livestock production since the late 1970s with varying degrees of success and environmental impact. The "modernization" process, however, began much earlier and in parallel with colonization of the region by Great Britain, France, Germany and the USA. One of the legacies left by expatriate colonizers is the plantation system, which has become the core of modern agroforestry throughout the Pacific region. In some PICTs, large-scale deforestation has led to monocultural crop production solely aimed at earning foreign exchange. The transition to cash cropping has seen a strong shift away from traditional low-input, diversified agroforestry systems and has resulted in growing reliance on imported food products. (FAO, 2008; IRETA, 1988: See TOOLS 1 & 27.)

The central objective of the modernization of agriculture in the Pacific Islands, as elsewhere, has centred on raising agricultural productivity to levels which allow farmers to produce more than that required for subsistence only (Ali and Murray, USP/IRETA, 2001: See TOOL 34). The drive to increase productively has typically led to an intensification of cultivation on existing farmland, and the extension of cultivation onto previously unused and/or forested and marginal land in PICTs. Examples of intensified modern farming practices are evident throughout all PICTs and include coffee in Papua New Guinea (PNG), taro in Fiji, vanilla and kava in Tonga, and past surges of squash production in Tonga and Vanuatu, to name but a few.

While examples of large-scale commercial farming practices, characterized by the clear-felling of trees and intensive use of fertilizers, insecticide and herbicide, can be found in most PICTs, the majority of these "modern" farming operations are largely restricted to the Melanesian countries. Elsewhere, large-scale farming operations have often met with limited success or outright failure. The Tonga squash boom of the late 1990s provides one such example of the fragility of modern monocultural cropping systems within the Pacific Island context. The squash production boom in Tonga left many subsistence farmers broke and alienated from their lands as banks foreclosed on loans and confiscated land that was used as collateral.

2.1 TRADITIONAL CROPPING SYSTEMS

While most TFSs are largely variations of shifting agriculture, there are other types of TFSs that focus on modifying soil growth conditions. Hunter and Delp (USP/IRETA, 2001: See TOOL 34) argue that the most important of these alternative cropping systems focus on soil-water management practices that have been developed for taro cultivation. They refer to these cropping systems as *pond-field*, *raised-bed* and *atoll-pit* cultivation systems. Ali and Murray (USP/IRETA 2001: See TOOL 34) also describe different types of *terrace garden systems* that were once prevalent in Fiji but are no longer widely employed in the region.

In the Pacific, raised-bed agriculture continues to be used for the cultivation of mainly root crops and represents a highly productive form of cultivation. The system typically comprises the formation of raised beds of soil or decaying plant materials. Soil material is often sourced from surrounding ditches which in turn encourages drainage in swampy or low-lying areas. Such systems are used for the permanent cultivation of sweet potato in the highlands of Papua New Guinea (Ali & Murray, USP/IRETA, 2001: See TOOL 34).

In contrast, pond-field systems are created by surrounding small plots with raised banks that facilitate the controlled ponding of water within the plots. These systems are still used in Fiji for the production of taro varieties that tolerate saturated soil conditions. Pit cultivation of giant swamp taro (*Cyrtosperma Chamissonis*), which is an important food production system in some atoll countries, could be considered another variation of the pond-field systems. Pit cultivation systems involve the excavation of large pits down to the water table which are partly refilled with soil and decaying organic matter. In Kiribati, for example, swamp taro (Pulaka) is planted in 10m x 20m pits, 2-3 m deep, with the taro corm placed in "organic baskets" of Pandanus and *Cocos nucifera* and anchored in holes 60 cm below the water level (IPCC, 1997; Tofinga in USP/IRETA, 2001: See TOOLS 25 & 34).

Variations of this method are used elsewhere in the region, including the Cook Islands and Kiribati, where giant swamp taro is either grown in pure stands or in combination with Colocasia taro and even bananas.

2.2 AGROFORESTRY SYSTEMS

Agroforestry systems deliberately combine selected forestry and agricultural crops (predominantly root crops in the Pacific) to ensure short-term crop productivity and longer-term environmental sustainability (IRETA, 1988).

Tofinga (USP/IRETA, 2001) and PRAP (1999) outline several categories of "traditional" agroforestry systems that are used in the Pacific region. (See TOOLS 29 & 34.) These include non-permanent, permanent, tree intercropping and "backyard garden" agroforestry systems. For the purposes of this toolkit, a coarse division can be made between: (i) extensive low-input shifting agroforestry systems, typical in areas of low population density in Melanesia and parts of Polynesia, and (ii) intensive agroforestry systems that are characteristic of the smaller, more highly populated islands and atolls of Polynesia and Micronesia, and of urban areas throughout the Pacific (Thaman, 2008: See TOOL 32).

2.2.1 Non-permanent agroforestry systems

Non-permanent or shifting agricultural systems are utilized throughout the Pacific region but particularly on larger islands within Melanesia and Polynesia. In areas of low population density, shifting agroforestry systems involve the felling or ring-barking of unwanted upper- and mid-canopy tree species. The underbrush and groundcover is then usually cleared by fire. The clearing process is typically carried out on fallow land or secondary growth forest but in some areas virgin forest may be cleared. The preserved trees, usually slow-growth forest, fruit or nut trees, and trees of medicinal or other cultural importance, are often pruned or pollarded, but not killed, to open up garden areas to sunlight and to add additional organic material and nutrients to the soil (Thaman, 2008: See TOOL 32). Clearing the land in this fashion facilitates the planting of a variety of food trees and crop species. The types of crops grown vary significantly from country to country or even island to island, but usually include one or more varieties of yam or taro. After several rotations, lowered soil fertility necessitates the cultivated land to be laid fallow for a period of 10 to 15 years or more.

Example of a shifting agriculture agroforestry system in Melanesia

A typical shifting agroforestry cropping cycle in Tonga starts with the clearing of understory vegetation which is burned off. On virgin land, upper-canopy species may be thinned by burning or alternatively felled for firewood or construction timber. Yams are then often intercropped with plantains, giant taro or other crops. After yam harvesting, American taro, swamp taro or cassava are generally planted next in succession. Other crops such as sweet potatoes, bananas, peanuts and a wide range of other crops may be co-planted at any time during the sequence. If taro is planted, then cassava is often planted up to four or five times before the land is allowed to revert to fallow (Fisk *et al*. 1976). In recent years, kava (*Piper methysticum*) has been increasingly integrated into the cropping cycle at the expense of food crops.

2.2.2 Permanent agroforestry systems

Home garden and permanent agroforestry systems are found within urban areas throughout the Pacific and are prevalent in rural locations within smaller atoll countries and upon smaller islands within Micronesia and Polynesia. They are typically more highly modified than non-permanent agroforestry systems and may require a greater level of input to maintain soil fertility and adequate soil moisture conditions, particularly on atolls where the soils tend to be thin, poorly structured and lacking in many major micronutrients. The agroforestry system in atoll countries is traditionally developed around three principal crops: coconut, breadfruit and pandanas.

2.2.3 Modern agroforestry in the Pacific

The high international demand for copra in the early twentieth century saw widespread areas of coastal land in Pacific Island countries planted to coconuts. In some PICTs, these coastal plantations also were intercropped with cacao and lowland coffee. Some plantation planting was also carried out in higher inland areas, such as the Central Highlands of PNG, where many large coffee plantations were established. Coffee was often inter-planted with introduced leguminous shade trees such as *Leucaena* spp.

Another version of modern agroforestry in the region is the silvopastoral type, in which cattle and horses are grazed under coconuts or timber tree species. The grazing cattle not only provide a source of valuable protein and income to the farmer, they also serve the multiple purposes of weeding plantations, reducing fire risk and contributing organic manure and nutrients to the surrounding trees (IRETA, 1988: See TOOL 27).

Example of a permanent or garden agroforestry system in Kiribati

A home garden in Kiribati is likely to include breadfruit, dwarf coconuts, te bero (a variety of fig), pandanus and pawpaw along with other selected tree species for forage, food and fuel. The trees are typically spaced out among an understory of vegetable and root crops. In favourable conditions, crops such as bananas, kava, pineapple, nonu and hibiscus species and coffee may also be integrated into permanent agroforestry systems.

2.2.4 Agroforestry tree species

The tree species integrated into Pacific agroforestry systems vary widely but often include coconut palms, a wide range of banana and plantain cultivars, breadfruit, sago palm, nut trees, edible pandanus species, malay or mountain apple, oceanic litchi, Polynesian vi-apple, pommel, joint-fir, edible figs, dragon plum, red-bead tree, a number of palms, including the betelnut and *Pritchardia* and *Veitchia* spp., and other less common species. Also increasingly common are recently introduced fruit trees, such as mangoes, avocado, papaya, soursop and sweetsop, carambola (*Averrhoa carambola*), new bananas (*Musa* cultivars) and a range of citrus trees, including sweet and sour orange, mandarin, lemon and lime (PRAP, 1999; Thaman, 2008: See TOOLS 29 & 32).

2.2.5 Agroforestry crops

The dominant staple ground crops in most traditional shifting agricultural systems are yams (*Dioscorea* spp.) and *Colocasia* taro, although other ground and tree crops, particularly banana and plantain cultivars, are also planted. Giant taro (*Alocasia macrorrhiza*) is also an important supplementary staple in Samoa and Vava'u in northern Tonga. Sweet potato, cassava and *Xanthosoma* taro are also becoming increasingly important in some PICTs.

Other ground crops include sugar cane, hibiscus spinach, pumpkin, pineapple, maize, chili peppers, cabbages, beans and non-food species such as kava (*Piper methysticum*), tobacco and the important handicraft plants, paper mulberry (*Broussonetia papyrifera*) and a wide range of *Pandanus* cultivars (PRAP, 1999; Thaman, 2008: See TOOLS 29 & 32).

2.3 LIVESTOCK SYSTEMS

Livestock production has played a very important role in the socio-economic development of the Pacific Island countries but has met with mixed success in the region. For many smallholder farmers, livestock production remains an important source of both protein and income. While pigs and poultry are produced throughout the PICTs, commercial production and the farming of ruminant animals including cattle, sheep and goat are largely restricted to the larger Pacific Island countries including PNG, Fiji, Solomon Islands, New Caledonia, Samoa, Tonga and Vanuatu. Elsewhere in the Pacific, the production of pigs, chickens, cattle and sheep tends to carried out on a smaller scale for household consumption. In 2001, ruminant livestock numbers were estimated at 713 050 cattle (beef/dairy), 262 400 goats, 24 900 sheep and around 120 000 farmed and feral deer (Aregheore *et al*., 2001: See TOOL 22).

The majority of livestock in the Pacific are reared on unimproved, poorly managed pastures; fallow land; roadsides; crop residues; under coconut agroforestry systems; and often on a combination of these forage sources. Accordingly, ruminant livestock rely mostly on native and some introduced grasses along with herbaceous shrubs and tree legumes, other non-leguminous trees, various weeds species and crop residues for their forage supply and intake.

The poor quality of pastures (carrying capacities of only 0.5 cattle/ha are common) is one of the main constraints hindering large-scale commercial livestock operations in the region. While significant research has been directed towards improving the stocking capacity of tropical pastures and identifying alternative, locally produced feeds including crop residues and industrial by-products, the quality and productivity of ruminant livestock production systems remains highly variable throughout the region (Aregheore *et al*., 2001: See TOOL 22).

Monogastric livestock, including poultry and pigs, are ubiquitous throughout Pacific Island countries and form an extremely important source of protein for many Pacific Islanders. An increasing number of countries are interested in establishing or expanding their livestock production beyond the present level, in order to increase the availability of animal protein and to substitute for imported products. However, small livestock production is still dominated by smallholders and households. Pigs and poultry are often kept in pens but many are also left to wander and forage in both rural and urban settings, often at the expense of vegetable gardens and crops!

2.4 COMBATING THE IMPACTS OF CLIMATE CHANGE

This section provides some keys steps that PICT governments, communities and/or individuals may consider to reduce the present and pending impact of climate change on Pacific agricultural production. They range from high-level, wide-reaching policy steps aimed at PICT governments and community leaders, to smaller practical steps that may be undertaken by individual farmers at the village level.

2.4.1 Combating poor planning

While climate change adaptation efforts must largely focus on concrete, on-the-ground initiatives within villages and communities, efforts also must be be levelled at climate change "mainstreaming". This refers to the process of ensuring that the impacts and causes of climate change, and the steps to combat climate change and reduce its impact on people and the environment are fully considered in all government policies and development initiatives. Climate change mainstreaming is designed to ensure that robust political, economic and cultural frameworks are in place to provide an effective and supportive environment to combat climate change. The following steps should be undertaken to help ensure that efforts to strengthen agricultural and food security in the region adequately address climate change.

~ **Step 1** – Farmers and communities should call for and support the mainstreaming of climate change adaptation and mitigation efforts into agricultural sector plans and all relevant national, sub-national and village policies and practices. Central themes of this mainstreaming work should include the promotion of food security initiatives and the development of National Adaptation Programmes of Action (NAPAs) and climate change strategies for all PICTs.

~ **Step 2** – Care should be taken to ensure that land-use and agricultural sector plans and policies are revised to ensure that they are flexible and responsive to the uncertainties of climate change. They must also closely consider gender roles and how climate change will impact village activities, such as the collection of fuelwood and water for cooking.

~ **Step 3** – In a future that will see existing water resources come under increasing pressure from growing populations, changing rainfall patterns and saltwater intrusion, the effective management of water resources for domestic and industrial use, electricity generation, recreation and tourism opportunities, and crop irrigation must become a top priority for all PICTs. Governments and Pacific communities alike must promote water resource management practices that look to promote water conservation; improved crop irrigation practices; and the development of water capture and storage initiatives.

~ **Step 4** – As sea levels rise and populations grow, land-use planning must become a top priority for PICTs. Along with water catchment areas and aquifer recharge zones, cropping land must be identified and protected against encroachment from poorly controlled urbanization and the relocation of people forced from low-lying land. In countries where adequate policies already exist, they must be implemented and relevant legislation enforced.

2.4.2 Combating information gaps

Much of the global climate change research conducted to date on crop production has focused on rice, sugarcane, maize, barley, wheat and millet. These crops feed much of the world's ballooning populations in Europe, Asia, Africa and the Americas. There has been comparatively little "Pacific specific" research conducted on the impacts of climate change on tropical root crop production, particularly within the context of climate change in PICTs. Here are some steps that could help ensure that we have up-to-date and best practice information available to farmers and decision-makers in the Pacific region.

- **Step 5 – PICTs need to call for and support climate change-focused scientific research that models the effects of climate change on Pacific agriculture and also seeks to identify practical village-level solutions to adapting to climate change. The research gaps are numerous but a few notable areas, listed below, requiring further attention.**
  - **Build a better picture of changing regional rainfall patterns and climatic variability associated with climate change. Information gaps could be filled by installing more meteorological observation stations, particularly in rural areas, and training staff on the use of climate information for farmers.**
  - **Assess climate impact at local level, which will be essential to determine appropriate adaptation measures.**
  - **Identify alternative crop production systems, such as coconut fibre farming and hydroponics.**
  - **Continue to identify and develop local and exotic crop varieties that can tolerate Pacific climate extremes, including heat stress, drought, water-logging, saline soils, wind throw and pests.**
  - **Optimise planting times for integrated cropping systems and low-input crop production practices.**
  - **Develop sustainable irrigation and water capture systems to combat variable rainfall and drought.**

- Match soils and land-use potential with suitable crop species.
- Identify and control invasive species that impact agricultural production such as weeds, disease and pests.
- Prepare storm water management and capture plans.

~ **Step 6** – To ensure climate change-focused agricultural research is successful, it must strongly target Pacific farmers' needs and, where practicable, draw upon their skills and expertise at all stages of the research process.

~ **Step 7** – A regional approach to the sharing of climate change adaptation initiatives and "lessons-learned" is critically important to build Pacific expertise that can be shared among neighbouring countries.

2.4.3 Combating sea-level rise

Many low-lying areas and flood plains will become increasingly impacted by rising sea levels, storm surges and flooding as the impacts of climate change take hold in the Pacific region. Effective land-use planning will be critical to help protect soil and water resources, and natural ecosystems against the impacts of climate change. As some agricultural land becomes inundated and/or contaminated from seawater incursion, other areas of land will need to be brought into production. Here are some steps aimed at protecting Pacific island natural resources.

~ **Step 8** – In addition to supporting the development and implementation of effective land-use plans (see mainstreaming section), it is vital that farmers and communities move to identify and protect soil and water resources such as valuable cropping land, water catchments, ground water reserves and coastal vegetation. For example, highly fertile and elevated land may need to be earmarked and retained for future agricultural use, particularly in areas where existing agricultural land is low lying and/or prone to flooding.

- **Step 9 – In the Pacific context, seawalls do not provide an economically viable nor environmentally sustainable solution for preventing sea-level inundation of low-lying coastal land. Rather, they are suited to specific applications such as protecting high value infrastructure, including roads and buildings in zones impacted by active coastal erosion. Constructing a seawall to protect your agricultural land is likely to be costly, ineffective in the long-term, harmful to the environment and will probably transfer erosion or flooding problems to neighbouring farms or villages.**

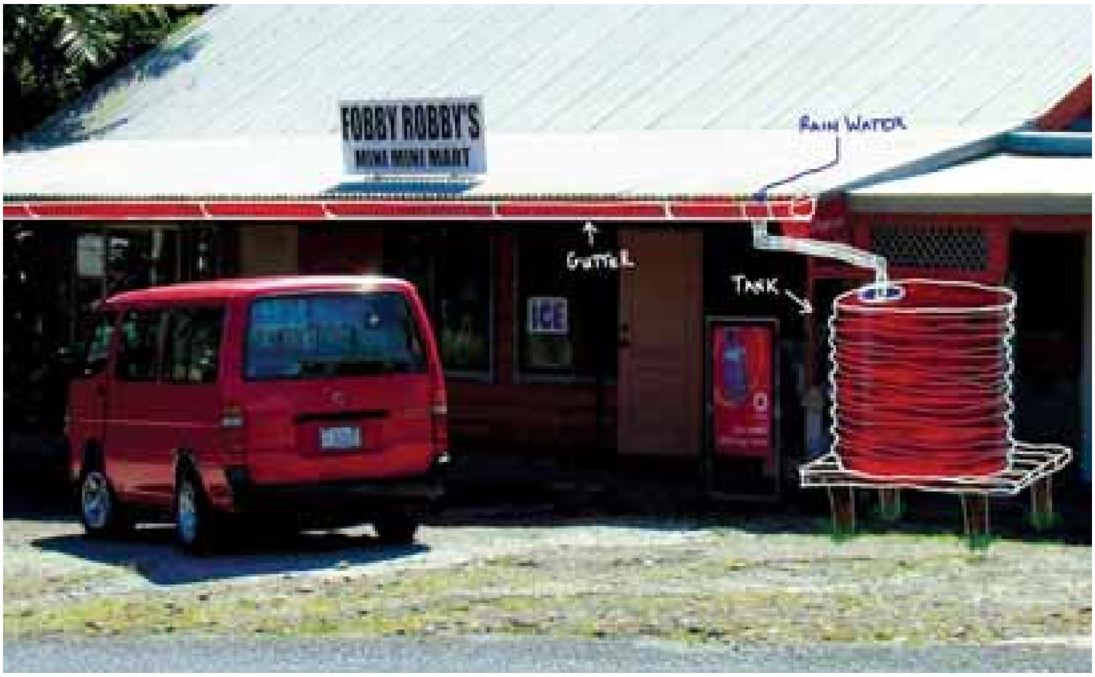
- **Step 10 – While it is unrealistic to think that climate change-induced coastal erosion in PICTs can be totally prevented, it is important to reduce human activities that further contribute to coastal erosion processes. Activities such as the mining of corals and sand, the development of coastal infrastructure, and the deforestation and degradation of coastal forests, mangroves and wetlands must be closely regulated.**

2.4.4 Combating droughts

Without question, water is one of the region's most precious and sometimes most undervalued natural resources. As populations grow and climate change takes hold, potable water will become an increasingly valuable resource in many PICTs particularly within low-lying atoll countries.

Many PICTs will have to make vast improvements in existing water resource management practices and begin to capture and store rainfall for drinking and crop irrigation. Here are some steps designed to combat the impacts of reduced rainfall and drought that may become more widespread in a future Pacific region.

Figure 2.1: **Harvesting rainwater is one way you can improve your family's water security for crop irrigation, washing and drinking. On this building, each square metre of roofing iron can capture 1 litre of high quality water following just 1mm of rainfall! When you multiple roof area by the total amount of rainfall received, it may be possible to capture and store tens of thousands of litres of clean water each year.**



~ **Step 11** – PICT communities must look to develop and enforce effective water resource management strategies that focus on water conservation, recycling and water harvesting practices. For example, water used for laundry, washing and bathing can be recycled and used for flushing toilets and may also be suitable for sustaining crops during times of drought.

~ **Step 12** – The adoption of bucket irrigation and water harvesting from buildings for crop irrigation are likely to become increasingly important practices, particularly in atoll nations and drought prone areas.

~ **Step 13 –** Drought increases the risk of forest, crop and grass fires. PICT governments and communities need to address these risks by developing and implementing strategies to reduce the risk of fires. At the community level, evacuation plans should be implemented and forest fire breaks can be cleared to isolate adjacent forest blocks, crops and buildings from one another. Individuals can also reduce fire risk by clearing vegetation and trees away from houses, farm buildings and crops.

2.5.5 Combating storms and cyclones

Cyclones and severe storms already impose significant costs on PICTs. Unfortunately there is growing evidence to suggest that El Niño conditions may become more prevalent and increase the intensity of cyclones and storms by increasing wind speeds and mean and peak rainfall. Strong storms will accelerate coastal erosion, increase flooding and saltwater intrusion, and directly damage crops and agricultural infrastructure.

~ **Step 14 – Exposed coastal areas are likely to be increasingly impacted by storms, high winds and salt spray. Live-tree shelter belts may provide farmers with a cost-effective means of protecting inland crops and soils from coastal winds that can rob soils of valuable moisture, elevate salinity levels and directly damage crops with wind throw and salt burn.**

~ **Step 15 – Farmers can build resilience to cyclones and storms by diversifying agricultural crops and incorporating root crop species that may be less susceptible to high winds, heavy rainfall and water-logged soil conditions.**

~ **Step 16 – As new buildings are constructed and old buildings upgraded, care should be taken to ensure that they are climate-proofed against high winds and heavy rainfall, and located away from flood prone areas, vulnerable coastlines and large trees that may be susceptible to wind throw.**

(See TOOLS section for further sources of information on a climate change mitigation and adaptation measures.)