5.10 Supporting farmers’ access to the global gene pool and participatory selection in taro in the Pacific

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Taro has always been here; it belongs to us and is part of our people. Taro is our life.
Melanesian taro farmers (Jansen, 2002)

Taro: an ancient food crop

Taro (*Colocasia esculenta*) is a clonally propagated aroid; it is an ancient food crop that was domesticated at least 9000 years ago, largely for its underground corm. All plant parts can be utilized. Its corms are baked, roasted or boiled; the leaves are frequently eaten as a vegetable and represent an important source of vitamins. The blades and petioles of leaves can be preserved or dried, and thereby become an important food in times of scarcity. Various plant parts are used for medicinal purposes (Rao et al., 2010). In common with other tropical roots and tubers, taro cultivars flower infrequently and are highly heterozygous. Although taro originates from South-East Asia, it has spread throughout the world and is now an important crop in Asia, the Pacific, Africa and the Caribbean. South-East Asia and the Pacific represent the two major and distinct gene pools.

The international scientific community has largely ignored taro, despite its local importance. This may be partly because genetic resource collection of taro is difficult and *ex situ* conservation in field gene banks is notoriously expensive (Lebot et al., 2005). In the Pacific, but also elsewhere, farmers remain the custodians of taro genetic and cultural diversity. They maintain thousands of cultivars that are adapted to a wide range of agro-ecologies, covering wetland and dry-land, marginal, complex and often harsh environments (Rao et al., 2010).

Taro: a people’s crop

Farmer management of taro genetic diversity is highly dynamic as it is embedded in the social structure of the community, such as kinship obligations that foster exchange. Taro cultivar portfolios are determined as follows: (a) the taros are introduced from outside the village; (b) they are the products of somatic mutations, which farmers observe in their fields and retain after evaluation; or (c) they are found as seedlings in rural and wild environments, the result of sexual recombination, and are retained by farmers after evaluation (Jansen, 2002; Caillon et al., 2006; Camus and Lebot, 2010).
The dynamism results in taro cultivars being exchanged within and among communities, and also within and between countries.

During participatory appraisals of taro diversity in the Solomon Islands, farmers were asked if they ever found taro seedlings (Jansen, 2002). Many farmers described finding taro genotypes that became new cultivars in the bush, primary forest, and along the banks of rivers. Some farmers also reported finding new taro cultivars that had been growing in farm sites under fallow for at least six years (some up to 25 years). Caillon and colleagues (2006) describe similar findings in Vanuatu, where observant farmers cultivated these taros, evaluating and selecting those that performed well. They included the taros that were useful to their agronomical, culinary and social needs. In some Pacific islands, community discussions revealed the presence of taro chiefs in certain communities who conserve a bulk of cultivars as a hobby. Camus and Lebot (2010) refer to them as collector farmers.

Despite the cultural significance of taro and its wide exchange networks in the Pacific, its genetic base in the Pacific is in fact quite narrow compared to that of South-East Asia. As a result, taro cultivars from the Pacific are vulnerable to new emerging pests and diseases, which are having an alarming effect in terms of genetic erosion. Because taro is so important to food and cultural diversity in the Pacific, we need to support farmers’ conservation efforts in battling this erosion of genetic diversity and associated traditional knowledge.

**Taro improvement project**

The narrow genetic base of taro was revealed in 1993 when taro leaf blight (*Phytophthora colocasiae*) arrived in Samoa, with dramatic consequences. Since all traditional cultivars were susceptible, almost overnight, the country’s most important domestic and export commodity, major source of income, essential food source and cultural icon was wiped out. The situation had to worsen before researchers began to shift their strategy towards facilitating farmers’ access to, and benefit-sharing from, taro genetic diversity originating from distant geographic areas. The problem of taro leaf blight and associated genetic erosion stimulated the establishment of the Taro Genetic Resources Conservation and Utilisation Network (TaroGen) in 1998.

Since 1999, farmers in Samoa have had access to exotic cultivars and breeding expertise through the establishment of a Taro Improvement Programme (TIP) at the School of Agriculture, in the University of the South Pacific (USP). Discussions between researchers and farmers revealed that previously introduced exotic cultivars had shortcomings, including susceptibility to disease in wetter parts of the country, plus low yields, and poor taste and storability. Farmers raised concerns about the delay in research for releasing and providing them with evaluated material. Responding to those complaints, TIP brought together regional and national scientists, extensionists and farmers from Samoa’s two islands, Upolu and Savai’i. TIP began to introduce and evaluate taro genetic resources and incorporate participatory varietal selection (PVS) in its taro improvement programme, as visualized in Figure 5.10.1. Participatory appraisals focusing on taro provided vital information on production problems and varietal perceptions. Through various scoring and ranking exercises, criteria for PVS trials were indentified (Singh et al., 2010). Since 2000, we have organized a
number of taro diversity fairs, as part of the TIP project to showcase TIP’s breeding and evaluation work. At the USP campus in Samoa, we set up a taro breeders’ club to integrate TIP into teaching, encouraging students to participate in germplasm evaluation and interact with farmers and scientists.

During their participation in TIP activities, farmers evaluate and select our clones, which have been produced through crosses between cultivars from Samoa, Palau and the Federated States of Micronesia (Hunter et al., 2001). Although selected clones enabled farmers to start growing and eating taro again, there was concern that breeding from such cultivars with only a Pacific origin would not significantly broaden the required genetic base (Camus and Lebot, 2010). As a next step, farmers obtained access to virus-indexed germplasm from Asia; and TIP brought together two distinct taro gene pools. Taro research is largely neglected by the international community, and before TaroGen, limited data on the genetic diversity of taro was available. Moving taro germplasm internationally was considered unsafe because of the limited availability of information on the presence of viruses and the inadequate methods used for their detection.

TaroGen contributed significantly towards improving this situation. Characterization and diagnostic tools were developed in order to identify taro viruses. The Centre for Pacific Crops and Trees, an international standard gene bank that conserves Pacific staples, and which is located at the Secretariat of the Pacific Community in Fiji, established a regional taro collection and a transit centre for the virus-indexing and safe movement of taro germplasm. The TaroGen gene bank has been facilitating substantial taro

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**Figure 5.10.1** The Taro Improvement Programme’s strategy for participatory taro improvement, illustrating links to the formal plant genetic resources system and informal farmer networks.
collection, characterization and conservation since 1998, including the development of a regional taro core collection (Mace et al., 2010; Taylor et al., 2010). The gene bank has continued to play an active role within TIP since the completion of the TaroGen project, improving farmers’ access to exotic cultivars and creating opportunities to distribute any clones developed by TIP to other countries (Figure 5.10.1).

Farmers in the Pacific are now able to access the diversity of the Asian gene pool. In 2005, several accessions from the core collection of a sister regional network in South-East Asia were included in the breeding cycle (Figure 5.10.1). To date, seven breeding cycles have been completed, including researcher and farmer selection (Table 5.10.1). In 2009, five new cultivars were formally released and recommended in Samoa. Top selections from each breeding cycle in Samoa are tissue cultured and subsequently transferred to the regional gene bank, where their virus status is assessed and included in the collection. TIP’s top selections are available to farmers and breeders in countries that are Contracting Parties to the International Treaty on Plant Genetic Resources for Food and Agriculture, as a result of the fact that in 2009 the Pacific region agreed that the regional gene bank collections be placed in the multilateral system.

The specific role of farming communities in the conservation and breeding activities of TIP

Forty-five farmers from the two main islands of Samoa, Upolu and Savai‘i, became members of TIP in 1999. Over the past ten years, the number of members has increased to over 100 farmers. Since 2010, a core group of 40 members have been actively engaged in the programme through meetings, evaluations and the distribution of clones. In joining TIP, farmer members sign a farmer/researcher agreement that sets out, in considerable detail, expectations and reciprocal roles and responsibilities. Researchers are largely responsible for the crossing, and for some preliminary on-station evaluations to identify potentially useful clones. Farmers are responsible for the planting, labelling, maintenance and selection of those clones, in particular for

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Year</th>
<th>No. of parental combinations</th>
<th>No. of seedlings evaluated</th>
<th>Top selections</th>
</tr>
</thead>
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<tr>
<td>Cycle-1</td>
<td>1996</td>
<td>4</td>
<td>2 000</td>
<td>10</td>
</tr>
<tr>
<td>Cycle-2</td>
<td>1998</td>
<td>5</td>
<td>2 000</td>
<td>26</td>
</tr>
<tr>
<td>Cycle-3</td>
<td>2000</td>
<td>26</td>
<td>2 000</td>
<td>30</td>
</tr>
<tr>
<td>Cycle-4</td>
<td>2002</td>
<td>45</td>
<td>5 000</td>
<td>30</td>
</tr>
<tr>
<td>Cycle-5</td>
<td>2005</td>
<td>30</td>
<td>5 000</td>
<td>42</td>
</tr>
<tr>
<td>Cycle-6</td>
<td>2007</td>
<td>33 + 9 BCF&lt;sub&gt;1&lt;/sub&gt;</td>
<td>11 000</td>
<td>40</td>
</tr>
<tr>
<td>Cycle-7</td>
<td>2009</td>
<td>36 (17 BC&lt;sub&gt;1&lt;/sub&gt;)</td>
<td>12 000</td>
<td>25&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> BCF<sub>1</sub>, first filial generation of the backcross to taro Niue (most preferred local cultivar, pre-taro leaf blight).

<sup>b</sup> BC<sub>i</sub>, second generation of the taro Niue backcross.

<sup>c</sup> As of May 2011, 70% of these selections are being conserved at the regional gene bank, 18% of which have been virus-indexed and distributed.
the evaluation of culinary traits. Farmers select and multiply the clones they prefer without any influence from the researchers. They then supply the researchers with the planting materials of their best selections for future breeding and inclusion in tissue culture (for regional distribution); and provide feedback to other TIP members. Future breeding cycles are therefore based on materials identified and selected by farmers, as well as researchers.

Each farmer is usually supplied with up to 100 clones (seedlings) from each cycle. Since 2000, when farmers began to be involved in evaluation on-farm, 6000 clones have been distributed. Some farmers maintain just a few clones, while others maintain many more, provided they produce a good yield and that their eating qualities are good. Farmers have the right to exchange or sell any planting material or corms from their selections. The experiences of TIP illustrate that Samoan farmers are skilful at handling, evaluating and selecting large numbers of clones, lines and cultivars.

The future of taro

In Samoa, prior to the arrival of taro leaf blight in 1993, the main problem was that all taro cultivars were highly vulnerable. This vulnerability still exists in those taro-growing countries in the region that have not yet been affected by the disease, and where the genetic base of the crop remains narrow. The devastating outbreak of taro leaf blight in Samoa resulted in the development of TIP, which led to a better understanding of the disease and of the importance of taro diversity among researchers and farmers. Diversity is now also used to improve taste, nutritional value, yield qualities and to identify clones suitable for value-adding. Farmers and researchers can access diversity through the regional gene bank, which offers them an opportunity to increase the diversity on-farm in order to meet their individual and community needs. Farmers and researchers alike are aware of what can happen when a disease strikes, and they are keener than ever to maintain diversity, a dynamic that in itself keeps interest and awareness alive and ensures greater diversity on-farm. TIP members are aware that they are part of a dynamic process that feeds not only the people of Samoa but, through linking with the regional gene bank at SPC, supports taro cultivation and production in the region.

TIP cultivars have made their way to countries in both the North and South Pacific, and in a sense this provides protection against the future emergence of taro leaf blight in countries that are currently free from the disease. Through the introduction of exotic materials and participatory taro improvement, researchers and farmers in the Pacific have made advancements unforeseen ten years ago. The development of resistant cultivars coupled with advanced virus-testing technology has now made it possible to share and disseminate farmer-selected materials rapidly, under the auspices of the multilateral system, should outbreaks of new diseases occur. Improved lines of taro were transferred to Nigeria because of a recent outbreak of taro leaf blight in the region. This means that unlike the situation in Samoa prior to the establishment of the TaroGen network, countries with new outbreaks of the disease no longer have to wait years to get access to lines with improved resistance. Furthermore, the transfer of these improved taro lines across the world, from the Pacific to Nigeria, reflects the global interdependence in plant genetic resource conservation and use.