

Root Crops Agrobiodiversity Project in Vanuatu

Funded by FFEM (*Fonds Français pour l'Environnement Mondial*) MQAFF and CIRAD. Details of the project are as follows:

Introduction, Background and Rationale

Vanuatu has found great difficulty in sustaining the conservation and genetic improvement of lesser root crops, mostly aroids (*Alocasia macrorrhizos*, *Amorphophallus campanulatus*, *Colocasia esculenta*, *Cyrtosperma chamissonis*, *Xanthosoma sagittifolium*) and yams (*Dioscorea alata*, *D. bulbifera*, *D. cayenensis-rotundata*, *D. esculenta*, *D. nummularia*, *D. pentaphylla*, *D. transversa*, *D. trifida*). The persistent attempts to collect and conserve germplasm and to make use of the resources over more than 30 years are evidence of this. Aroids and yams have also become the neglected crops of the international community, although locally important as staples and/or reserve foods used in times of need, as rich sources of vitamins, dietary fibre and minerals or as folk medicines. Invariably, they are grown or left to grow without the addition of fertilisers or pesticides. As a group, these species are efficient food plants and if marginal land is to be brought into production to support burgeoning populations, the potential of these crops is interesting.

In Vanuatu and elsewhere in the tropics, their conservation is fraught with difficulty: ex situ collections are expensive to maintain and methods for “on-farm” conservation have not been studied. Numerous collections have been made and lost several times in Vanuatu (and in many other tropical countries). In response to the problems of maintaining ex situ field collections, some countries have established in vitro collections without significant results. Cryopreservation, although attractive, has not proven to be practical. Furthermore, the storage of true botanical seeds is still problematical for most root crops species.

In Vanuatu, collections have been assembled and described using conventional approaches, involving agro-morphological descriptions and molecular tools, but they have been poorly utilised in genetic improvement programmes. Since Independence in 1980, the various Vanuatu governments have shown repeatedly the desire to improve their production but have been unable to maintain the technical capacity required over the long term. The consequence for the lack of interest in root crops species is now that they are losing their competitive position in traditional cropping systems as diets are changing rapidly.

Similarities shared by root crop species in Vanuatu

All cultivars are vegetatively propagated and they share a narrow genetic base. Their flowering is erratic, they have variable ploidy levels, are predominantly allogamous, highly heterozygous and are, of course, cultivated for the interesting chemical compositions of their underground organs. Some of these biological characteristics are not specific to these root crops but they often present all of them together. Unlike most crops, they are not cultivated for the characteristics of their sexual organs (i.e., fruits and seeds). In fact, in many cases, flowers and true botanical seeds are virtually unknown to farmers. Many cultivars are clones of edible wild forms and a few putative wild forms are probably feral plants escaped from cultivation. Some cultivars are also clones of hybrids between wild forms and feral or cultivated plants. It is also possible to observe a deterioration of the attractive traits exhibited by a cultivar when it becomes feral. The physico-chemical characteristics

of the under-ground organs deteriorate rapidly if the soil texture is not improved regularly and/or if the plant is not subjected to a periodic sexual propagation and selection.

Diversity

Most of the allelic diversity is found within the wild gene pool, although most of the agromorphological variation is found within the cultivars. Compared to cultivars, wild forms present limited morphological variation. Cultivars share a narrow genetic base but present numerous variable morphotypes which are probably the result of past sexual recombinations and clonal selections of somatic mutants. Root crop growers can select variants for the sake of increasing the number of distinct morphotypes preserved in their varietal portfolio. In Vanuatu, the national cultivars collections are therefore assembling limited allelic diversity. This has been observed for cultivars of taro and for *D. alata*.

Farmers' needs

In Vanuatu, farmers often give the priority to taste rather than yield and yield potential is never reached in farmers' fields. Yam tubers and aroid corms do not present a uniform shape at harvest, thus making it difficult for mechanical peeling and marketing. Internal colour ranges from white to dark purple and may include combinations of two or more colours. Their texture varies after cooking and there is a lack of information on the physico-chemical characteristics of the starches that hinders utilisation. Among the priority breeding objectives are corms and tubers with acceptable quality, *i.e.*, an appropriate dry matter content, a good cooking texture, taste, and no oxidation (rate of enzymatic browning). We can therefore draw some practical guidelines for the preservation and use of root crops genetic resources in Vanuatu.

We know that the genetic bases of these crops are narrow, vulnerable to introduced pathogens and that it must be broadened if the crop is to be able to respond to rapid environmental changes. However, in order to be acceptable to farmers, and to be kept as part of their varietal portfolio, any new genotypes must exhibit an interesting attribute or perform better than those presently cultivated. Also, for them to be useful in the future, these genotypes need to have sexual reproductive potential, which means that their ploidy levels, crossability and genetic make-up must be understood. Considering the economic situation of minor root crop producers and the low-input cultivation systems which are often involving different cultivars, an appropriate approach could be to increase farmers' long-term access to useful genes. This could be done via the geographical distribution of allelic diversity and is probably a practical alternative to present conservation activities.

The geographical distribution of allelic diversity follows a three steps approach:

1. composition of a core sample representing the useful diversity of the species,
2. geographical distribution of genotypes for direct use or for breeding,
3. distribution of genes under the form of clones resulting from segregating progenies.

Distribution of genotypic diversity

The identification of useful genotypes, exchange and propagation for direct distribution to farmers is the easiest way to distribute allelic diversity. This can be done with genotypes selected for only four attributes (origin, diversity, quality, performance). Field multiplication allows direct

distribution to farmers. When this is done on a wide scale, farmers insert exotic germplasm into their portfolio which is broadening the allelic diversity they use and maintain. As these genotypes are clonally propagated, farmers can exchange and distribute them further.

Compared to the Vanuatu national *ex situ* germplasm collections, maintained at VARTC, Santo, this simple system presents a few advantages. The distribution and preservation of allelic diversity avoids “putting all the eggs in one basket”. The core sample is distributed to as many partners as possible who subsequently propagate and distribute it. It is therefore a fully decentralised system which can address the production problems rapidly (i.e.: the preservation of a national Samoan taro collection before the introduction of *Phytophthora colocasiae* in this country in 1993 was probably a sheer waste of efforts).

Distribution of allelic diversity

It is possible to produce yam seeds via controlled crosses or open pollinations. Likewise, seeds of some aroids can be generated in large quantities with hundreds of seedlings grown in small nurseries with minimum efforts. In practice, a core sample is first composed. Selected genotypes are then intercrossed and the hybrids are raised for distribution as clones, directly to the farmers. Farmers select clones adapted to their local conditions and discard the others. Selected clones are eventually recombined with others.

The Project objectives

This is a five year project coordinated by CIRAD and funded by FFEM, MQAFF and CIRAD. There are six (6) objectives:

1. To collect and record traditional knowledge associated with the traditional uses for ten different species of root crops cultivated in Vanuatu and to study socio-economic behaviours of producers and users regarding their genetic resources.
2. To survey and record all cultivated varieties and to study (using morpho-agronomic descriptors, chemical analyses and DNA markers) the genetic diversity used in ten different villages (each located on a different island).
3. To identify new varieties aiming at broadening the existing genetic bases and to propose them to producers and users, taking into account their needs and preferences.
4. To conduct participatory assessments of the suitability of the introduced varieties and to attempt to understand why they are accepted or rejected.
5. To develop an information system for the civil society in Vanuatu aiming at discussing and explaining the importance of root crops genetic resources for present and future generations.
6. To elaborate a methodology for the “on farm” preservation and use of root crops species genetic resources which could be adapted elsewhere, in tropical countries.

Selection of villages (communities)

Five villages have been selected in wet zones (taro dominant in Tanna, Pentecost, Ambae, Santo, Vanua Lava) and five in dry zones (yam dominant in Erromango, Epi, Ambrym, Malekula, Malo).

Field work

Year 1: all villages were visited and surveys have been conducted. Monographs have been produced and reports given to the communities. These include:

- the complete list of the root crops species genetic resources,
- the morpho-agronomic description of the varieties for each species,
- a census of the plants per cultivated genotypes in farmer's fields,
- a comprehensive record of all traditional knowledge associated to their cultivation,
- a comprehensive record of all traditional knowledge associated to their uses,
- a chemical analysis of their physico-chemical characteristics,
- a molecular diversity study of the germplasm cultivated and preserved in the village.

This constitutes a record of the situation at time 0, the beginning of the project.

Year two: based on the information obtained, a list of genotypes "suitable for introduction" has been selected and these genotypes have been propagated in Santo for the northern islands (Santo, Malo, Malekula, Pentecost, Ambae, Vanua Lava) and in Efate for the southern islands (Tanna, Erromango, Epi, Ambrym). Propagules have been distributed to farmers in the ten villages so that their varietal portfolio is diversified.

Year three: technical backstopping has been provided to the communities (villages) on:

- improved and sustainable cultivation techniques,
- true botanical seeds production and simple breeding techniques,
- simple processing techniques and new uses (drying, pounding... etc).

Year four: surveys have been conducted to assess the potential changes at the village level in farmers' portfolio and study the causes for adoption or rejection of the genotypes introduced. An assessment of the preservation stage of local genotypes has been conducted. Monographs have been produced and distributed to villages (communities) to present the situation in year 4 of the project.

Year five: based on the results obtained, a methodology has been developed for regional and/or international distribution.

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