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

- Farmers of the Mekong Delta use a technique to stunt Tall-type coconut varieties. A study should assess if this technique, as shown in a recent movie[17], is manageable for genebanks.
- The genetic determinism of Dwarfism is still unknown, but the vertical growth of the coconut palm is very probably under phytohormonal control. When these mechanisms will be elucidated, it could become possible to apply phytohormones during a 2-4 years period for strongly reducing the vertical growth.

In the future, it is envisioned that regenerating an accession will be undertaken only when the palms are 60-years old, when more than a fifth of the palms are dead, or when their annual yield drops below 20 fruits per palm during two successive years.

3.3.3. Triplication of germplasm in distinct geographical sites

Coconut germplasm is highly vulnerable to disease and other threats, making safety duplication and rationalization of its conservation at the global level an immediate priority. As pointed out in section 1.1.5, much of the germplasm in *ex situ* collections is poorly safety-duplicated outside of the host collection. This puts the material at risk from loss.

Physically speaking, a coconut accession in an *ex situ* field genebank is something very consistent. This is not only a small handful of seeds; it is often more than half a hectare of large palms planted in the field for 30 to 60 years. COGENT believes that, in the case of the coconut palm, the most efficient way to globally manage coconut genetic resources is to do it at the accession level. The specificities and history of each accession conserved in *ex situ* genebanks must be meticulously recorded for optimizing conservation and use.

Triplication as a practical and pragmatic approach

The numerous discussions conducted with genebank curators and COGENT representatives led to the proposal that coconut cultivars should preferably be conserved in three different countries. They could be planted in field genebanks in three different countries on three distinct continents. Alternatively, in the future, they could be planted in the field genebanks of only two different countries, and cryopreserved in another country. As discussed in section 2.3.7, this "triplication" system would be applied at the cultivar level, and not for all the accessions presently conserved in *ex situ* genebanks.

This triplication proposal is based on a simple, practical and pragmatic approach. For curators, safety duplication is effectively reached only when the coconut germplasm is available for international transfer. The present system of five international genebanks does not meet this requirement: in reality (as discussed in section 3.2.3), three of the five existing international genebanks released little or no germplasm during the last 20 years. Moreover, in 2012 and 2013, the international genebanks of PNG and Côte d'Ivoire (the most active in releasing germplasm) became threatened by lethal yellowing diseases caused by Phytoplasma. So the situation is critical. It

[17] See the URL: http://coconutvietnam.blogspot.com/2016/01/coconut-bonzai-reducing-vertical-growth.html

becomes more and more difficult to move germplasm. The great majority of curators and member-countries agree that each cultivar should be kept in three countries. In this way, it will be easier to access the germplasm they need.

Meticulous management of conservation at the accession level: a practical example

In order to better understand the constraints and specificities of this triplication proposal, and to show how germplasm should be carefully managed, accession by accession, it is better to illustrate the triplication process by using practical examples. The example of the cultivar "Sri Lanka Tall" is developed in this section while some other examples are also presented in annex 9 of this document.

The cultivar Sri Lanka Tall (SLT) is presently conserved worldwide by 103 accessions totalling 7082 palms. The proposed triplication system is to internationally conserve the SLT population *Ambakelle* in just 3 accessions of no more than 96 palms, and located in 3 distinct countries on 3 continents. Table 3.1 gives details about some of the accessions of Sri Lanka Tall presently conserved worldwide.

Table 3.1. Some of the 103 SLT accessions registered in CGRD and the 3 of them (in grey) to be presently considered for conservation at global level.

Country	Accession Number	Population Number	Population name	Conservation site	Acqui-sition date	Number of living palms
Sri Lanka	CRI SLT02	SLT02	Ambakelle	Ambakelle	1954	1609
Sri Lanka	CRI SLT02 R2	SLT02	Ambakelle	Pothukulama	1988	81
Sri Lanka	CRI SLT03	SLT03	Debarayaya	Pothukulama	1991	79
Sri Lanka	CRI SLT04	SLT04	Goluwapokuna	Pothukulama	1991	74
Sri Lanka	CRI SLT83	SLT83	Thatin	Pallama	2008	14
Sri Lanka	CRI SLT84	SLT84	Unawatuna	Pallama	2008	18
Côte d'Ivoire	SMD GSL	SLT02	Ambakelle	M. Delorme	1972	266
Côte d'Ivoire	SMD GSL R1	SLT02	Ambakelle	M. Delorme	2002	144
India	IND015	SLT		Kasaragod	1939	11
India	IND015 R1	SLT		Kasaragod	1990	13
India	IND015 R2	SLT		Kidu	2001	90
Jamaica	CIB SLT	SLT		CIB	1966	NULL.
Solomon Islands	YSI SLT	SLT		RIPEL	1965	43
Thailand	CHRC010	SLT02	Ambakelle	Chumphon	1965	133

Sri Lankan researchers have collected many SLT populations across their country. They have been working on this germplasm with the help of a PhD internship partly funded by CGIAR research program FTA. As explained in the box below, Sri Lankan researchers will have to make decision about the future of these populations.

International cultivar names may evolve with time. For instance, researchers from Vanuatu, a Melanesian Archipelago, gave population names to the many Tall-type accessions they collected, under the cultivar “Vanuatu Tall”: Pélé, Nipeka, Waluembue, Walanaro, etc... Researchers will observe in the genebank the characteristics of these populations, using morphological, productivity and molecular traits (DNA analysis). For instance, if the population "Vanuatu Tall Nipeka" proves to have distinct traits, its name will have to evolve: it will be renamed as a new cultivar, probably “Nikepa Tall”. On the other hand, if the populations "Vanuatu Tall Waluembue" and "Vanuatu Tall Walarano" prove to be identical, these accessions or cross between selected palms of these accessions could be merged under one name only, to be chosen by curators; when the accessions will have to be regenerated, the two accessions will be merged, as there is no need to conserve the same germplasm as two separate accessions.

If for instance, the population *Thatin* (SLT83) is proven to be an interesting distinct cultivar, they will have to change the status to rename this population: The SLT population “Sri Lanka Tall *Thatin* (SLT083)” will probably become the new cultivar Thatin Tall (THIT). If such an evolution occurs, and if Sri Lankan researchers agree to release this new cultivar in the public domain or to exchange it, THIT will also have to be conserved as three accessions located in three countries on three continents.

On the other hand, if some of the other SLT populations prove to be similar (for instance: SLT15, SLT16, SLT17 namely *Palugaswewa*, *Pitiyakanda* and *Razeena*), Sri Lankan researchers will have to make the decision to merge these populations or discard some of them from the accessions conserved by their national genebank.

Which cultivars need triplication?

Some cultivars are found only in one genebank while some other cultivars are conserved in more than 15 countries. According to the CGRD, among the 338 living cultivars conserved in COGENT *ex situ* genebanks:

- 269 are conserved in only one country, thus they would ***theoretically*** need to be transferred in 2 more countries,
- 25 more cultivars are conserved in 2 countries so these would ***theoretically*** need to be transferred to only 1 genebank,
- 44 cultivars are already conserved in at least 3 countries.

So ***theoretically*** 563 accessions need to be moved internationally.

A comprehensive and documented list of the coconut cultivars presently conserved in *ex situ* genebanks has been released on the COGENT website[18]. Among the cultivars

[18] See the URL: http://www.cogentnetwork.org/images/FAQ/2012_04_419_cultivars_ranked_by_names.pdf

conserved in only 1 country, 11 are conserved with only 1 to 5 living palms, and 58 Tall-types are conserved with 6 to 40 living palms, values which remain far below the recommended standard size for effective conservation. For some of these cultivars, the first priority will be to increase their genetic bases by re-collecting seednuts, embryos or pollen from farmers' fields. Some of these cultivars with low palm numbers are at risk of being also discarded from the list of cultivars to be internationally conserved if they are deemed to have no special advantageous characteristics.

A few cultivars will also be kept by the countries which do not want to share this particular germplasm at the international level. Despite the problems encountered with international genebanks, COGENT past experience indicates that this case will not be very frequent *if the countries receive germplasm from abroad* in exchange to their own cultivars.

As discussed in section 2.3.6, there is another level of analysis which is not yet fully implemented: choosing among accessions conserved under different names but which are appear genetically similar, although molecular analysis must be supported by phenotyping and other means to avoid the risk of excluding epigenetically-based diversity. So in order to avoid additional and unnecessary duplication, there is a need to prioritize deploying a three-step approach:

1. Improve the data available in the CGRD. For instance, Mexico recently obtained many varieties from Côte d'Ivoire, but this transfer was not registered in CGRD. In order to rationalize conservation at global level, it is highly recommended that all the germplasm movements be appropriately registered in CGRD and done through SMTA or at least MTA in order to be registered at the Treaty level. If not, this will conduct COGENT to undertake useless international transfers of cultivars which are already adequately triplicated.
2. Increase the characterization and evaluation level of selected accessions. This will include field observations, assessment of quality traits and genomic analysis. Encourage capacity building and/or technology transfer on coconut genomic analysis for regions that have established laboratories and or regions that could afford to establish genomic facilities.
3. Coordinate at COGENT level the germplasm movements for conservation purposes with the best common interest of both member-countries and the global conservation approach.

As discussed in section 2.6.3, from a global perspective, access to crop genetic resources has been recently subject to various forms of exclusive technological and legal restrictions. COGENT's opinion is that *promoting the Treaty at the international level should not become a constraint that limits germplasm exchanges*. During the past 15 years, COGENT's practical experience shows that some countries that placed coconut germplasm in the public domain have released little or no germplasm to other countries, whereas some countries working under a bilateral or multilateral exchange system have exchanged and shared a considerable amount. *The procedure for a set of accessions, or even a single accession, to be released into the public domain should also be optimized, streamlined, and published as an international guideline* and facilitated through the COGENT website. Beyond the Multilateral System (MLS), other systems for exchanging germplasm already exist at local and national levels (traditional and cultural exchanges in the Pacific and in Africa for example). Other movements like the Open Source Seed Initiative[19] are emerging today and moving material in some countries. In the future, COGENT will try to keep its members informed of these initiatives.

International management of the cultivar Sri Lanka Tall

In the specific case of the cultivar "Sri Lanka Tall", global triplication is already achieved. The most renowned SLT population is *Ambakelle* (SLT02). In fact Ambakelle is a large isolated seed garden, interplanted with Dwarf varieties and SLT, which have produced tens of millions of hybrids and Tall-type seednuts from the 1940s.

This seedgarden is still active, with more 1,600 living palms of Sri Lanka Tall *Ambakelle*. For conservation purposes, Sri Lankan researchers have also regenerated 81 palms of SLT02 in a distinct conservation site (Pothukulama). So ***Sri Lanka is obviously the first component of the triplication system.*** Although in Sri Lanka, SLT02 is not under international mandate, this population was already released from Sri Lanka to many countries.

In Côte d'Ivoire, SLT02 was planted in 1972, regenerated in 2002, and is under international mandate. Côte d'Ivoire was very active in releasing coconut germplasm. Although the lethal yellowing disease is now at about 150 km from the genebank, ***Côte d'Ivoire can be considered as the second component of the triplication system***.

In India, the SLT accession held at the Kidu International genebank is under international mandate. In 1939, only 11 palms were planted at Kasaragod, Kerala. This initial introduction was regenerated in 1990 by planting only 13 palms, again at Kasaragod. In 2001, the palms available in Kasaragod were used to plant 90 palms at Kidu. The three successive regenerations are still alive in the field. This population was named SLT and not SLT02. India never released this population to another country. The accession has a narrow genetic basis and its genetic integrity is questionable[1]. So, at this stage, and although this accession is under international mandate, ***this 'SLT' population cannot be considered as part of the triplication system*** If needed, India could renew its accession by importing pollen from Sri Lanka.

The SLT02 accession held in Thailand was obtained from open pollinated seednuts harvested in the isolated Ambakelle seed garden. The palms are 48 years old, Thailand does not have the skills for conducting mass controlled hand-pollination on such tall palms, and the accession is not under international mandate. However, ***Thailand could be considered as part of the triplication system***. The accession held in Solomon Islands is very old; as no recent information was transmitted by curator, and we do not know if the palms are still alive in the field.

In the present situation, a country requesting SLT02 would probably obtain a ***lot of embryos from open pollinated seednuts harvested in the Ambakelle Seed garden*** in Sri Lanka[2], or a more costly lot from controlled pollination produced in Côte d'Ivoire.

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[1] It would be necessary conduct a molecular study (by using the 15 SRR markers kit) in order to understand the composition and pedigrees of SLT accessions in India, and to compare them to the SLT accessions presently held in Sri Lanka and Côte d'Ivoire. From this study, and from the comparison of the field characterization data, a decision could be made to include the accession conserved in India in the triplication system.

[2] So the isolated Ambakelle seed garden, initially designed for seednut production, will be used *de facto* for conservation and multiplication purposes, avoiding the need to reproduce this accession by using expensive controlled hand-pollinations.

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[19] http://osseeds.org/

Such a global triplication process needs again to be precisely quantified, but *would aim to move about 250 accessions within a period of ten years*. A possible strategy could be for international donors to pay for preparing and sending the germplasm (embryos or plantlets cultivated *in vitro*), and for the interested recipient countries to assume other costs (from reception of embryos or plantlets cultivated *in vitro* to palms growing in the field).

Coordinating and implementing the triplication process

Coordinating and implementing these germplasm transfers will have to integrate the following aspects:

- The countries' willingness to release their germplasm, be it in the public domain or under a bilateral or multilateral exchange system.
- The curators' and breeders' knowledge of the germplasm they conserve and use, part of it being made accessible in the CGRD.
- The curators' and breeders' preferences for germplasm they would like to receive.
- The status of accessions: is there a sufficient number of living palms? Is this accession conserved in a place free from lethal disease(s), or transferred with a technique ensuring that the disease(s) will not be transmitted? This last point is first under the responsibility of the germplasm provider, but is also addressed via the quarantine sites.
- The characterization and evaluation data of these accessions, including field data and genomic, transcriptomic, proteomic and metabolomic analyses when available.
- The requirements in terms of global efficiency of the conservation. The international system would not pay for the same germplasm to be conserved in more than three countries. The requests from curators can be different from was it needed for global conservation: for instance, many curators could ask for receiving the Rennell Island Tall, when this cultivar is already well conserved at global level.
- The willingness of countries to place the received germplasm in the public domain. Countries that place the received germplasm in the public domain will be favoured for the exchanges devoted to conservation purposes at global level.

The higher costs of cryopreservation is due to the higher number of embryos needed. It is not expected that the improvement of the technique will allow a great reduction of embryo numbers to be preserved: *one* cryogenebank is generally constituted by *two* sets of similar accessions; lots of embryos should also be made available for regeneration and for the genebanks which will request the germplasm. Cryo genebanking is discussed in the next section.