South Pacific

Status of coconut genetic resources research in Vanuatu

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Introduction

Vanuatu, formerly called New Hebrides, is an archipelago located in the Southwest Pacific Ocean between the Solomon and Fiji Islands. It consists of some 80 widely dispersed islands between the Torres Group (13°S) to the uninhabited Matthew and Hunter islets (22°S). As in most of the Pacific Island countries, coconut is widely planted and used by the rural populations for food and for numerous other domestic purposes. The production of copra started in the 1870s and was the mainstay of Vanuatu's economy until the 20th century. Even when world demand and prices for the product declined, copra remained as the most important export commodity of the country, with around 30 000 metric tonnes exported annually. Coconut is grown in an estimated 90 000 ha, representing nearly 60% of the total cultivated area in the country.

On the southeast coast of Espiritu Santo Island, near the village of Saraoutou, a coconut research station was established in 1962. Up to 2001, the station was managed by the French research organization Institut de Recherches pour les Huiles et Oléagineux (IRHO), which became the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) in 1985. The Saraoutou Research Centre is now called the Vanuatu Agricultural Research and Technical Centre (VARTC).

Researchable problems and opportunities

Tolerance to coconut foliar decay

When the Saraoutou Station was created, the main objective of its research work was to increase coconut productivity through agronomic and genetic improvement, particularly by developing high-yielding and suitable hybrids to replace the ageing established local varieties. A number of exotic varieties were planted in a field genebank, but they quickly started

to succumb to a previously unseen wilt of unknown aetiology, while the local Vanuatu Tall (VTT) variety, remained unaffected. This new wilt was named 'coconut foliar decay' or CFDV, a viral disease transmitted by the insect vector *Myndus taffini* (Julia 1982). Following this discovery, tolerance to CFDV was decided as the main criterion for selecting and developing coconut planting materials for Vanuatu.

Enrichment of VARTC field genebank and conservation of local coconut genetic resources

As the main source of CFDV tolerance, the use of the local Vanuatu Tall was the central strategy for the coconut breeding programme. Before the International Plant Genetic Resources Institute's International Coconut Genetic Resources Network (COGENT)-sponsored projects started, the genetic diversity of local coconut genetic resources in Vanuatu was not properly assessed and conserved. There was also a need to conduct a survey to identify the different uses of coconut, other than copra. At that time, the *in situ* management of coconut genetic resources by farmers was still unexplored.

Improvement of coconut-based farming system

With the recent drop in world copra prices, it is urgent to find ways to improve smallholders' incomes. The coconut groves are senescent and occupy large areas. The planting of precocious, high-yielding cultivars created through research can optimize the landuse. However, the dissemination of the improved planting material is expensive due to the distant locations of the cultivated areas, and the difficulties and high cost of transport around the archipelago. Diverse associations of coconut with other crops have been observed during farmers' participatory surveys. The performance, the sustainability and market opportunities of such associations must therefore be assessed.

Diversification of coconut uses

Even if a wide range of coconut by-products and uses have been observed at rural household level, very few are marketed in the urban areas or exported. The industrial processing for grated coconut, canned coconut milk and other similar products is not profitable in Vanuatu due to the limited domestic market, expensive inputs, high transport and labour costs. Nevertheless, the marketing of fresh products (tender and mature coconuts) and small-scale processed products (e.g. virgin oil) could be developed. The use of copra oil as biofuel for vehicles shows promise. Projects for the electrification of remote areas by using copra oil powered-generators are also being explored.

Research and training activities conducted in the country

During the last 10 years (1994-2003), the Department of Agriculture and Rural Development (DARD) and VARTC have actively participated in the different projects and training activities coordinated by COGENT, which are as follows:

Evaluation of selected coconut cultivars planted in farmers' fields in Vanuatu

The agronomic performance of three improved coconut cultivars, distributed to farmers during the implementation of the Coconut Development Project (CDP) between 1982 and 1993, were evaluated through COGENT's Asian Development Bank (ADB)-funded project. For this purpose, observations were conducted on farmers' plots and results are presented in Table 1.

Table 1. Comparative performance of three cultivars in Vanuatu for yield and copra processing

Characteristics	VTT	VTT x RIT	VRD x VTT
Average annual yield under farmers' field conditions as evaluated from 1994 to 1997 (tonnes)	2.0	2.6	2.2
Average copra content per nut as measured from 1994 to 2000 (in grams)	199	258	134
Percentage of oil in albumen dry matter	66.2	66.0	65.4
Percentage of water in fresh albumen	47.4	50.8	55.8
Number of nuts needed for one tonne of copra	5555	4360	7600
Time to process these nuts (comparison with VTT x RIT)	26.5 hours (+ 11%)	24 hours	37 hours (+ 55 %)
Quantity of copra obtained from one tonne of fresh kernel by hot air drying process (in kg)	467	447	415

Legend: *VTT = Vanuatu Tall RIT = Renelle Tall VRD = Vanuatu Red Dwarf*

Collecting, evaluation and characterization of coconut genetic resources in Vanuatu

The main purpose of this ADB-funded project was the evaluation and the *ex situ* conservation of the genetic diversity of local coconut genetic resources. Fourteen sites located in 10 different islands of the archipelago were surveyed. Two hundred nuts each of the 12 populations were collected. Eighteen variants showing special characteristics (spicata form, unique nut colour, etc) were also collected but with smaller sample size. They were all established in VARTC field genebank (Labouisse and Sileye 2001). As of 2003, the local germplasm collection of VARTC consists of 20 populations of Vanuatu Tall and the Vanuatu Red Dwarf (VRD).

Enhancing farmer incomes and germplasm conservation through coconut- based farming system and identification of varieties for multipurpose uses

This International Fund and Development (IFAD)-funded project consisted of three components:

Component 1: Farmer participatory surveys

During the period July 1998 - December 2000, eight participatory rural appraisal surveys (PRAS) were conducted on seven different islands gathering substantial information about local names and uses of coconuts, and different coconut-based farming systems. An average of 11 distinct types (or variants) of coconuts per village were identified by the farmers with numerous by-products and uses documented (Table 2). Some variants are associated to specific uses (Lahva and Labouisse 2000). This component is closely linked with the project on characterization and conservation of local cultivars. Samples of leaves of some collected populations were analyzed with the microsatellite kit developed by CIRAD (Baudouin and Lebrun 2002) to assess the genetic diversity within and between the populations.

The results of the PRAs were presented and discussed in a journal article by Labouisse and Caillon (2001). A set of three posters in bislama (Vanuatu's official language) was prepared and posted in the rural communities in order to make them aware of coconut genetic resources conservation strategies.

Component 2: Feasibility of coconut based intercropping systems for promoting coconut germplasm conservation through use

During the PRAs, the associations between coconuts and others crops have been documented. The socioeconomic survey on marketable crops produced in association with coconuts shows the opportunities and constraints of the different crop varieties and present some data on costs and returns (Bule 2000). The survey indicated that *Xanthosoma sagittifolium* and *Musa* sp. are the most frequently cultivated crops under coconuts, while Kava (*Piper methysticum*) is shown to be the most profitable. It was also identified that high transportation costs from farms to markets is the main productivity constraint.

Component 3: Evaluation of the improved cultivars used by farmers in Vanuatu for processing

Under the ADB-funded Project, the agronomic performance of three cultivars, (improved VTT, VRD x VTT hybrid, VTT hybrid x RIT hybrid, were assessed in farmers' fields (Labouisse and Buletare 1997). Under

Table 2. List of the common uses of and products from the coconut as surveyed in the villages of Vanuatu
(Source: Lahva and Labouisse 2000)

Coconut part	Uses and products
Whole palm	• Land marking • Garden ornamentation • Cattle shade
Roots Trunk	• Medical uses • Building material and furniture (post, plank, part of canoe) • Support for plants (yams, vanilla) • Medical uses (bark)
Leaves	• Handicrafts (hat, mat, fan, broom, baskets, hoop net) • Building material (roof, walls) • Support for plants • Fuel and light (torch) • Filter for kava
Whole fruit	• Ceremonial uses (wedding present, customary exchanges)
Husk	• Rope for building and for canoe • Container, support and protection for plants • Fuel • Abrasive
Shell	• Handicrafts (container, cup, spoon) • Kava cup • Fuel
Water	• Beverage • Medical and 'magic' uses (excipient)
Albumen	• Food • Copra
Milk	• Food • Medical uses (excipient)
Oil	• Food • Oil for human body and hair conditioning • Fuel (for lamp)

the IFAD-funded project, the quality of the fruits of these three varieties was also evaluated for copra production and processing (Lahva and Labouisse 2000). Results showed that the hybrid VTT x RIT outperformed the two other varieties in terms of nut yield and copra production (Table 1).

Contribution to the Coconut Genetic Resources Database (CGRD)

The entries of Vanuatu in the International Coconut Genetic Resources Database (CGRD) comprise of 60 living accessions. In addition,

morphometric and passport data of 12 accessions which do not exist anymore (due to cyclones or felling) have also been recorded and included in the CGRD.

Training activities sponsored by COGENT

Two regional training courses were held in Vanuatu while five Vanuatu researchers were sponsored by COGENT to undergo staff development training on topics such as standardized research technique in coconut breeding (STANTECH), coconut germplasm collecting and conservation, farmer participatory research, computer use, documentation and data analysis, and technical writing and seminar presentation (Table 3).

Table 3. List of COGENT-sponsored training courses with participating Vanuatu researchers

COGENT training courses organized in Vanuatu	No. of trainees/ participating countries
Regional STANTECH course for South Pacific (VARTC, 6-13/8/1996)	9 / PNG, Solomon Islands, Tonga, Fiji, Kiribati, Vanuatu
STANTECH training course on collecting and management of coconut genetic resources (VARTC, 29/6-10/7/1999)	4 / Kiribati, Cooks Islands, Marshall Islands, Tuvalu
COGENT training courses organized outside Vanuatu	**Participating Vanuatu researchers**
Coconut collecting and conservation course (PCA, Philippines, 1-12/9/1997)	Godefroy Buletare
Farmers participatory research on coconut diversity (Taveuni Coconut Centre, Fiji, 24-28/3/1998)	Pierre-Chanel Watas, Jeffrey Lahva, Jean-Pierre Labouisse
Computer use, documentation and data analysis course for South Pacific (SPC, Suva, Fiji, 3-7/8/1998)	Godefroy Buletare
Technical writing, seminar presentation and proposal writing course (PCA, Philippines, 30/8-3/9/1999)	Jeffrey Lahva
Coconut data analysis training course (PCA, Philippines, 6-10/9/1999)	Jeffrey Lahva
Establishment and management of field genebanks for conservation and use (PSGT, Malaysia, 28/9 – 10/10/1999)	Tiata Sileye

Other activities carried out within the framework of COGENT

1995 - Participation in the finalization of the STANTECH Manual (Santos *et al.* 1996) in Manado, North Sulawesi, Indonesia.

1996 - Pacific Projects review of Coconut Genetic Resources Network and Asia Pacific (CGRNAP) at VARTC.

1996 - Participation in the COGENT Steering Committee in Merida, Mexico as a representative of the Pacific region.

1999 - Participation in the COGENT consultancy on coconut collecting strategy (Bourdeix *et al.* 1999).

2000/2001- Appointment of VARTC as the implementing agency for the ADB-CGRNAP project on 'Coconut germplasm collecting, characterization and conservation in Cook Islands, Kiribati, Marshall Islands and Tuvalu' (Labouisse and Bourdeix 2003).

2002 - Participation in the preparation of the International Catalogue of Conserved Coconut Germplasm and Farmers' Varieties.

Activities supported by other donors

Conservation and observation of exotic germplasm

Exotic varieties which are susceptible to CFDV can be conserved in VARTC field genebank by removing, within a radius of about a hundred meters, all stumps of *Hibiscus tiliaceus,* the breeding host of the CFDV vector. Through the Pacific Regional Agricultural Programme (PRAP) project, the exotic germplasm of VARTC have been fully rejuvenated by hand pollination between 1992 and 2000. To date, the collection comprises of 14 distinct Tall and 13 Dwarf varieties imported from different countries of Africa, America, Asia and Pacific. Growth characteristics, yield, fruit component analysis are regularly recorded. Observations were also done in 1999 on the tolerance of Dwarfs to strong winds (Figure 1).

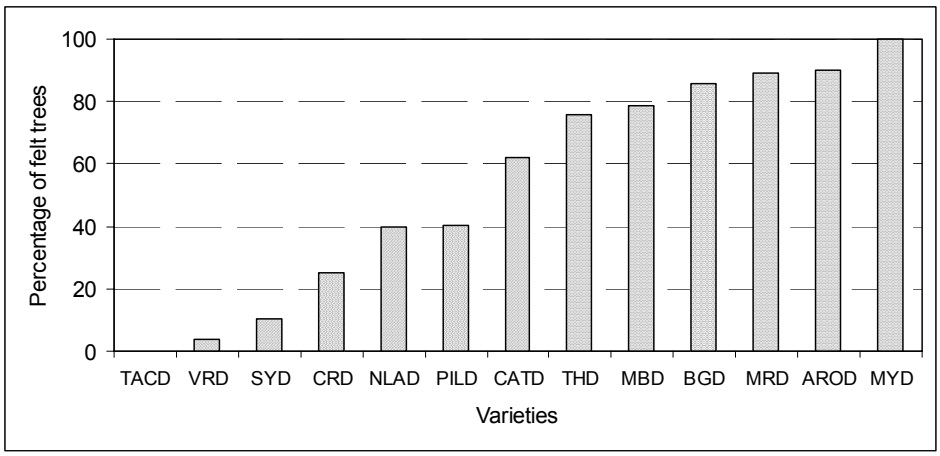

Figure 1. Damage inflicted by cyclone Dani (January 1999) on the different Dwarf varieties (aged 15) in the VARTC genebank.

Improvement of coconut planting materials for Vanuatu

Three cultivars were selected for propagation in Vanuatu for their tolerance to CFDV. These include the improved Vanuatu Tall, the VRDxVTT and the VTTxRIT hybrids.

The improved Vanuatu Tall, obtained from several cycles of mass selection, has an average copra yield of 2.2 t/ha/year and a copra content of 195 g/nut. It is completely tolerant to CFDV and can be easily multiplied by farmers.

The VRD x VTT hybrid line, tolerant to CFDV, is produced in seedgardens at Saraoutou Station and was released to farmers between 1986 and 1996. In spite of its high-yielding potential of 3.4 t/ha/year (as recorded in station trials), its dissemination was discontinued due to its low germination rate in the nursery, a low copra content (154 g) and the frequent dropping of immature bunches.

The VTT x RIT hybrid is the most promising with an average yield of 2.6 t/ha/year and a high copra content of 237 g/nut. The first lines of this hybrid showed very slight susceptibility to CFDV. However, the tolerance has been improved by using, as female parent, several self-pollinated progenies of RIT which show no symptoms of the disease. The VTT and the VTT x RIT hybrid, with good nursery and cultivation practices coupled with an ideal climate, start to bear flowers 30 months after planting, which is remarkable for Tall cultivars.

PRAP - PDICC Project

From 1989 to 1999, with the financial support of the European Union (EU) and the French Ministry of Foreign Affairs, and the technical assistance of CIRAD, VARTC implemented the Production and Dissemination of Improved Coconut Cultivars (PDICC) project in the framework of the PRAP. Eight countries (Fiji, Kiribati, PNG, Tonga, Samoa, Solomon Islands, Tuvalu and Vanuatu) were associated with this regional programme. The objectives of the PDICC project were:

1. To improve the potential of coconut production by increasing the choice of hybrid coconut cultivars in the South Pacific Region. A wide range of hybrids was created and the performance assessed in experimental trials established at VARTC. Before 1999, the project also supported the maintenance and the data collecting of VARTC coconut germplasm; and
2. To improve the quality of planting materials disseminated to farmers from the seedgardens of the participating countries. Technical assistance and training were provided to these countries for seedgarden management, coconut breeding and coconut genetic resources management.

Under the project, 39 new hybrid crossings were made by hand-pollination and eight trials were successfully established in Saraoutou Station between 1992 and 1999. This represents a total area of 57 hectares with approximately 9000 palms under individual observation. Each of the first seven trials included hybrids created by crossing diverse Dwarf cultivars with a Tall cultivar native to the region (i.e., Rennell Tall (RIT), Tonga Tall (TONT), Rotuman Tall (RTMT), Kiribati Tall (KIT), Gazelle Peninsula Tall (GPT), Samoan Tall (SMOT) and Markham Valley Tall (MVT)). In the eighth trial, six different Tall cultivars were crossed with RIT. For each trial, the following data were gathered: rate of germination, growth in the nursery, growth in the field (young age), flowering, yield, fruit component analysis, oil content, stem measurements, resistance to cyclone and susceptibility to diseases.

For copra yield, the hybrid MRD x RIT showed good performance in all the trials, producing about five tonnes of copra/ha when six years old. The hybrids MYD x RIT, BGD x RIT, MRD x TONT and MRD x RTMT also showed good potential. Some of the varieties also showed some promise on the tolerance to cyclones (Labouisse 2002).

Study of *in situ* management of coconut genetic resources

With the support of CIRAD and the Institut de Recherche pour le Développement (IRD), a three-year study in the framework of a PhD thesis was conducted since 2001 on *in situ* management of coconut genetic resources by farmers in Vanuatu (Caillon 2001). The study aims to further understand the biological and sociological processes that build the diversity of a crop system.

The study was performed in Vanua Lava in the north of Vanuatu. The farmers themselves distinguished the existing variants in Vanuatu Tall variety according to some specific morphological traits, production characteristics or particular origin. The average number of variants identified by village in Vanua Lava is 30, far above the number found during the IFAD-funded project, which was attributed to a longer and more intensive survey (Caillon and Malau 2002).

Variants are being described according to the STANTECH Manual. Statistical analyses done on 105 individuals showed that the most discriminant characters are those related to the description of fruit components. The results of molecular analysis using 14 microsatellites performed on 69 coconut leaves collected in Vanua Lava from 12 variants revealed that the whole population is distinct from the rest of Vanuatu and other Pacific countries. However, this technique is inadequate to differentiate the variants except for one (a Tall with yellow fruits). As the sampled population is small (two to eight individuals per variant), additional analyses have do be done to confirm these initial results.

Study on coconut-based farming systems

Since 2002, a study on the methods of assessment of performances and sustainability of associations of staple crops with old coconuts has been undertaken on the island of Malo in the framework of a PhD thesis sponsored by CIRAD (Lamanda *et al.* 2003).

Interpretation of significance or impact of output

The use of participatory approach for the assessment of coconut diversity in Vanuatu was very fruitful. Several coconut variants were identified and traditional uses discovered. VARTC's collection has been enriched with populations of Vanuatu Tall collected in different environments.

The improved VTT represents a significant advancement compared to ordinary VTT, with a better yield but, above all, a higher copra content which reduces the labour needs for copra processing. The hybrid VTT x RIT is also promising but its utilization by farmers is impeded by the high cost of transportation of nuts or seedlings within the archipelago. Contrary to improved VTT, it cannot be reproduced by farmers.

The results of the PRAP trials constitute a database of great value for the research and extension services within the region. These results will also benefit other Pacific countries which would be advised to reproduce the best crossings by using their own germplasm and seedgardens. Unfortunately, these hybrids would not be disseminated to Vanuatu farmers because of their susceptibility to CFDV.

Future research and development activities in coconut

Maintenance and observations of VARTC germplasm

The recently collected populations of Vanuatu Tall will be observed and the most interesting and promising ones could be used for further genetic breeding programme. Besides potential copra yield, the characteristics of the fruits for processing will be assessed.

Maintenance and dissemination of the results of PRAP-PDICC hybrids trials

Due to the biological cycle of the coconut, the performance assessment of a hybrid could only be undertaken about 9-10 years after field planting. Therefore, the evaluation of the first seven trials established at VARTC would only be done by 2006 although the financial support of the EU ended in 1999. Due to the regional significance of these trials, VARTC needs to source external funds for the maintenance and full evaluation of these trials until 2006.

Improvement of coconut-based farming systems

With the objective of improving the effectiveness and profitability of coconut-based farming systems (CBFS), the evolution of the different CBFS in Malo Islands is being studied. Likewise, the assessment of performance of the association of ageing coconut with other crops requires further research on agronomy, plant protection and physiology of coconuts and other crops (fruit trees, rootcrops, kava *Piper methysticum*, legume trees, etc) and on farm economy. The results of these studies will enrich CBFS technologies and, hopefully, provide increased benefits to resource-poor coconut farmers and their households.

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