A Global Strategy

for the conservation and use of Coconut Genetic Resources

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Coconut genetic resources
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2.5.6 Breeding for quality traits

The main commercial products of coconut are obtained from the fruits, and are used fresh as well as agro-industrially processed for food, human health, cosmetics, and fine chemicals.

Botanically speaking, the coconut fruit is a drupe, consisting of pericarp and mesocarp (husk), endocarp (shell) and testa enveloping the mature endosperm (kernel) which has a central cavity (vacuole) containing liquid endosperm (enriched water). From a genetic perspective, both kernel and coconut water are triploid, comprising two sets of chromosomes from the female parent, and one set of chromosomes from the male parent. So the genetic nature of the pollen strongly influences the quality of both kernel and coconut water.

The top breeding priority is developing cultivars bearing high quality fruit adapted to the various uses. Breeding for copra (dried oily kernel) quantity has been the main target of the last 40 years of selection and often the only one. However, the international copra market is continuously declining (Prades et al. 2016). In coconut kernel for instance, high oil content, rich in lauric acid and minerals is much valued (Dayrit 2015). Thus, instead of breeding for copra content, a more interesting approach is to seek a specific fatty-acid profile.

Coconut water is naturally tasty, and rich in minerals, along with traces of proteins and vitamins but very little oil. Its international market has grown exponentially during the last ten years. In this case, immature coconut fruits are the most suited for the production of this natural beverage. However, a few countries (mainly Brazil and Thailand) have launched breeding programme dedicated to the relevant traits: volume of water, sugar content (measured as Brix), aromatic profile and mineral composition.

Coconut fruits can seem user-unfriendly. The fibrous coconut husk is hard when mature and generally it is impossible to manually remove it. The shell is also hard and can be quite dangerous to break if a suitable tool is not used. The kernel is strongly attached to the shell. It remains too thin, firm and fibrous and sometimes its consumption can harm gums. Regarding tender coconut harvested for water consumption, the husk is too thick and the water makes up only 15 to 26% of the total fruit weight. Thus there remains considerable work for breeders to upgrade the coconut palm to the status of a fully domesticated species. And new selection schemes are urgently needed.

Fortunately, breeding programmes are increasingly interested in selection for quality traits. The most observed quality traits include: husk, shell and kernel percentages in mature fruits (Aragao et al. 2009); kernel oil content (Abreu et al. 2013); oil fatty-acid composition (Kumar 2011); coconut water percentage in tendernuts (Passos et al. 2009); and the sugar content, pH, mineral and vitamin content and flavour quality of coconut water (Prades et al. 2012). Sensory evaluation of coconut water has recently been

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but is sensitive to the Ghanaian pathogen. The hybrid PGD x MRD was created in 1993; in 2005 the F2 generation was planted by selfing this hybrid, so (PGD x MRD) x (PGD x MRD). From this progeny it is expected to find new Dwarf combinations with both tolerance to LYD and good agronomic value. See the Plate 3.1 in Chapter 3.

conducted on four cultivars (Assa et al. 2013). The sweeter water of immature nuts from Dwarf-type cultivars was the most appreciated.

Along with the development of new descriptors, new quality measurement tools and methods are now available for high throughput phenotyping. Near infrared spectroscopy, high performance chromatography, digital image analysis combined with proteomics and metabolomics analyses are available. Some of these tools have already been optimized for the study of coconut fruits' quality (Prades et al. 2006).

2.5.7 Breeding for drought and other abiotic stresses

A wide range of anatomical, physiological, and biochemical features contribute to various stress adaptations in plantation crops. Recent developments in biotechnology and molecular genetics are essential to fasten the breeding processes. Using diverse criteria, early mass screening methods have included:

- For drought tolerance: leaf water potential, leaf stomatal frequency, epicuticular wax content, level of lipid peroxidation, osmotic pressure applied to plantlets cultivated *in vitro* (Gomes and Prado 2007);
- For cold tolerance: measurement of coldness on leaves by electrical conductivity (Caom et al. 2009);
- For resistance to cyclones: presence of a bole, stem base width, stem height 10 and crown characteristics (weight and volume of fronds and fruits) (Labouisse et al. 2007);
- For salinity adaptation: leaf stomatal frequency, leaf gas exchange, the quantum yield of chlorophyll fluorescence, and the relative chlorophyll index (Da Silva et al. 2017).

Water is an increasingly scarce natural resource required for crop production. Growing cultivars that use water efficiently is a key step in achieving sustainable coconut production in the many areas affected by a long dry season.

Coconut killed by drought in Nuku Hiva, Marquesas Islands. (R. Bourdeix, CIRAD)

The coconut palm generally grows well where annual rainfall is between 1300 and 2500 mm or more. An average monthly precipitation of 150 mm is generally considered ideal in zones where irrigation is not practiced. A prolonged dry season lasting for up to four months may adversely affect the palms. This constraint occurs periodically in various coconut growing zones, such as in southern India (Kerala), Sri Lanka or the West African coast. In low rainfall areas and in places where the soils have poor moisture-retention ability, improvement of soil moisture retention capability will reduce damage to palms and even reduce mortality of palms