A Global Strategy
for the conservation and use of Coconut Genetic Resources
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LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

COGENT
Coconut genetic resources for enhanced livelihoods

Bioversity International

The development of mass production techniques for hybrid seednuts dates back to the 1970s. These techniques opened the way for distributing coconut hybrids at scale, enabling many farmers to adopt them.

The first international meeting of coconut breeders was organized by Burotrop, GTZ and IPGRI (now Bioversity) and hosted at Marc Delorme Research Station in Côte d'Ivoire in 1994. The meeting aimed to create a connection between the existing coconut breeding programmes around the world and to standardize the techniques employed in coconut breeding (Batugal and Rao 1998, Santos et al. 1996). At the end of the meeting, it was observed that most of the national breeding programmes preferred to rely on their local cultivars rather than to introduce advanced varieties from the largest breeding centres, such as the Marc Delorme research station in Côte d'Ivoire.

In 2001, COGENT supported the APCC in conducting a survey on farmers' varietal preferences in 10 coconut-producing countries. The results showed that: 1) social facts are critical for explaining varietal preferences (Bourdeix et al. 2008); 2) although, there is no universal hybrid, hybrids generally performed better than the Tall traditional varieties under adequate rainfall and good soil conditions; and 3) farmers had not focused exclusively on high yields but were also interested in other traits such as robustness requiring low inputs and special characteristics for producing high-value products.

Between 1999 and 2004, COGENT conducted a multi-location trial (CMT) involving seven countries from Africa, Latin America and the Caribbean. This experiment, funded by the Common Fund for Commodities (CFC) compared the same six promising hybrids for copra production, shipped from Côte d'Ivoire with hybrids and traditional varieties produced locally. Sixteen coconut hybrids tested in this project started to flower two and a half to three years after planting, compared with the five to six years normally required for traditional Tall-type varieties to reach flowering stage. Potential annual copra yield projections for the best hybrids was up to 5 t/ha at the peak of production (10-12 years) compared to the 1t/ha generally produced by the traditional cultivars (Batugal et al. 2005a). Exploitation of mutations has also been considered, such as the breeding work on varieties known as Makapuno/Kopyor or Aromatic (See box next page).

2.5.4 Breeding for yield increase

Coconut yield is expressed in different ways according to uses and markets. Until the 1990s, breeders mainly expressed yield in terms of tons of copra or oil per hectare. Those focused on coconut water consider the number of fruits per hectare, or the water volume per hectare. Sometimes yield is also expressed as the weight of whole fruits per hectare, or quantity of toddy per palm.

Makapuno and Aromatic Green Dwarf: unique cultivars

Some examples illustrating the importance of coconut genetic diversity: a fruit from a Makapuno palm pollinated by another variety will not have the soft and thick kernel specific of Makapuno. A tender coconut from an Aromatic Green Dwarf but pollinated by another variety will lose its special delightful fragrance. Observations conducted notably in Papua New Guinea reveal a wide genetic diversity in fruit quality, which is extremely difficult to capture. For instance, 10 to 20% of the fruits produced by some rare palms have tasty kernels as crispy and tender as apples. In fact, as for Makapuno and Aromatic Green Dwarf, the quality of the kernel and coconut water relies on the genotype of the pollen: the kernel will be tender and crispy only when the mother-palm self-pollinates. This phenomenon occurs less frequently for Tall varieties which are mainly pollinated by surrounding palms. Most Dwarf varieties are homozygous and self-pollinating, so the three sets of chromosomes in kernel and coconut water are almost identical.

Yield was the main breeding target in all locations unaffected by lethal diseases. Yield improvement breeding strategies are either intra-varietal selection (also called mass selection methods) or inter-varietal hybridization.

Mass selection methods, i.e. selecting the best palms within the best plots began to be scientifically applied in the 1940s. All the research stations involved with coconut breeding have used this mass selection method.

There are three variants of mass selection, differing according to the reproduction system used: mass selection using open pollination; selfing[44]; or intercrossing (Bourdeix 1988). Positive mass selection using open pollination has been the most practised, but with variable results[45]. In the most favourable cases, the drastic selection necessary to obtain a substantial improvement would considerably reduce the potential of seednut production. One more generation of multiplication is needed to multiply the best palms. Thus, it is better to use this generation to evaluate parent palms not only from their own performance but also from their progeny's performance. In any event, breeding methods based on progeny tests within a variety (intra population) have rarely been used, generally because the pedigree of the progenies was not kept after planting. Pioneering work was conducted in Indonesia where evaluation of open pollinated progenies of the Mapanget Tall (Tammes 1958) started in 1926.

A list of hybrids tested by most coconut breeding centres was published in 1999 (Bourdeix 1999). From 1960 to 1999, about 400 hybrids between traditional cultivars were evaluated. After 2000, the creation of new hybrids strongly decreased in favour of

[44] Selfing, also called self-pollination, induces a yield decline without appreciably increasing production homogeneity. In the most favourable cases, the drastic selection necessary to obtain an improvement considerably reduces seednut production potential.

[45] The main drawback of mass selection using open pollination is the unknown rate of selfing, which fluctuates according to seasons and numerous other parameters. From a genetic point of view, this rate is important because selfing often induces inbreeding depression in Tall-type cultivars. Efficiency of mass selection in the case of the coconut palm is hotly debated.

the evaluation of existing hybrids in a wider range of environments. A composite variety was also created in the Philippines and disseminated among farmers.

The genetic progress achievable by crossing two by two traditional varieties appears to be limited. Improvement of the best hybrids started in 1970, leading to a new generation of hybrids producing 10 to 25% more that the initial hybrids between traditional cultivars. The method is based on a half-sib family progeny test and requires multiplication by selfing of parent palms. This demanding process was applied only in Côte d'Ivoire and Vanuatu by planting experiments between 1970 and 1998.

Efforts were also initiated to conceptualize coconut breeding as a continuous process, leading to regular and sustainable genetic progress. The method of recurrent reciprocal breeding started to be applied in Côte d'Ivoire (Bourdeix 1991) but was stopped by the political crisis in 2000.

2.5.5 Breeding for pest and disease resistance

Selection for pest and disease resistance in coconut populations has been one of the primary activities of coconut breeders and pathologists. Fighting crop diseases has proved challenging, for coconut, where pathogens often persist for 50 years. Efficient control methods generally include reducing vector populations, eradicating the first diseased palms, and adopting suitable tolerant varieties. Each of these components appears to be insufficient to control the diseases individually, but together would sometimes be capable of reducing its incidence to an economically manageable level.

Diseased coconut leaflets in Mozambique. (M. Dollet, CIRAD)

The average effective lifespan of a gene for disease resistance has been described as only 10 to 15 years, and then the pathogen generally overcomes the resistance. This happened in Jamaica in the 1980s the Malayan Yellow Dwarf (MYD) and its hybrid with the Panama Tall (PNT) or Maypan were widely used to replant LYD affected regions. This strategy seemed successful for the next 20 years, and then LYD devastated the previously resistant materials[46]. Similar resistance breakdown could also occur where phytoplasma-tolerant varieties are used, such as in Ghana, India, Mexico, Sri Lanka and Tanzania.

In the 1980s, Ghana imported many cultivars from the international genebank in Côte d'Ivoire to test their resistance to local LYD phytoplasma strains. So far, the only tolerant cultivars identified are the Sri Lanka Green Dwarf and the Vanuatu Tall, both coming from countries were the Ghanaian phytoplasma does not exist. This clearly illustrates the crucial value of conserving and using coconut genetic resources.

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[46] Treatment through injection of a tetracycline-type antibiotic is efficient but its high cost and environmental effects prevent its wide application.