ICG - LAC APPRAISAL

RATIONALE

Generally, the concern for conservation is focused on preventing loss of crop genetic diversity worldwide. Hence, international agreements have been designed to encourage preservation of genetic diversity and promote the exchange of germplasm. The FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITGRFA) oversees the activities related to the exchange of germplasm for crops, however, effective implementation has been hampered often by lack of consensus among the parties under the treaty on the issue of the value of genetic resources. Thus, challenges of conservation must be addressed to ensure the sustainability of the conservation activities and exchange of germplasm, especially in the case of coconut, being an economically important and long-term perennial crop.

It is a recognized fact that crop genetic resources play a vital role in addressing challenges of agricultural productivity. But, based on the report of a General Accounting Office (1997) study, it is found that current conservation efforts may fall short of what scientists believe are necessary levels for future crop breeding needs, suggesting a need for a more active role for public policy. These are policy initiatives could include broad-based programs of multilateral and bilateral financial assistance, stronger intellectual property rights, and international agreements for germplasm exchange. In the case of coconut, the role of COGENT in achieving stated goals is crucial. COGENT as a conservation network for coconut intends to achieve these two-pronged objectives in safeguarding the existing ICGs and NCGs 1) towards improving productivity and 2) protecting coconut biodiversity for future generations. However, the economic importance of conservation in relation to the use of coconut must be assessed to be able to establish the economic relevance of conservation. As such, for this appraisal, the focus is not only on the technical aspects, but also on inclusion of economic valuation and policy implication, to achieve a comprehensive appraisal.

The main goal establsihing these ICGs is to protect and conserve coconut germplasm for future generations. In the treaty between the host countries of the ICGs, the International Plant Genetic Resources Institute (IPGRI), now Bioversity International and the FAO, placing coconut germplasm collections under the auspices of FAO. (Annex 01). Each ICG has been assigned its member countries.depending on the geographical location of the countries desiganted germaplasm as stipulated in the FAO-ITGRFA.

Further to the abovementioned Treaty, another agreement has also been signed between COGENT and its member counties on the provision of sharing germplasm with their designated ICGs. This agreement needs to be renewed, as the agreements signed previously have automatically expired after the COGENT was moved from Bioversity International to ICC in year 2019. In 1999, COGENT which was previously under Bioversity International, has established five International Gene Banks (ICGs) across the Globe designating five member countries as the "**Host Country**"namely;

i. ICG-SEA (for South East and East Asia) in Indonesia
ii. ICG-SAME(for South Asia and Middle East) in India

iii. ICG-SP for South Pacific in PNG
iv. ICG-AIO (for Africa & Indian Ocean) in Ivory Coast
v. ICG-LAC (for Latin America & Caribbean) in Brazil

More than 1,000 coconut accessions representing more than 400 cultivars are now conserved within these International Coconut Genebanks (ICGs) and in 19 other National Coconut Genebanks (NCGs) established by COGENT member countries across the world. The aim is to support in optimizing the conservation and use of as much representative coconut diversity as possible.

COGENT conducted gene bank appraisals, in order to assess their hosting agreement status, collection status as per agreement, general maintenance status of the ICG, services & use of ICG, future targets and work plans.The first ICG appraisal of this series has been conducted and completed in September 2019 for the International Coconut Genebank for South Pacific (ICG-SP) in Papua New Guinea (PNG) and the second ICG appraisal was organised for the International Coconut Genebank for Africa and Indian Ocean (ICG-AIO) in January 2021. The corresponding appraisal reports are being finalized.

It is for this reason that standard ICG appraisal guidelines must be developed for explicit assessment of the status and the challenges in the establishment and its management. Empirical data and non-subjective observations must be considered in the process to formulate strategic recommendations aligned to the set of objectives and agreements under the duly signed Memorandum of Understanding (MoU) and as stated in the ITGRFA of FAO.

Objectives

a. Review the status of hosting agreements to ensure legal and institutional support
b. Assess the effectiveness and efficiency of the management, operations, facilities, and activities of each of the ICGs.
c. Assess the roles, services and use of the ICGs, and the linkages with users and other partners.
d. Review the status of the ICGs with respect to performance targets and the feasibility of proposed work plans to achieve the targets.
e. Consider the status of individual collections maintained by the ICGs in the context of a global system for long-term conservation and use of the selected coconut accessions in question.
f. Provide actionable recommendations and pathways for the strengthening of the ICGs' operations within the host Government framework and their linkages to COGENT member countries based on perceived country needs.

BACKGROUNDER

Brazil is the largest and most populous country in South America. Bounded by the Atlantic Ocean on the east, Brazil has a coastline of over 7491 km. It is bordered on the north by Venezuela, Suriname, Guyana and the overseas department of French Guiana; on the northwest by Colombia; on the west by Bolivia and Peru; on the southwest by Argentina and Paraguay and on the south by Uruguay. Numerous archipelagos in the Atlantic Ocean are part of the Brazilian territory.

Coconut growing is important for the economies of north-eastern and northern Brazil, accounting for approximately 82% of the country's production. Brazil ranks fifth among the coconut producing countries in the world (FAO 2002). Coconuts are planted from the northern State of Roraima to the State of Paraná in the south, with high concentrations in the coastal line from Pará to Rio de Janeiro. Coconuts are cultivated in the most `diverse soil, climate and management conditions. The most utilized coconut parts are water from the green coconut (tendernut) and the fresh meat from the mature nut. The use of coconut by-products in Brazil is still very limited.

Populations of Tall coconut palms introduced by the Portuguese in the 16th century spread through the north-eastern coastal zone, adapting themselves to various environmental conditions to create different ecotypes (Ribeiro et al. 1995). The Brazilian Agricultural Research Corporation (EMBRAPA) collected, characterized and conserved the genetic variability of these populations, and used them for developing superior hybrids with better production traits and quality, adapted to different Brazilian agroecological zones. Brazil has established a coconut genebank in the State of Sergipe to serve EMBRAPA´s coconut improvement programme. There is now a commitment to upgrade this genebank to become an International Coconut Genebank for Latin America and the Caribbean (ICGL-LAC) with the support of the Bioversity International and the International Coconut Genetic Resources Network (COGENT) now transferred under the auspices of the International Coconut Community (ICC).

ICG-LAC is the center of coconut ex-situ conservation of genetic resources and biodiversity protection for Latin America and the Caribbean. It serves as the core source of quality genetic material for mass propagation and varietal improvement in this region. Brazil as the host country of the international genebank, and as repository of the germplasm for the ICG-LAC, It is committed to: a) regenerate, conserve and identify national, regional, and international coconut populations, b) should assess the diversity and performance of the conserved germplasm and disseminate information to coconut producing countries; make available and promote the exchange of the germplasm evaluated according to the standard protocols; c) integrate database and conduct research and training regarding coconut germplasm management. These were stipulated in an MoU between Brazil, FAO-ITGRFA and IPGRI now Bioversity in 1999 to undertake such functions.

APPRAISAL PROCESS

Since 2018, COGENT has been conducting periodic gene bank appraisals, in order to assess their hosting agreement status, collection status as per the agreement, general maintenance status of the ICG, services & use of ICG, and future targets and work plans. The first ICG appraisal of this series was conducted and completed in September 2019 for the International Coconut Genebank for South Pacific (ICG-SP) in Papua New Guinea (PNG) and the second ICG appraisal was organised for the International Coconut Genebank for Africa and Indian Ocean (ICG-AIO) in January 2021. The corresponding appraisal reports are being finalized.

For the appraisal of the ICG-LAC in Aracaju, Brazil, the technical appraisal team conducted the activity in coordiantion with the ICG-designated curators of Dr. Marcelo Fernandez and Emiliano of EMBRAPA from 28 April 15 to 21, 2022. The team was assisted by the research staff of EMBRAPA and with the support of Saulo who served as the English translator since most of the staff are Portuguese speaking.

The appraisal team met with the research staff and curators for activity briefing and the team was warmly welcomed by the by the Executive Director of EMBRAPA, Mr. Marcus Santos. The event was attended by the researchers and support staff involved in the establishment of the ICG-LAC. The Appraisal team headed by Dr. Jelfina Alouw, the ICC Executive Director and COGENT Coordinator Mrs. Erlene Manohar were interviewed by the local television network regarding the appraisal of the ICG in Brazil.

STATUS OF THE ACCESSIONS

The accessions conserved at ICG-LAC comprises local varieties and introductions from Côte d'Ivoire. There are 7 dwarf accessions and 23 tall accessions (4 duplicates). They are hosted at two Embrapa's experimental fields (Itaporanga and Betume).

The tall accessions conserved at Betume (Table 1) is an old collection and needs regeneration. Some tall accessions conserved at Itaporanga are being recovered.

Table 1. Tall accessions conserved at Betume

	Accession	Planting date	Age
1	West African Tall	1983	39
2	Malayan Tall	1983	39
3	Polynesia Tall	1983	39
4	Vanuatu Tall	1983	39
5	Rennel Tall	1983	39
6	Rotuman Tall	1983	39
7	Tonga Tall	1983	39
8	Brazilian Tall Baia Formosa	1995	27
9	Brazilian Tall Merepe	1991	31
10	Brazilian Tall Pacatuba	1995	27

11	Brazilian Tall Praia do Forte	1982	40
12	Brazilian Tall Santa Rita	1995	27
13	Brazilian Tall São José Mipibu	1991	31

A. Current Status of the Research Activities Being Conducted on the Existing Accessions and Future R&D Plans.

Aiming to increase the genetic variability and to provide a sustainable breeding program it is necessary to enrich the genebank by introducing other accessions (LYD tolerant materials, compact materials) to increase diversity into the ICG-LAC. Once all the funds for germplasm conservation, characterization, introduction and regeneration comes from EMBRAPA, additional funds are needed for the expansion of the ICG-LAC.

1. Utilization of the promising germplasm

The germplasm collections in ICG-LAC are being used by EMBRAPA in their hybridization program for varietal improvement and distribution to farmers and private sectors.

a. Dwarf x Dwarf hybrids

Twelve selected mother palms of each dwarf coconut populations of the Genebank were used: Brazilian Green Dwarf Jiqui (BGDJ). Cameroon Red Dwarf (CRD), Malaysian Yellow Dwarf (MYD) and Malaysian Red Dwarf (MRD). These last two populations were composed of six plants from Malaysia and six plants from Gramame, given the same origin and similarities between the populations. For the development of Dwarf x Dwarf hybrids, the palms were crossed palm by palm in a partial diallel scheme, unbalanced with pedigree, obtaining combinations of three plants from each population with the four other populations, including the parents, resulting in 12 hybrids per population or 48 new hybrids.

b. Dwarf x Tall hybrids

There were 12 selected mother palms of each dwarf coconut populations in the Genebank: Brazilian Green Dwarf Jiqui (BGDJ). Cameroon Red Dwarf (CRD), Malaysian Yellow Dwarf (MYD) and Malaysian Red Dwarf (MRD) used in this hybridization program. In addition, twelve palms were selected from each of these four populations: Polynesian Tall (PYT), Tonga Tall (TONT), Vanuatu Tall (VTT) and Rennel Island Tall (RIT). For the development of hybrids, the mother palms were crossed in partial diallel scheme, resulting in 16 interpopulational hybrids.

c. Synthetic

For the development of the synthetic variety 12 best plants within the four populations: Polynesian Tall, Rennel Island Tall, Tonga Tall and Vanuatu Tall were utilized. The idea is to produce synthetic variety with maternal control, to be subjected to mass selection of parental sources in order to develop a broad-based variety to meet the needs of tall coconut producers.

d. Tissue Culture

It is being developed a technique of plant tissue culture that allows the rapid production of seedlings with the same agronomic characteristics of the parents in order to expand the supply of seedlings of elite plants, hybrids and the conservation of genetic resources.

e. Cryopreservation

The long conservation of germplasm enables the implementation of genebank or safety collections complementary to the conservation on field, with less physical space demand, lower maintenance cost and propagating material for regeneration at any time of the year. Studies are being conducted on cryopreservation by vitrification of zygotic embryos; vitrification of plumules; droplet vitrification and droplet vitrification of plumules.

The utilization of the germplasm is summarized in the table 2.

Table 2. Utilization of ICG-LAC germplasm

ACTIVITY	IDENTIFIED ACCESSION *	PURPOSE	TARGET BENEFICIARIES
SELECTION	MYD; BYD; BGDJ; MRD; CRD; BRD; WAT; MLT; PYT; VTT; RTT; TONT; GBRT	Breeding	Breeding program; farmers, industry
MASS PROPAGATION			
HYBRIDIZATION	MYD; BYD; BGDJ; MRD; CRD; BRD; PYT; VTT; RTT; TONT	DxD hybrids; DxT hybrids; Synthetic hybrids.	Farmers; industry
TISSUE CULTURE	BGDJ; PB-121	Research	Breeding program
CRYOPRESERVATION	BGDJ; PB-121	Research	Breeding program

* Malayan Yellow Dwarf (MYD); Gramame Yellow Dwarf (BYD); Brazilian Green Dwarf Jiqui (BGDJ); Malayan Red Dwarf (MRD); Cameroon Red Dwarf (CRD); Gramame Red Dwarf (BRD); West African Tall (WAT); Malayan Tall (MLT); Polynesia Tall (PYT); Vanuatu Tall (VTT); Rennel Tall (RIT); Rotuman Tall (RTT); Tonga Tall (TONT); Brazilian Tall Praia do Forte (GBRT).

B. Focused Group Discussion with ICG Curators and Members of the Appraisal Team (Actual + Virtual)

a. **Probing questions**: these introduce participants to the discussion topic and encourage them to converse and feel more comfortable in sharing their opinions with the group
b. **Follow-up questions**: delve further into the discussion topic and the participants' opinions

The use of probe questions and follow-up questions during the FGD was undertaken to inspire the key informants to participate actively and share their knowledge of the status and challenges of the project, as they are the ones involved in the activities. It is therefore logical

that they should be part of the strategic planning and the operationalization of the activities that they will implement. Considering that this is the initial appraisal conducted in EMBRAPA, Aracaju, Brazil, there is a need to establish the ICG profile as the core *ex-situ* genebank conservation for the Latin America and the Caribbean Region. The information gathered in FGD provided the appraisal team of the activities undertaken in relation to the objectives of establishing the ICG-LAC. Questions asked were as follows:

- ✓ How familiar are you with ICG as a project or program of the Government of Brazil?
- ✓ What is your perception of the ICG Appraisal and what is your role in the appraisal and its purpose?
- ✓ How do you assess this process of ICG appraisal, easy and simple, not very easy but do-able, or any other comment?
- ✓ What do you think will be the benefits for the Government of Brazil having an ICG here in Manado? Any commitment that you are aware and please specify the details?
- ✓ In your opinion what is your assessment of the status of the ICG, the gaps and the needs?
- ✓ What do you think are actions needed to address the gaps which you have mentioned?
- ✓ Who will be the appropriate partners that can influence the policy makers of Brazil to support for sustainability of the ICGs?
- ✓ If we were to decide on the mechanisms to address the challenges what are those?
- ✓ Based on the recommendations of the experts what will be the priority actions for the sustainability of the ICG-LAC in Brazil?

C. Problem Analysis

This process engaged the key informants to specific issues/problems, and on how to prioritize activities based on the objectives of establishing ICGs and the role of host countries. The key informants discussed the problems in the context of their perceptions. The major issue that was raised was the series of transfer of the original ICG site as decided upon in the MoU. After discussion, the facilitator asked probing questions to identify cause and effect of these problems. All problems raised were classified into technical and non-Technical. Outputs from this activity were input in the crafting of the Participatory Action Plan (PAP).

On the perception of the ICG Appraisal, the process was clarified by the facilitator to the participants. Based on the discussion the designated curator admitted that he is struggling in complying with the required activities in the management of the ICG-LAC. Emiliano who has just started barely a year is in the transition phase of handling the ICG-LAC as curator. Marcelo

Fernandes who is the head of the research department of EMBRAPA supervised him and he was assisted by two field supervisors who are more knowledgeable of the activities in the ICG-LAC farm. Emiliano presented the needed information and briefed the appraisal team of the status and encountered challenges in his current responsibility. In this activity they served as the key informants and/ or resource persons. Just like any assessment, they perceive the appraisal as a way of knowing the status of the genebank or the plantation in order to determine what could be done to improve it.

On the benefits of ICG-LAC for EMBRAPA of having an ICG-LAC. Based on the discussion they are aware of the potential benefits of the ICG to the institution. As expected, the ICG-LAC plantation is regarded seen as source of material for breeding or hybridization work. The FGD revealed that compliance to the ICG-LAC required activities is dependent to the assigned responsibilities in the institution where they work. As per commitment of the government of Brazil through EMBRAPA, the commitments of the key informants is in accordance to their duties as research staff of EMBRAPA.

On the issue of the status of the ICG-LAC, based on the assessment of the key informants the ICG-LAC according to the key informants is a major program of EMBRAPA. Currently, labor for maintenance of the plantation is moderately maintained and regular monitoring is in place. However, direct supervision is not on regular with activities unattended. The two farm managers directly involved in the operations and maintenance of the plantation are aware of the details of the ICG-LAC activities as a program. However, the rules of germplasm exchanges among member countries are not clear to them.

The researchers who attended the FGD have the knowledge and direct support to care for the accessions in the ICG-LAC. Problems raised are in relation to stability of support of EMBRAPA and the transition period in transferring the responsibilities. But, research support was provided in relation to conservation of the accessions of which a pending release of the fund balance has to be settled through ICC-COGENT interference. In the problem analysis, FGD participants are keen to be involved in the proposed plans, but the need to have clear guidelines and appropriate guidance from ICC-COGENT. In the discussion, the promotion of the ICG-LAC was made clear as the logical approach to influence the policy makers to support the ICG-LAC for long term and in understanding the importance of the genetic collections.

D. Participatory Action Planning (PAP)

Action Plans were prepared by EMBRAPA researchers indicating the specific activities, details, objectives, timelines, responsible unit/person(s) and the needed support to ensure implementation. The facilitator of the PAP provided the list of recommendations per activity and discussed on how it will be undertaken. The participants rationalized the conduct of way forward activities during the presentation of outputs of the workshop and interactive deliberation and the appraisal team provided reactions, comments, or suggestions in enhancing the **ACTION PLAN** as the major component of the **ICG APPRAISAL REPORT.**

ACTION PLAN

As reported by Dr. Marcelo Fernandes, a pending release of the funds from the Brazil government has to be facilitated to be able to use the funds for the proposed activities to be carried out with resources (LoA, US$ 16,000.00) which is already in account. The need to have an updated Memorandum of Agreement (not yet available due to lack of agreement in force) with ICC-COGENT.

The activities to be undertaken as per Workplan of the US$ 16,000.00 budget

a) Regeneration and transfer of the tall coconut accessions from Betume Experimental Field to Itaporanga Experimental Field:

- Establish a protocol for the transfer of tall accessions;
- Recover plant vigor with intensive fertilization and phytosanitary management, take advantage of the beginning of the rains (May 22 to April 23);
- Pollination (May 23 to Dec 23);
- Seed collection and nursery (May 24 to Dec 24);
- Planting of regenerated accessions in Itaporanga Experimental Field (Jul 24 to Mar 25).

b) Seed production for germplasm exchange with other ICGs and national collections, according to COGENT conservation priorities.
- Opportunity to multiply key accessions to COGENT using the same pollination operations for the regeneration and transfer of the genebank from Betume to Itapotanga experimental field (May to Dec 24);
- Opportunity to strengthen the links with other ICGs or national Collections for the exchange and introduction of key accessions to the Brazilian breeding program.

The main activities performed at ICG-LAC are the maintenance, characterization, evaluation, documentation, breeding, and use of conserved accessions. The maintenance is made in accordance with the cultural practices recommended for coconut (weeding, fertilizing, irrigation, pest control). Embrapa provides about US$12.000 by year to the maintenance of the genebank. Characterization, evaluation and documentation is made palm by palm and under observation of the descriptors list. The documentation is realized in the Brazilian genetic resource data platform “ALELO”. Some of these accessions are being used on the breeding program and on the development of tissue culture and cryopreservation protocols.

Others activities to be carried out at Aracaju, Betume and Itaporanga Experimental Fields.

- Pest and disease diagnosis and control;
- Weeding, fertilizing and irrigation;
- Germplasm evaluation and characterization;
- Germplasm data management;
- Breeding;
- In vitro tissue culture research;
- Cryopreservation research.

TECHNICAL OBSERVATIONS

1. **Status of the Germplasm Collection ICGs Based on Field Assessment of the Germplasm Collections in Betume and Itaporanga Genebanks, Aracaju, Brazil**

The International Coconut, Genebank for Latin America and Caribbean (ICG-LAC), hosted by Embrapa Coastal Tablelands, Aracaju, Sergipe, is part of the Brazilian Agricultural & Research Corporation, under the umbrella of the Ministry of Agriculture, Livestock & Food Supply, Brazil. Coconut germplasm conservation sites are located at two places, viz., Itaporanga (CEI) and Betume (CEB) in Sergipe, Brazil. In Brazil, coconut germplasm collection and introduction of germplasm was initiated in 1982, followed by coconut breeding programme during 1990. The MOA for hosting the ICG-LAC was executed with FAO/Bioversity during 2005 with Itaporanga (CEI) as the new genebank location. The old germplasm collections, undertaken during 1980s, are planted at Betume (CEB).

The Itaporanga farm of Embrapa Coastal Tablelands, is spread over 300 hectares, of which only a small area is under coconut plantation, including germplasm, parental blocks, breeding lines and hybrid evaluation trials. As envisaged under the MOA for establishment of the ICG-LAC, the following are the designated germplasm to be conserved.

List of designated germplasm for ICG-LAC

Number	Name	Origin	Status
Talls			
001	BRT Praia do Forte	BA	Planted in 2000/Conserved at Itaporanga
002	BRT Olho de Cravo	SE	Planted in 2005/Conserved at Itaporanga
003	BRT Senador Georgino Avelino	RN	Planted in 2005/Conserved at Itaporanga
004	BRT Barreirinhas	MA	Planted in 2005/Conserved at Itaporanga
005	BRT Santa Rita	PE	Planted in 2005/Conserved at Itaporanga
006	BRT São José do Mipibu	RN	Planted in 2005/Conserved at Itaporanga
007	BRT Luiz Correia	PI	Planted in 2005/Conserved at Itaporanga
008	BRT Baia Formosa	RN	Planted in 2005/Conserved at Itaporanga
009	BRT Merepe*	PE	Planted in 2002/Conserved at Betume
010	BRT Pacatuba*	SE	Planted in 2002/Conserved at Betume
011	Polynesian Tall* ***	Polynesia	Planted in 85/Conserved at Betume
012	Tonga Tall* ***	Tonga	Planted in 85/Conserved at Betume
013	Rotuman Tall* ***	Rotuman	Planted in 85/Conserved at Betume
014	VTPVanuatu Tall* ***	Vanuatu	Planted in 85/Conserved at Betume
015	MLT Malaysian Tall* ***	Malaysia	Planted in 85/Conserved at Betume
016	West African Tall* ***		Planted in 85/Conserved at Betume
Dwarfs			
001	BGD Jiqui (green) **	RN	Planted in 1984/Conserved at Betume and Itaporanga
002	BRD Gramame (red) **	PB	Planted in 1984/Conserved at Betume and Itaporanga
003	BYD Gramame (yellow) **	PB	Planted in 1984/Conserved at Betume and Itaporanga
004	MRD Malaysian Red Dwarf** ***	Malaysia	Planted in 1984/Conserved at Betume and Itaporanga
005	MYD Malaysian Yellow Dwarf** ***	Malaysia	Planted in 1984/Conserved at Betume and Itaporanga
006	CRD Cameron Red Dwarf** ***	Cameron	Planted in 1984/Conserved at Betume and Itaporanga

* It will be replanted in Itaporanga.
** It was replanted in Itaporanga in 2003.
***Obtained from Côte d'Ivoire

At Itaporanga, six dwarf accessions viz., Brazilian Green Dwarf Jiqui, Malayan Yellow Dwarf, Malayan Red Dwarf, Cameroon Red Dwarf, Gramame Yellow Dwarf, Gramame Red Dwarf, planted during 2003. These dwarf accessions, are part of the designated list of germplasm and have been regenerated from the earlier germplasm conserved at Betume farm of Embrapa Coastal Tablelands. The dwarf palms are planted at a spacing of 7.5 m with sufficient replications, and population size of more than 45 palms, the standard size recommended for dwarf populations. In addition to the six dwarfs, a population of Brazilian Green Dwarf Souza is also conserved. As per the information shared by the curator, the population size of the Brazilian Dwarf accessions is more than 100 palms per accession, while the rest of the accessions are represented with about 48-70 palms (as listed in the table below). However, the population size based on the existing living palms may be lesser, as many gaps are observed in the plots, owing to death of the palms following pest/disease incidence.

Conservation Status of Dwarf Coconut Germplasm at Itaporanga

Sl No	Acession	Age of palms (years)	No. of palms based on Alleo database
1	Malayan Yellow Dwarf	19	71
2	Gramame Yellow Dwarf	19	71
3	Brazilian Green Dwarf Jiqui	19	110
4	Brazilian Green Dwarf Souza	19	116
5	Malayan Red Dwarf	19	48
6	Cameroon Red Dwarf	19	78
7	Gramame Red Dwarf	19	80

In addition to the seven dwarf accessions, 10 Brazilian Tall accessions are conserved in this genebank. These include the Brazillian Tall Terra do Rei, Brazillian Tall Avenida, Brazillian Tall Baia Formosa, Brazillian Tall Barreirinhas, Brazillian Tall Luis Correa, Brazilian Tall Olho de Cravo, Brazillian Tall Praia do Forte, Brazillian Tall Santa Rita, Brazillian Tall São José Mipibu and Brazillian Tall Senador Georgino Avelino. Of these, eight are designated tall germplasm, while Brazilian Tall Terra do Rei and Brazilian Tall Avenida are

new accessions planted in 2009 with a population size of 90 palms, the standardpopulation size recommended for tall accessions. Among the designated tall germplasm, only Brazilian Tall Praia do Forte is represented by a large population size of 157 palms. Three of the designated germplasm namely, Brazillian Tall Senador Georgino Avelino, Brazillian Tall Baia Formosa and Brazilian Tall Olho de Cravo have a critically low population size of less than 10 palms and require urgent attention for rejuvenation. Three other designated germplasm viz., Brazillian Tall São José Mipibu, Brazillian Tall Barreirinhas, Brazillian Tall Luis Correa and Brazillian Tall Santa Rita are represented by small population size of 23-28 palms and also need attention for regeneration and enhancing population size to the recommended level of 90 palms per accession.

Conservation Status of Tall Coconut Germplasm at Itaporanga

Sl No	Acession	Age of palms (years)	No. of palms based on Alleo database
1	Brazilian Tall Terra do Rei	13	90
2	Brazilian Tall Avenida	13	90
3	Brazilian Tall Baia Formosa	17	9
4	Brazilian Tall Barreirinhas	18	24
5	Brazilian Tall Luis Correa	18	26
6	Brazilian Tall Olho de Cravo	18	9
7	Brazilian Tall Praia do Forte	19	157
8	Brazilian Tall Santa Rita	19	28
9	Brazilian Tall São José Mipibu	19	23
10	Brazilian Tall Senador Georgino Avelino	22	4

The characterization of the dwarf accessions has been initiated at the station during 2008 and continued for 5-8 years. Observations on vegetative growth characters, inflorescence characters, fruit component traits as well as floral biology have been recorded as per standard procedures. Among the tall accessions, characterization has been undertaken for only the Brazilian Tall Praia do Forte. Production data, however, is recorded in all accessions and harvesting is undertaken once in four months.

Planting material production is undertaken at the farm and seedlings are raised in the nursery. As informed by the curator, hybridization is undertaken by team of two people, by using a 12 feet ladder for climbing the palm and undertaking emasculation, bagging, collection of male flowers and pollination activities. The male flowers are dried using oven and processed for pollen collection as per standard procedures, and stored in dessicators/refrigerator before use.

The dwarf palms are maintained under micro-drip irrigation, during the dry months from September to April. The talls being planted away from the water source are not provided any irrigation. Weed control is by application of glyphosphate at 4-5 month intervals, followed by manual wedding. NPK and Boron is applied to the basins in split doses, based on soil/leaf nutrient status, as directed by the agronomist. Palm weevil is a major pest attacking the palms and causing mortality at the Itaporanga site.

The Betume genebank site has an area of 99 ha, of which only 29 ha is planted. This site conserves older coconut germplasm collections of Embrapa and includes the two exotic dwarf (Malayan Yellow and Red Dwarf) and. In addition, six Brazilian Tall populations are conserved in this gene bank. The details of tall accessions conserved at Betume are detailed below.

Conservation Status of Tall Coconut Germplasm at Betume

Sl No	Acession	Age (years)	No. of palms based on Alleo database
1	West African Tall	39	206
2	Malayan Tall	39	35
3	Polynesia Tall	39	193
4	Vanuatu Tall	39	34
5	Rennel Tall	39	92
6	Rotuman Tall	39	80
7	Tonga Tall	39	90
8	Brazillian Tall Baia Formosa	27	43
9	Brazillian Tall Merepe	31	149
10	Brazillian Tall Pacatuba	27	51
11	Brazillian Tall Praia do Forte	40	110
12	Brazillian Tall Santa Rita	27	57
13	Brazillian Tall São José Mipibu	31	149

However, there has been considerable mortality of palms in this gene bank due to poor management coupled with severe termite and other pest attacks, especially from *Rhynchophorus palmarum* accelerating the death of palms. As stated by the farm supervisor, the palms were earlier under irrigation from 1985-2005. Presently onl y production data is recorded on these palms. Most of the palms, especially the first batch of planting (1980s), are very tall and many palms are showing signs of senility. The tall palms are planted at a spacing of 9 m, with populations size of 160 palms/ha. Some of the accessions at Betume, viz., the dwarfs and the Brazilian Tall populations have been regenerated and planted at the Itaporanga genebank site. The exotic talls viz., Vanuatu Tall, West African Tall, Malayan Tall, Polynesia Tall, Rennel Tall, Rotuman Tall, Tonga Tall are proposed for regeneration and planting in the Itaporanga genebank site in subsequent years, subject to fund availability. However, among these exotic talls, the number of living/productive palms of the Malayan Tall as well as Vanuata Tall is very less. Further, the height of the palms as well as the poor state of health of many of these tall accessions could be a challenge in the rejuvenation process.

Germplasm Exchange

No germplasm has been exchanged in recent years. Three exotic dwarf accessions viz., Malayan Yellow Dwarf, Malayan Red Dwarf, Cameroon Red Dwarf and the seven exotic tall accessions namely, West African Tall, Malayan Tall, Polynesia Tall, Vanuatu Tall, Rennel Tall, Rotuman Tall, Tonga Tall, were originally obtained from CNRA Cote d'Ivoire in the early 1980s and conserved in the field gene bank at Betume.

Researchers from EMBRAPA have visited Mexico to study the Lethal Yellowing Disease tolerant coconut varieties available in that country. However, owing to concern about the LYD disease, no germplasm has been obtained from any of the regional member countries for conservation in the ICG-LAC. Hence the ICG-LAC does not represent the coconut diversity of the region.

Utilization of Conserved Germplasm

Conserved germplasm is being utilized in the breeding programme for development of varieties with higher productivity, for standardization of tissue culture protocols for mass propagation of elite lines and also for developing complementary germplasm conservation strategies viz., zygotic embryos and pollen. In addition to production of the planting material of the Brazilian Green Dwarfs and the released hybrids using dwarfs and Brazilian Tall populations viz., BRS001, BRS002, BRS003 and the Jiqui hybrid. In recent years new programmes have been initiated and are enumerated below.

Utilization of ICG-LAC Germplasm

Activity	Identified Accessions*	Purpose	Target Beneficiaries
SELECTION	MYD; BYD; BGDJ; MRD; CRD; BRD; WAT; MLT; PYT; VTT; RTT; RIT; TONT; GBRT	Breeding	Breeding program; farmers, industry
MASS PROPAGATION	BGDJ; BRS001, BRS002, BRS003	Commercial varieties	Farmers; industry
HYBRIDIZATION	MYD; BYD; BGDJ; MRD; CRD; BRD; PYT; VTT; RIT; TONT	DxD hybrids; DxT hybrids; Synthetics	Farmers; industry
TISSUE CULTURE	BGDJ; PB-121	Research	Breeding program
CRYOPRESERVATION	BGDJ; PB-121; GBRT	Research	Breeding program

*****Malayan Yellow Dwarf (MYD); Gramame Yellow Dwarf (BYD); Brazilian Green Dwarf Jiqui (BGDJ); Malayan Red Dwarf (MRD); Cameroon Red Dwarf (CRD); Gramame Red Dwarf (BRD); West African Tall

(WAT); Malayan Tall (MLT); Polynesia Tall (PYT); Vanuatu Tall (VTT); Rennel Tall (RIT); Rotuman Tall (RTT); Tonga Tall (TONT); Brazilian Tall Praia do Forte (GBRT).

Research conducted

Work on coconut breeding has resulted in development of hybrids involving Dwarfs with Brazilian Tall populations viz., BRS001, BRS002, BRS003 and the Jiqui hybrid. In recent years, new evaluation trials have been planted and are under evaluation: D x T combinations involving selected dwarf & exotic tall accessions; (ii) D x D combinations involving indigenous and exotic dwarfs (iii) Development of synthetic varieties using exotic talls and (iv) improvement of Brazilian Green Dwarf-Jiqui, based on request of private sector. In addition, development of parental blocks of selected dwarf and tall parents to facilitate enhanced planting material production of new varieties and planting material for rejuvenation/regeneration of germplasm accessions are in progress.

The new programmes, initiated in recent years are enumerated below.

a) Dwarf x Dwarf hybrids

Twelve selected mother palms in each of the dwarf coconut populations in the ICG-LAC at Itaporango viz., Brazilian Green Dwarf Jiqui (BGDJ). Cameroon Red Dwarf (CRD), Malayan Yellow Dwarf (MYD), Malayan Red Dwarf (MRD), have been used for development of experimental Dwarf x Dwarf hybrids. Further, in the case of the Malayan Dwarfs namely MYD and MOD, six plants from Malayan and six plants from Gramame dwarfs (Gramame Yellow Dwarf - BYD and Gramame Red Dwarf - BRD) have been used for the crossing, taking into consideration the similarities between the Malaysian and Gramame Dwarf populations and assuming to have same origin. For the development of Dwarf x Dwarf hybrids, the palms were crossed palm by palm in a partial diallel scheme, unbalanced with pedigree, obtaining combinations of three plants from each population with the four other populations, including the parents, resulting in 12 hybrids per population or 48 hybrid combinations.

b) Dwarf x Tall hybrids

Twelve selected mother palms of the four dwarf coconut populations in the Genebank viz., Brazilian Green Dwarf Jiqui (BGDJ). Cameroon Red Dwarf (CRD), Malayan Yellow Dwarf (MYD) and Malayan Red Dwarf (MRD). Four exotic tall populations viz., Polynesian Tall (PYT), Tonga Tall (TONT), Vanuatu Tall (VTT) and Rennel Island Tall (RIT) were identified for use as pollen parents and 12 palms were selected from each of these populations. For the development of hybrids, the dwarf mother palms were crossed with tall parents in partial diallel scheme, resulting in 16 interpopulation D x T hybrids.

c) *Synthetic*

Four exotic tall populations, namely Polynesian Tall, Rennel Island Tall, Tonga Tall and Vanuatu Tall have been identified for development of synthetic variety. Twelve best palms of each of these accessions have been used for producing planting material and the progenies planted in a compact block for the formation of a synthetic, with maternal control, to be subjected to mass selection in order to develop a broad-based variety to meet the needs of tall coconut producers.

d) Tissue Culture

Work on coconut tissue culture is underway, using explants of BGDJ and the PB-121 hybrid, to standardize protocols to facilitate rapid production of seedlings with the same agronomic characteristics of the parents in order to expand the supply of seedlings of elite plants, hybrids and the conservation of genetic resources.

e) ***Cryopreservation***

Cryopreservation enables long term conservation with lesser space requirement, lower maintenance cost and possibility for utilizing for regeneration of the propagating material at any time of the year. To enable safety duplications of germplasm, complementary conservations strategies are being developed, using different explants from Brazilian Green Dwarf Jiqui, PB-121 as well as Brazilian Tall populations and techniques: cryopreservation by vitrification of zygotic embryos; vitrification of plumules; droplet vitrification of plumules and pollen cryopreservation.

Germplasm Data Management

It appears that characterization data of the dwarf accessions as well as some of the tall accessions have been undertaken in earlier years. As informed by the curator, the characterization data recorded earlier is entered in Allelo database. The data was not available with the present curator as well as at the gene bank site for perusal.

Recommendations

Coconut germplasm conserved under the International Coconut, Genebank for Latin America and Caribbean (ICG-LAC), hosted by Embrapa Coastal Tablelands, is presently located at two places, viz., Itaporanga (CEI) and Betume (CEB) in Sergipe, Brazil. The institute has large area available for planting and also expansion of the genebank at the Itaporanga site. There is an urgent need to rejuvenate the tall germplasm available at Betume, for conservation at the Itaporanga site. Possibility of having uniform management for tall and dwarf accessions conserved in the gene bank needs to be considered, since growth and yield projections will vary based on the management of the palms. The coconut germplasm wealth in the ICG-LAC, Brazil is very limited and regional diversity is not represented owing to concerns about lethal yellowing disease existing in most countries of Central America and the Caribbean Islands. Possibility of obtaining regional germplasm from Lethal Yellowing disease free regions may be explored, subject to phytosanitary clearance/quarantine regulations.

BREEDING REPORT FOR COGENT'S APPRAISAL OF THE INTERNATIONAL COCONUT GENEBANK FOR LATIN AMERICA AND CARIBBEAN, ARACAJU, SERGIPE, BRAZIL

Introduction

International Coconut, Genebank for Latin America and Caribbean (ICG-LAC), hosted by Embrapa Coastal Tablelands, Aracaju, Sergipe, is part of the Brazilian Agricultural & Research Corporation, under the umbrella of the Ministry of Agriculture, Livestock & Food Supply, Brazil.

Status of Accessions

Coconut germplasm conservation sites are located at two places, viz., Itaporanga (CEI) and Betume (CEB) in Sergipe, Brazil. In Brazil, coconut germplasm collection and introduction of germplasm was initiated in 1982, followed by coconut breeding programme during 1990. The MOA for hosting the ICG-LAC was executed with FAO/Bioversity during 2005 with Itaporanga (CEI) as the new genebank location. The old germplasm collections, undertaken during 1980s, are planted at Betume (CEB).

The Itaporanga farm of Embrapa Coastal Tablelands, is spread over 300 hectares, of which only a small area is under coconut plantation, including germplasm, parental blocks, breeding lines and hybrid evaluation trials. As envisaged under the MOA for establishment of the ICG-LAC, the following are the designated germplasm to be conserved.

List of designated germplasm for ICG-LAC

Number	Name	Origin	Status
Talls			
001	BRT Praia do Forte	BA	Planted in 2000/Conserved at Itaporanga
002	BRT Olho de Cravo	SE	Planted in 2005/Conserved at Itaporanga
003	BRT Senador Georgino Avelino	RN	Planted in 2005/Conserved at Itaporanga
004	BRT Barreirinhas	MA	Planted in 2005/Conserved at Itaporanga
005	BRT Santa Rita	PE	Planted in 2005/Conserved at Itaporanga
006	BRT São José do Mipibu	RN	Planted in 2005/Conserved at Itaporanga
007	BRT Luiz Correia	PI	Planted in 2005/Conserved at Itaporanga
008	BRT Baia Formosa	RN	Planted in 2005/Conserved at Itaporanga
009	BRT Merepe*	PE	Planted in 2002/Conserved at Betume
010	BRT Pacatuba*	SE	Planted in 2002/Conserved at Betume
011	Polynesian Tall* ***	Polynesia	Planted in 85/Conserved at Betume
012	Tonga Tall* ***	Tonga	Planted in 85/Conserved at Betume
013	Rotuman Tall* ***	Rotuman	Planted in 85/Conserved at Betume
014	VTPVanuatu Tall* ***	Vanuatu	Planted in 85/Conserved at Betume
015	MLT Malaysian Tall* ***	Malaysia	Planted in 85/Conserved at Betume
016	West African Tall* ***		Planted in 85/Conserved at Betume
Dwarfs			
001	BGD Jiqui (green) **	RN	Planted in 1984/Conserved at Betume and Itaporanga
002	BRD Gramame (red) **	PB	Planted in 1984/Conserved at Betume and Itaporanga
003	BYD Gramame (yellow) **	PB	Planted in 1984/Conserved at Betume and Itaporanga
004	MRD Malaysian Red Dwarf** ***	Malaysia	Planted in 1984/Conserved at Betume and Itaporanga
005	MYD Malaysian Yellow Dwarf** ***	Malaysia	Planted in 1984/Conserved at Betume and Itaporanga
006	CRD Cameron Red Dwarf** ***	Cameron	Planted in 1984/Conserved at Betume and Itaporanga

* It will be replanted in Itaporanga.
** It was replanted in Itaporanga in 2003.
***Obtained from Côte d'Ivoire

At Itaporanga, six dwarf accessions viz., Brazilian Green Dwarf Jiqui, Malayan Yellow Dwarf, Malayan Red Dwarf, Cameroon Red Dwarf, Gramame Yellow Dwarf, Gramame Red Dwarf, planted during 2003. These dwarf accessions, are part of the designated list of germplasm and have been regenerated from the earlier germplasm conserved at Betume farm of Embrapa Coastal Tablelands. The dwarf palms are planted at a spacing of 7.5 m with sufficient replications, and population size of more than 45 palms, the standard size recommended for dwarf populations. In addition to the six dwarfs, a population of Brazilian Green Dwarf Souza is also conserved. As per the information shared by the curator, the population size of the Brazilian Dwarf accessions is more than 100 palms per accession, while the rest of the accessions are represented with about 48-70 palms (as listed in the table below). However, the population size based on the existing



living palms may be lesser, as many gaps are observed in the plots, owing to death of the palms following pest/disease incidence.

Conservation Status of Dwarf Coconut Germplasm at Itaporanga

Sl No	Acession	Age of palms (years)	No. of palms based on Alleo database
1	Malayan Yellow Dwarf	19	71
2	Gramame Yellow Dwarf	19	71
3	Brazilian Green Dwarf Jiqui	19	110
4	Brazilian Green Dwarf Souza	19	116
5	Malayan Red Dwarf	19	48
6	Cameroon Red Dwarf	19	78
7	Gramame Red Dwarf	19	80

In addition to the seven dwarf accessions, 10 Brazilian Tall accessions are conserved in this genebank. These include the Brazillian Tall Terra do Rei, Brazillian Tall Avenida, Brazillian Tall Baia Formosa, Brazillian Tall Barreirinhas, Brazillian Tall Luis Correa, Brazilian Tall Olho de Cravo, Brazillian Tall Praia do Forte, Brazillian Tall Santa Rita, Brazillian Tall São José Mipibu and Brazillian Tall Senador Georgino Avelino. Of

these, eight are designated tall germplasm, while Brazilian Tall Terra do Rei and Brazilian Tall Avenida are new accessions planted in 2009 with a population size of 90 palms, the standardpopulation size recommended for tall accessions. Among the designated tall germplasm, only Brazilian Tall Praia do Forte is represented by a large population size of 157 palms. Three of the designated germplasm namely, Brazillian Tall Senador Georgino Avelino, Brazillian Tall Baia Formosa and Brazilian Tall Olho de Cravo have a critically low population size of less than 10 palms and require urgent attention for rejuvenation. Three other designated germplasm viz., Brazillian Tall São José Mipibu, Brazillian Tall Barreirinhas, Brazillian Tall Luis Correa and Brazillian Tall Santa Rita are represented by small population size of 23-28 palms and also need attention for regeneration and enhancing population size to the recommended level of 90 palms per accession.

Conservation Status of Tall Coconut Germplasm at Itaporanga

Sl No	Acession	Age of palms (years)	No. of palms based on Alleo database
1	Brazilian Tall Terra do Rei	13	90
2	Brazilian Tall Avenida	13	90
3	Brazilian Tall Baia Formosa	17	9
4	Brazilian Tall Barreirinhas	18	24
5	Brazilian Tall Luis Correa	18	26
6	Brazilian Tall Olho de Cravo	18	9
7	Brazilian Tall Praia do Forte	19	157
8	Brazilian Tall Santa Rita	19	28
9	Brazilian Tall São José Mipibu	19	23
10	Brazilian Tall Senador Georgino Avelino	22	4

The characterization of the dwarf accessions has been initiated at the station during 2008 and continued for 5-8 years. Observations on vegetative growth characters, inflorescence characters, fruit component traits as well as floral biology have been recorded as per standard procedures. Among the tall accessions, characterization has been undertaken for only the Brazilian Tall Praia do Forte. Production data, however, is recorded in all accessions and harvesting is undertaken once in four months.

Planting material production is undertaken at the farm and seedlings are raised in the nursery. As informed by the curator, hybridization is undertaken by team of two people, by using a 12 feet ladder for climbing the palm and undertaking emasculation, bagging, collection of male flowers and pollination activities. The male flowers are dried using oven and processed for pollen collection as per standard procedures, and stored in dessicators/refrigerator before use.

The dwarf palms are maintained under micro-drip irrigation, during the dry months from September to April. The talls being planted away from the water source are not provided any irrigation. Weed control is by application of glyphosphate at 4-5 month intervals, followed by manual wedding. NPK and Boron is applied to the basins in split doses, based on soil/leaf nutrient status, as directed by the agronomist. Palm weevil is a major pest attacking the palms and causing mortality at the Itaporanga site.

The Betume genebank site has an area of 99 ha, of which only 29 ha is planted. This site conserves older coconut germplasm collections of Embrapa and includes the two exotic dwarf (Malayan Yellow and Red Dwarf) and. In addition, six Brazilian Tall populations are conserved in this gene bank. The details of tall accessions conserved at Betume are detailed below.

STATUS OF THE ICG-LAC COLLECTIONS

List of the accessions at Betume, Aracaju, Brazil. 2022

Sl No	Acession	Age (years)	No. of palms based on Alleo database
1	West African Tall	39	206
2	Malayan Tall	39	35
3	Polynesia Tall	39	193
4	Vanuatu Tall	39	34
5	Rennel Tall	39	92
6	Rotuman Tall	39	80
7	Tonga Tall	39	90
8	Brazillian Tall Baia Formosa	27	43
9	Brazillian Tall Merepe	31	149
10	Brazillian Tall Pacatuba	27	51
11	Brazillian Tall Praia do Forte	40	110
12	Brazillian Tall Santa Rita	27	57
13	Brazillian Tall São José Mipibu	31	149

However, there has been considerable mortality of palms in this gene bank due to poor management coupled with severe termite and other pest attacks, especially from *Rhynchophorus palmarum* accelerating the death of palms. As stated by the farm supervisor, the palms were earlier under irrigation from 1985-2005. Presently only production data is recorded on these palms. Most of the palms, especially the first batch of planting (1980s), are very tall and many palms are showing signs of senility. The tall palms are planted at a spacing of 9 m, with populations size of 160 palms/ha. Some of the accessions at Betume, viz., the dwarfs and the Brazilian Tall populations have been regenerated and planted at the Itaporanga genebank site. The exotic talls viz., Vanuatu Tall, West African Tall, Malayan Tall, Polynesia Tall, Rennel Tall, Rotuman Tall, Tonga Tall are proposed for regeneration and planting in the Itaporanga genebank site in subsequent years, subject to fund availability. However, among these exotic talls, the number of living/productive palms of the Malayan Tall as well as Vanuata Tall is very less. Further, the height of the palms as well as the poor state of health of many of these tall accessions could be a challenge in the rejuvenation process.

Germplasm Exchange in the Latin America and the Caribbean Regions

No germplasm has been exchanged in recent years. Three exotic dwarf accessions viz., Malayan Yellow Dwarf, Malayan Red Dwarf, Cameroon Red Dwarf and the seven exotic tall accessions namely, West African Tall, Malayan Tall, Polynesia Tall, Vanuatu Tall, Rennel Tall, Rotuman Tall, Tonga Tall, were originally obtained from CNRA Cote d'Ivoire in the early 1980s and conserved in the field gene bank at Betume.

In consideration of the MoU between FAO and IPGRI dated September 21, 19990 on the respective roles of the two organizations in establishing, maintaining and managing germplasm collections and setting standards for these collections; and considering the importance of the International Coconut Genebank held by the Government of Brazil and COGENT as supported by IPGRI as part of the global strategy for germplasm conservation, availability of germplasm exchange as stipulated in Article 10 of the MoU, the accessions should have been donated by the Latin American and Caribbean countries on the understanding that these accessions will remain freely available.

For the basic undertaking of the MoU, Article 2 states that the Government of Brazil under the auspices of FAO, as part of the International Undertaking on Plant Genetic Resources, the accessions of genetic resources listed in the Appendix hereto (hereinafter "designated germplasm"), in accordance with the terms and conditions set forth in this MoU. An updated list of designated germplasm will be provided to FAO every two years.

Hence, the Government of Brazil shall hold the designated germplasm in trust for the benefit of all countries in accordance with the International Undertaking on Plant Genetic Resources and the terms and conditions under this Agreement **(Annex C)**

Researchers from EMBRAPA have visited Mexico to study the Lethal Yellowing Disease tolerant coconut varieties available in that country. However, owing to concern about the LYD disease, no germplasm has been obtained from any of the regional member countries for conservation in the ICG-LAC. Hence the ICG-LAC does not represent the coconut diversity of the region.

Utilization of Conserved Germplasm in ICG-LAC

Conserved germplasm is being utilized in the breeding programme for development of varieties with higher productivity, for standardization of tissue culture protocols for mass propagation of elite lines and also for developing complementary germplasm conservation strategies viz., zygotic embryos and pollen. In addition to production of the planting material of the Brazilian Green Dwarfs and the released hybrids using dwarfs and Brazilian Tall populations viz., BRS001, BRS002, BRS003 and the Jiqui hybrid. In recent years new programmes have been initiated and are enumerated below.

List of identified and utilized accessions in the ICG-LAC. 2022

Activity	Identified Accessions*	Purpose	Target Beneficiaries
SELECTION	MYD; BYD; BGDJ; MRD; CRD; BRD; WAT; MLT; PYT; VTT; RTT; RIT; TONT; GBRT	Breeding	Breeding program; farmers, industry

MASS PROPAGATION	BGDJ; BRS001, BRS002, BRS003	Commercial varieties	Farmers; industry
HYBRIDIZATION	MYD; BYD; BGDJ; MRD; CRD; BRD; PYT; VTT; RIT; TONT	DxD hybrids; DxT hybrids; Synthetics	Farmers; industry
TISSUE CULTURE	BGDJ; PB-121	Research	Breeding program
CRYOPRESERVATION	BGDJ; PB-121; GBRT	Research	Breeding program

*****Malayan Yellow Dwarf (MYD); Gramame Yellow Dwarf (BYD); Brazilian Green Dwarf Jiqui (BGDJ); Malayan Red Dwarf (MRD); Cameroon Red Dwarf (CRD); Gramame Red Dwarf (BRD); West African Tall (WAT); Malayan Tall (MLT); Polynesia Tall (PYT); Vanuatu Tall (VTT); Rennel Tall (RIT); Rotuman Tall (RTT); Tonga Tall (TONT); Brazilian Tall Praia do Forte (GBRT).

Researches Conducted

Work on coconut breeding has resulted in development of hybrids involving Dwarfs with Brazilian Tall populations viz., BRS001, BRS002, BRS003 and the Jiqui hybrid. In recent years, new evaluation trials have been planted and are under evaluation: D x T combinations involving selected dwarf & exotic tall accessions; (ii) D x D combinations involving indigenous and exotic dwarfs (iii) Development of synthetic varieties using exotic talls and (iv) improvement of Brazilian Green Dwarf-Jiqui, based on request of private sector. In addition, development of parental blocks of selected dwarf and tall parents to facilitate enhanced planting material production of new varieties and planting material for rejuvenation/regeneration of germplasm accessions are in progress.

The new breeding programmes, initiated in recent years are enumerated below.

a) Dwarf x Dwarf hybrids

Twelve selected mother palms in each of the dwarf coconut populations in the ICG-LAC at Itaporango viz., Brazilian Green Dwarf Jiqui (BGDJ). Cameroon Red Dwarf (CRD), Malayan Yellow Dwarf (MYD), Malayan Red Dwarf (MRD), have been used for development of experimental Dwarf x Dwarf hybrids. Further, in the case of the Malayan Dwarfs namely MYD and MOD, six plants from Malayan and six plants from Gramame dwarfs (Gramame Yellow Dwarf - BYD and Gramame Red Dwarf - BRD) have been used for the crossing, taking into consideration the similarities between the Malaysian and Gramame Dwarf populations and assuming to have same origin. For the development of Dwarf x Dwarf hybrids, the palms were crossed palm by palm in a partial diallel scheme, unbalanced with pedigree, obtaining combinations of three plants from each population with the four other populations, including the parents, resulting in 12 hybrids per population or 48 hybrid combinations.

b) Dwarf x Tall hybrids

Twelve selected mother palms of the four dwarf coconut populations in the Genebank viz., Brazilian Green Dwarf Jiqui (BGDJ). Cameroon Red Dwarf (CRD), Malayan Yellow Dwarf (MYD) and Malayan Red Dwarf (MRD). Four exotic tall populations viz., Polynesian Tall (PYT), Tonga Tall (TONT), Vanuatu Tall (VTT) and Rennel Island Tall (RIT) were identified for use as pollen parents and 12 palms were selected from each of these populations. For the development of hybrids, the

dwarf mother palms were crossed with tall parents in partial diallel scheme, resulting in 16 interpopulation D x T hybrids.

c) ***Synthetic***

Four exotic tall populations, namely Polynesian Tall, Rennel Island Tall, Tonga Tall and Vanuatu Tall have been identified for development of synthetic variety. Twelve best palms of each of these accessions have been used for producing planting material and the progenies planted in a compact block for the formation of a synthetic, with maternal control, to be subjected to mass selection in order to develop a broad-based variety to meet the needs of tall coconut producers.

d) Tissue Culture

Work on coconut tissue culture is underway, using explants of BGDJ and the PB-121 hybrid, to standardize protocols to facilitate rapid production of seedlings with the same agronomic characteristics of the parents in order to expand the supply of seedlings of elite plants, hybrids and the conservation of genetic resources.

e) ***Cryopreservation***

Cryopreservation enables long term conservation with lesser space requirement, lower maintenance cost and possibility for utilizing for regeneration of the propagating material at any time of the year. To enable safety duplications of germplasm, complementary conservations strategies are being developed, using different explants from Brazilian Green Dwarf Jiqui, PB-121 as well as Brazilian Tall populations and techniques: cryopreservation by vitrification of zygotic embryos; vitrification of plumules; droplet vitrification of plumules and pollen cryopreservation.

f) **Germplasm Data management**

It appears that characterization data of the dwarf accessions as well as some of the tall accessions have been undertaken in earlier years. As informed by the curator, the characterization data recorded earlier is entered in Allelo database. The data was not available with the present curator as well as at the gene bank site for perusal.

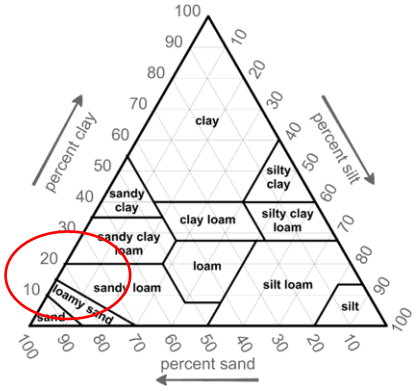
Recommendations

Coconut germplasm conserved under the International Coconut, Genebank for Latin America and Caribbean (ICG-LAC), hosted by Embrapa Coastal Tablelands, is presently located at two places, viz., Itaporanga (CEI) and Betume (CEB) in Sergipe, Brazil. The institute has large area available for planting and also expansion of the genebank at the Itaporanga site. There is an urgent need to rejuvenate the tall germplasm available at Betume, for conservation at the Itaporanga site. Possibility of having uniform management for tall and dwarf accessions conserved in the gene bank needs to be considered, since growth and yield projections will vary based on the management of the palms. The coconut germplasm wealth in the ICG-LAC, Brazil is very limited and regional diversity is not represented owing to concerns about lethal yellowing disease existing in most countries of Central America and the Caribbean Islands. Possibility of obtaining regional germplasm from Lethal Yellowing disease free regions may be explored, subject to phytosanitary clearance/quarantine regulations.

Biophysical Description of the Two Genebanks (Betume And Itaporanga)

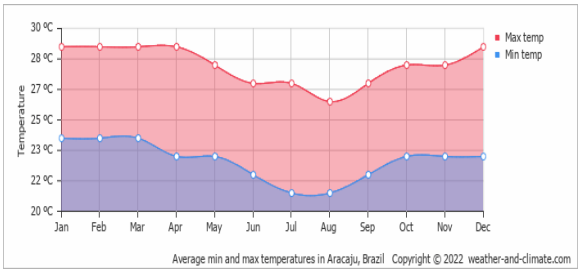
The 1,131 ha ICG-LAC is located around 11 degrees south of the equator, in **two sites** within the coastal tablelands of Sergipe state, Brazil, near EMBRAPA's agricultural research center in Aracaju city:

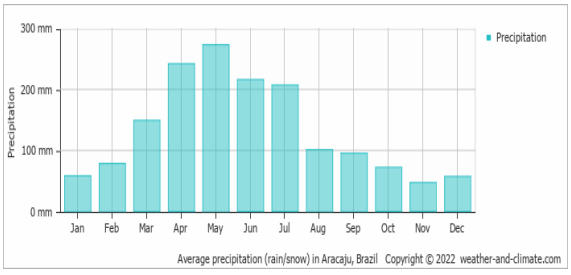
1. **Itaporanga** site is situated 30km southwest of Aracaju and comprises 1,031 hectares: 10 ha are planted to **17 accessions**, (10 Tall- and 7 Dwarf-types- see list later in the report); 360 ha set aside for research and other activities, and 670 ha allocated to the Atlantic Forest nature reserve. The whole site is surrounded by a low perimeter fence, which is damaged in places, so easily breached by opportunists. Indeed, we encountered a nut thief on leaving the site. The uniform soil texture is characterized as **sand to loamy sand** (see fig 1) with a **pH of 5**. There is a high-water table and adequate annual rainfall. The accessions appear relatively healthy, but subject to some pest and disease pressure (see section x).

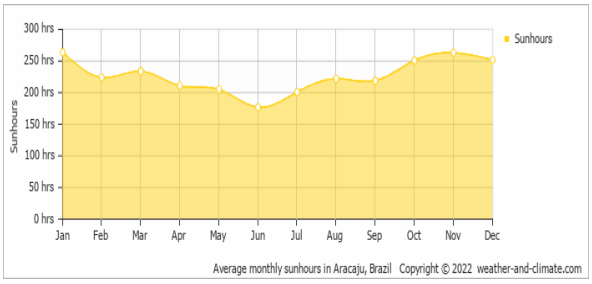


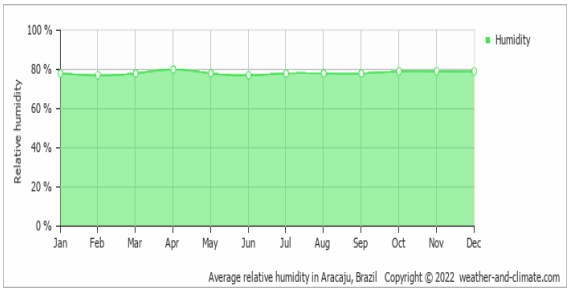
2. **Betume site**, situated in a more remote location 100km north of Aracaju, comprising 99 hectares, of which around 7 ha are planted to **13 Tall accessions**, (see list later in the report), with the remaining 92 ha set aside for grazing. The site has flimsy fencing, which has been breached, allowing opportunists to graze their cattle. This helps to control the weeds and provides some fertility from manure, but it also attracts insect pests. The uniform **sandy soil texture** is similar to Itaporanga, but with a slightly higher clay content and **pH of 6**. It is also drier than Itaporanga with high water table. The accessions seem less healthy than at Itaporanga, and display a higher palm mortality at around 8%, probably mostly due to termite damage.

Recorded Climatological Data in the two sites. 2022



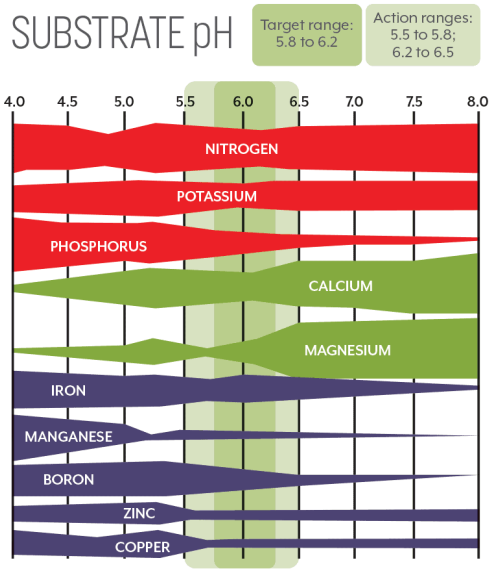






Meteorological records show that both sites enjoy climates reasonably conducive to coconut cultivation, although higher rainfall levels would be ideal. The average annual rainfall is 170cm (67 inches), with some rainfall every month, but a significantly wetter season between April and July. The temperature ranges between 21C and 29C, with a cooler period between April and October. On average the sun shines for around 250 hours per month between November and March, and around 200 hours per month between April and October (rainy season). Relative humidity remains constant throughout the year at around 80% (see fig x)

Nutritional Status and Requirements



Site soil pH is between 5 and 6, but there is little nutrient lockup on account of low soil clay content. According to fig 3, the main risk of lockup at this pH level would be magnesium and manganese. However according to routine soil and tissue sampling (following standard sampling protocols), potash (K) and magnesium (Mg) are the key nutrient deficiencies that need to be rectified.

The station staff manually apply a fertiliser mix of N,P,K, Mg, Bo, Mn, according to analysis results, at the start of the rainy season (ideally twice) within 50cm of each palm. Routine lime applications supplement Ca and Mg levels. As a sustainable means of providing nitrogen, interplanting with N-fixing *Glyceridia sp* has been trialled in Itaporanga, indicating 8 plants per row of palms is an appropriate planting density.

EMBRAPA has developed an excellent digital advisory service for coconut planting and fertilizer applications called *FertOnline* – which is available at https://www.embrapa.br/tabuleiros-costeiros/fertonline-recomendacoes-para-adubacao.

ICG's Agronomic Management Based on Good Agricultural Practice (GAP)

Our appraisal visit indicated that the ICG-LAC accessions are generally fairly well-maintained at Itaporanga, but less well managed at the more isolated Betume site. This could partly be on account of Betume being so far away, and with a staff and equipment shortage, with poorer nutrient and pest and disease status and also because Itaporanga has a higher **water** table and is drip irrigated (overnight during the dry season from September to March) using an on-site pump house and wells fed by the nearby river, whereas Betume is not irrigated. The accessions are generally **well-labelled**, and planted according to a standard triangular **spacing** regime of 7.5m for dwarf types and 9.5m for tall-types The appraisal has indicated that the accessions receive i) **adequate fertilization** (see above), ii) **adequate weed control** through mowing, and with timely glyphosate applications (also with leaves being cleaned

at harvest), and iii) **reasonable pest-control measures**, although perhaps pest and disease management could be improved with additional resources, especially human resources and equipment, and especially at Betume.

It was also observed that there are insufficient **staff** to effectively maintain the accessions. Currently the Itaporanga site employs one technician, three other staff and six apprentices, whereas it needs nine fulltime staff. In the past interns provided a valuable source of assistance, but this has been dwindling in recent years. Brazilian labor laws and recent funding cuts are constraining recruiting new, younger staff- so a succession problem is now looming, especially for Betume, where the four staff are all older and will need replacing.

Production Data

Table ___ summarizes production data provided by EMBRAPA (for accession-level production data. A comparable local commercial situation reports hybrid nut production levels in excess of 200 nuts per palm per year. For the ICG-LAC of course they only maintain dwarf and tall accessions, but according to table 1 it is likely that the productivity could be increased to 80 to 100 nuts/ palm /year for tall-types and even for some well-managed highest performing tall accessions to 240 fruits / nuts / year

Table ___ Production data of the ICG-LAC accessions. 2022

Element	Unit	Dwarfs	Hybrids	Talls
Inflorescences	number/year	15 to 20	14 to 17	12 to 17
Water content	In milliliterl	≈ 350 ml	≈ 350 ml	≈ 600
Productivity	fruits/palm/year	150 to 250	120 to 150	60 to 80
Albumen weight	In grams	250	400	350

No intercropping is currently practiced in ICG-LAC, but it seems that managing intercropping within genebanks can be problematic due to limited people in-charge of the maintenance of the genebanks. Suitable intercrops with less maintenance can be established to improve the microclimate of the sites and to generate at least additional income that can used for agronomic management of these genebanks.

Recommendations

Given EMRAPA's limited resources, the overall level of agronomic management of the accessions, at least at Itaporanga seems reasonable. However for further improvements, the appraisal team recommends the following:

1. Develop secure ICG perimeter fencing and possibly hedging.
2. Run the Itaporanga site for greater research activity and commercial gain/ income generation, and consider disaggregating/ separating the genebank from the rest of the site activities
3. Consider rationalising the ICG-LAC accessions on just the Itaporanga site, where the Betume-based tall accessions can be rejuvenated

4. Further improve water use efficiency, including perhaps straw roof shading for the irrigation pond at Itaporanga
5. More effectively address the main pest and disease concerns, including controlling mites, termites, leaf blight, and palm weevil/beetles, as well as developing a contingency plan to control coconut lethal crown atrophy disease
6. Develop and implement a robust staff succession plan so that the accessions maintenance is not further compromised in the future
7. Invest in equipment, especially a new tractor with a cab, and establish internet access for the site.

The idea in collecting the biophysical factors is for comparative assessment of the performance of the accessions in the ***in-situ*** and **ex-situ** conservation of the germplasm. These biophysical factors are significantly correlated to production and reactions to pest and diseases of the accessions such as temperature, Relative Humidity (RH) and rainfall. On the level of maintenance and stands of each of the accessions in the genebank, No severe mineral deficiencies observed on palm leaves and stand of the accessions are normal except for slight damages due to pests and diseases. Regular fertilization and provision of irrigation is necessary to improve the poor stand of the accessions. It was also noticed that the palms in two ICG-LAC sites need to be properly numbered and painted with different color codes for easy identification and accurate data collection, the need to have a standard international code system for coherence in all ICGs.

Based on the observations of the appraisal team, the ICG-LAC needs to access the fund balance from the support of the government of Brazil to EMBRAPA relative to the sustainability of the activities in the two sites of the ICG-LAC as compliance to the agreement. Other technical aspects for support of COGENT is the capacity building on the enhancement of the somatic embryogenesis protocol adopted from CICY of Mexico. It was recommended by the appraisal team to send a researcher involved in this research activity to the forthcoming workshop training on tissue culture in CPCRI, in Kerala, India. Likewise, data management, production systems and good agricultural management practices including research and income-generating activities must be considered to be able to upgrade and improve the status of the ICG-LAC.

PEST AND DISEASE MONITORING AND SURVEILLANCE REPORT

Dr. Jelfina Alouw, an entomologist by profession with doctorate degree on Entomology with Asst. Director Mridula Kottekate, a plant pathologist conducted the appraisal of the pests and diseases observed in the ICG-LAC. They also discussed with thee assigned entomologist and plant pathologist of EMBRAPA to the genebank. Based on the FGD during the visit in EMBRAPA station, pests and diseases observed in the ICG-LAC is being reported to them for identification and appropriate recommended preventive and eradicative measures. Based on the outputs of the technical FGD listed are the major pests and diseases affecting the accessions planted in the ICG.

Major Pests and Diseases, Level of Infestation, Palm Damage & Yield Losses in Itaporanga and Betume

Itaporanga

1. Coconut mites (*Aceria guereronis*, *Steneotarsonemus spp.*) attacking nuts
2. Red palm mite (*Raoiella indica*) attacking leaves
3. Whitefly (*Aleurodicus pseudogesii*)
4. *Palm weevil Rhyncophorus palmarum*
5. Three foliar diseases (Leaf blight - *Botryosphaeria cocogena* having as a teleomorph the fungus Lasiodiplodia theobromae*; Small verrucosis - Camarotella torrendiella; Large verrucosis - Camarotella acrocomiae)*

Betume

1. Coconut mites (*Aceria guereronis*) attacking nuts; red palm mite (*Raoiella indica*) attacking leaves; whitefly (*Aleurodicus pseudogesii*)
2. Termite sp.
3. *Rhynchophorus palmarum*
4. Three foliar diseases (Leaf blight - *Botryosphaeria cocogena* having as a teleomorph the fungus Lasiodiplodia theobromae*; Small verrucosis - Camarotella torrendiella; Large verrucosis - Camarotella acrocomiae)*

Figure _. Coconut infected by mites (Photo: Jelfina Alouw)

Figure 2. Nuts attacked by mite. (Photo: Jelfina Alouw)

Figure _. Leaves attacked by red palm mite (Photo: Jose Carlos Verle Rodrigues)

The fungal diseases called small verrucosis, large verrucosis and leaf blight are the predominant diseases in ICG-LAC. These diseases are widely distributed where coconut palms are cultivated in Brazil. Leaf blight is a foliar disease caused by the fungus *Botryosphaeria cocogena* having as a teleomorph the fungus *Lasiodiplodia theobromae* (synonym *Boryodiplodia theobromae*). Although it is considered an opportunistic pathogen, its attack results in great damage to plants. It penetrates the leaves of the coconut tree through wounds and through the lesions of large and small verrucosis. The symptoms caused by leaf blight are characteristic, with the initial appearance of an inverted "V" shaped lesion. Then, the disease develops and takes over the entire leaf area, resulting in necrosis and consequent leaf death (Figure 4).

Figure 4. Symptoms of coconut leaf blight showing the loss of the green leaf area of the plants and consequently the number of leaves that support the bunches. (Photo: Viviane Talamini – Embrapa Coastal Tablelands)

Small verrucosis is caused by the fungus (*Camarotella torrendiella*). The symptoms are characterized by the formation of stroma on the dorsal surface of the leaflet, in an organized shape, similar to a lozenge, with small stroma, dark in color and well adhered (Figure 5).

Figure 5. Symptoms of coconut small verrucosis showing a lozenge -shaped lesions on the leaflet. (Photo: Viviane Talamini – Embrapa Coastal Tablelands)

Large verrucosis is caused by the fungus *Camarotella acrocomiae*. The symptoms are the formation of stroma that grow in the limbus and leaf rachis in a disorderly way, from dark brown to black, with variable sizes, and which are easily removed (Figure 6).

Figure 6. Symptoms of coconut large verrucosis showing the stromas on the leaflet. (Photo: Viviane Talamini – Embrapa Coastal Tablelands)

Considering the opportunistic behavior of the fungus *L. theobromae*, which causes leaf blight, whose penetration and colonization of leaves are favored by sandpaper lesions, the joint occurrence of such diseases is known as the coconut verrucosis and leaf blight complex - VLBC (Figure 7) potentiating the damage that can be caused to plants with a drastic reduction of the leaf area and causing the early loss of

leaves with consequent fall of the bunch before the harvest period, since these are supported by the leaves, causing losses of up to 50 % to production.

Figure 7. Symptoms of coconut verrucosis and leaf blight complex – VLBC. (Photo: Viviane Talamini – Embrapa Coastal Tablelands)

Research, Development and Management of Pests & Disease of Coconut in ICG-LAC by EMBRAPA

Bioactivity of cottonseed oil, soybean oil, coconut oil and essential oil had been assessed against coconut mite, *A. guerreronis* (Acari: Eriphyidae) and side effects on *Thyphlodromu*s, the predator of the pest. The research results showed that *A. guerreronis* was more susceptible to cotoonseed oil, which contain linoleic and oleic acids to repel the pests, than its predator. This research supports the use of cottonseed oil to be integrated in controlling *A. guerreronis*. Three species of predatory mites had also been studied against coconut mite. Among the three predators, *Amblyseius largoensis* proved to be the most efficient in terms of number of preys consumed and handling time. Entomopathogen *Beauveria bassiana* was also tested against adult *Rhyncophorus palmarum.* The list of research and development conducted by EMBRAPA are attached in this report.

Ongoing EMBRAPA Research and Projects:

- Diagnosis of coconut crown lethal atrophy: an emerging disease in Brazil
- Development of new coconut cultivars for the sustainability and competitiveness of Brazilian agribusiness – 2nd Phase (disease assessment)
- Studies on a Nanoviridae associated with Coconut crown lethal atrophy in the State of Pará
- Lethal yellowing of coconut trees: research and technology transfer for the implementation of the disease contingency plan in Brazil. Finished in 2021.

Pest and Disease Management Challenges

a. Relatively Low success rate of the current management technologies

EMBRAPA researchers have conducted some research on the identity, biology and ecology and management of pests and diseases. Parasitoid for mites, entomopathogen for palm weevil have been found and propagated. Low success rate of field trials compared to the laboratory trials revealed the need to do assessment on the environmental factors and application technique affecting the success rate and find out ways to improve the strategies.

b. Unidentified diseases or physiological plant problem near ICG-LAC and lack of management technology to manage the disease/problem

Some major diseases potentially become threat to the ICG-LAC includes coconut crown lethal atrophy (CCLA) , red ring nematode, hartrot and lethal yellowing disease. According to researcher from EMBRAPA, CCLA was first reported by Ferraz et al. (2012) in the state of Pernambuco. The first symptoms appear on the youngest leaves. Initially, the ends of the leaflets turn yellow, and they become necrotic and twisted. The length of the leaflets is reduced from the tip to the midrib of the leaf (Figure 8). Symptoms culminate in crown atrophy and in severe cases the plant dies. This symptomatology is observed in all varieties of coconut trees in the region, such as dwarf coconut (green, yellow and red), giant coconut and hybrids. This anomaly was detected in the states of Pernambuco, Paraíba and Pará, Roraima, Sergipe, Bahia and Espírito Santo. The etiological agent of ALCC in Brazil is under investigation, with research reports pointing to the possibility of being associated with the occurrence of a fungus, Fusarium sp. and/or a nanovirus, viruses of the Nanoviridae family. The possibility that ALCC is a biotic-nutritional complex cannot be ruled out, due to some evidence demonstrating the relationship with some nutrients such as Magnesium and Boron. Dr. Niral, a breeder from CPCRI and curator of ICG-SAME might be caused by unbalanced nutrient so she suggested to have a trial using cow urine based on experiences in India.

Figure 8. Symptoms of coconut crown lethal atrophy (CCLA). (Photo: Viviane Talamini – Embrapa Coastal Tablelands)

The red ring is caused by the nematode *Bursaphelenchus cocophilus* and causes serious damage to coconut production throughout Brazil being lethal to infected plants. Generally, the symptoms appear after the third year of implantation of the coconut plantations, when the tissue of the trunk is already formed, leaving the plants susceptible to the attack of the nematode. The disease is more common in coconut trees aged 5 to 15 years. Externally, the leaves wither, turning golden yellow, a symptom that begins at the tip of the leaflets and progresses towards the rachis. The main agent of transmission of the disease is the pest *Rhynchophorus palmarum* (Coleoptera: Curculionidae) according to GRIFFITH (1968).

Hartrot is caused by the protozoan *Phytomonas* sp., of the Trypanosomatidae family, which survives in the phloem of infected plants. The external symptoms of the foliage can be confused with those of other diseases, such as lethal yellowing and red ring, and it is therefore imperative to visualize flagellated protozoa in the phloem, especially in regions where the disease is not well known.

The lethal yellowing of coconut trees still does not occur in Brazil, being considered a quarantine pest of priority importance, occurring in countries close to Central America and the Caribbean. Symptoms are very similar to hartrot; the difference lies in the fact that, in lethal yellowing, the drop of fruits is sudden and generalized, while, in the case of hartrot, the drop is gradual. Infected plants die 3 to 5 months after the onset of first symptoms. The leafhopper *Haplaxius crudus* is the transmitting insect of lethal yellowing and has a proven occurrence in Brazil.

Recommendations

a. Monitoring pests and diseases regularly and detecting adequate levels of resistance in accessions.
b. Developing map showing pests and diseases in ICG-LAC and nearby areas to see potential threat to the germplasm collection in ICG-LAC
c. Building a reporting system based on monitoring of pests and diseases to gain government, private sectors, & farmers' supports
d. Managing pests and diseases using the best option based on scientifically proven techniques
e. Selecting the best option to conserve the collection of endangered and vulnerable coconut accessions in Betume to other locations
f. Continuously conducting research on Integrated pest & disease management, and seeking collaboration with CICY and other research institutes to develop resistant varieties to LYD and major diseases & pests
g. Using molecular tools to confirm pests and disease identity
h. Developing Biosecurity protocol for germplasm exchange among regions in Brazil and among member of ICG-LAC
i. Establishing projects to acquire resources to sustain programs to prevent lethal yellowing and other diseases that threaten ICG-LAC.
j. Establishing projects to obtain resources definition of a disease management program with a focus on ecological control.

ECONOMIC APPRAISAL

The economic value and projections of opportunities of conserving germplasm both from the local and international sources are vital in engaging the active support of the host country and its designated institution to establish and maintain the germplasm collections. Introducing the income-generating activities that can be of support to major fund requirements is worth considering. In assessing the value of ICG, the need to rationalize the investment in the collection, preservation, and management of genetic resources for provision of opportunities to the host country. In the case of the ICG-LAC investment support from the government was provided, however, sustainability of maintaining and regenerating the collections must be ensured. As such, exploring the income-generating activities such as intercropping and village-level processing of coconut-based products can hopefully augment considerably the investment to have the continuity of the needed funds to rehabilitate and regenerate the accessions of the ICG-LAC in the long term targets.

However, it is imperative to achieve a near-complete collection of the designated germplasm as committed in the MoU, in a cost-efficient manner. Prompt measures to undertake steps towards acquisition of the uncollected materials will greatly augment the value of the germplasm collection and conservation at the site. There is an express need to develop a well-designed program of collections, to make sure that costs incurred can be reasonable. There are ways and means to achieve this, and hopefully national and international investments in research related to collecting, managing, and using genetic resources should also be increased. Given the economic impacts of genetic resources, it is important that further economic studies be made to develop a more complete body of knowledge and evidence on which to base germplasm exchange policy and emerge as a successful gene bank in Latin America and the Caribbean.

Investment Costs and Fund Source

Based on Article 4 of the MoU:

"The premises, i.e. land and/or laboratories in which the designated germplasm is conserved shall remain in the charge of the Government of Indonesia". As stipulated in Article 5 of the MoU *"the Government of Indonesia undertakes to manage and administer the designated germplasm in accordance with the internationally accepted standards as agreed upon by COGENT and the International Genebank Standards endorsed by the Commission".* As such investment for the ICG-LAC as managed by EMBRAPA was provided by the government through a research grant in the total amount of US dollar _____with the remaining balance of US 16,000 to be accessed upon signing of the MoA with ICC as the principal of COGENT.

Challenges and Strategies

Results of Appraisal showed that there are gaps and needs to be addressed in ICG-LAC. Maintenance of the area needs to be improved and this will entail higher cost to be shouldered by EMBRAPA. As

per estimate, the cost of maintenance is more than the income being generated from the production of the accessions. An additional funding must be generated to augment the current income from the sales of the nut production of the existing palms. If there will be completion of planting the designated germplasm as listed in the MoU, establishment of new blocks for these new collections needs initial high investment. Strategically, as discussed in the action plan, the remaining balance from the grant to EMBRAPA by the government of Brazil is more than enough for the completion of the activities as listed in the work and financial plan prepared by EMBRAPA.

POLICIES AND AGREEMENTS

MoU Provisions

The International Treaty on Plant Genetic Resources for Food and Agriculture, (also known as ITPGRFA, International Seed Treaty or Plant Treaty) is a comprehensive international agreement in harmony with the Convention on Biological Diversity, which aims at guaranteeing food security through the conservation, exchange and sustainable use of the world's plant genetic resources for food and agriculture (PGRFA), the fair and equitable benefit sharing arising from its use, as well as the recognition of farmers' rights. It was signed in 2001 in Madrid and entered into force on 29 June 2004.

With the terms and conditions agreed between the Government of Brazil and the International Plant Genetic Resources Institute (IPGRI) represented by COGENT and the Food and Agriculture Organization of the United Nations s (FAO), compliance to the agreements should be ensured among the contracting parties. Hence, this MoU will serve as legal basis of appraisal in consultation with the institutions and designated people under the agreement.

Review of the MoU

COGENT was established in 1992 to improve coconut production on a substantial basis and to increase incomes in developing countries through improved cultivation of the coconut and efficient utilization of its products. COGENT is actively undertaking an international collaborative program with member countries to improve the conservation and use of coconut genetic resources in the following areas:

1. Establishing and maintaining an International Database on existing and future collections
2. Encouraging the protection and utilization of existing germplasm collections
3. Identifying and securing additional threatened diversity through the development and adoption of suitable technologies and conservation strategies
4. Promotion of greater collaborations among research groups in producer countries and advanced technology sources in the exchange of germplasm and the development of new techniques and

5. Appropriate training, information dissemination and securing the necessary funding.

Whereas, in Article 6 of the MoU, it emphasizes the policies wherein the Government of Indonesia and IPGRI recognize the intergovernmental authority of FAO and the Commission in setting policies for the International Undertaking and undertake to consult FAO and its Commission on proposed policy changes related to the conservation of the accessibility to, the designated germplasm, subject always to the provision of Article 9 hereinafter. The Government of Indonesia and IPGRI shall consider full consideration to the policy changes proposed by the Commission.

Legal Status of the Arrangements Between COGENT and the Hosting Country Governments in Hosting the International Coconut Gene Banks (ICGs).

The MOU signed on 26th May 1999 between the Government of Brazil hosting the ICG-LAC and IPGRI and the FAO is still in effect, as the agreement states that it is automatically renewed for further periods of 4 years unless notice of non-renewal is given in writing by either party not less than two years before the end of any of 4-year period.

However, as per the information from ICC, the agreement signed between COGENT and its member countries on sharing germplasm for the ICGs have come into termination from the date of transfering COGENT to Bioversity International, the previous host of the COGENT and now under ICC. . It is suggested that with the amendments of the MoU as prepared by FAO-ITGRFA the policy changes must be considered based on the appraisal raised by the host country and must stipulate the identified conditionalities of both contracting parties. This is a possible stategy to enhance the ICG-SEA management. Likewisr, an annual review of the agreements with the concerned people and host institution should be a regular activity plan with respective target timelines to be aware of the commitments and esponsibilities.

Problems of Immediate Concern

The present status of the ICG-LAC in Brazil apparently requires the immediate action on the renewal of agreement between ICC and the Government of Brazil since COGENT is now under ICC. This will facilitate the access to the remaining balance of fund support to EMBRAPA to continue the workplan as agreed in the project.

GENERAL RECOMMENDATIONS

In addressing the challenges of the ICG-LAC, it is necessary to improve the current stands of the accessions and to be in conformity with the terms and conditions in the agreements as stipulated in the MoU.

1. There is an urgent need to have the revision of the MoU now with ICC instead of Bioversity and renew the germplasm acquisition agreement (GAA) for the materials intended for the additional designated accessions as listed in the MoU.
2. To review and consider the relevant amendments, if necessary, on the Material Transfer Agreement (MTA).
3. To conduct an enhancement training for the new curators and conduct a consultative conference involving the contracting parties with the identified institutions, policy makers and ICG curators and researchers involved in the maintenance of the ICGs-for germplasm exchange and prompt compliance to the provisions of the MoU.
4. The additional germplasm to complete the collections from other countries should be brought as in vitro embryos to prevent the possible introduction of pests and diseases, the lethal yellowing disease which is present in the Caribbean regions.
5. To capacitate the EMBRAPA Tissue Culture Laboratory with improved facilities and trained young researchers.
6. To provide replication of the exotic accessions in different location is highly recommended, to prevent possible loss due to unforeseen threats in the future.

As provided in the action plan, ICG-COGENT shall facilitate the sourcing of the needed support systems of the ICG-LAC. The sustainability of the ICG activities, protection and conservation of the designated accessions are the priority objectives of establishing ICGs in five regions globally. It is imperative that such goals should not be jeopardized as mentioned in Article 16 of the Treaty, that the ccontracting parties will encourage, as appropriate, all relevant institutions, including governmental, private, non-governmental, research, breeding and other institutions, to participate in the international networks.

CONCLUSION

Immediate remedial measures to mitigate identified challenges confronted by ICG-LAC and the must priority actions to be undertaken by ICC-COGENT to support the initiatives of EMBRAPA as indicated in the action plan. EMBRAPA has the capacity to manage the ICC but there is a need for continuing support from the government.

1. The finalization of the new MoA between EMBRAPA and ICC as to have the legal basis in accessing the remaining balance of the government grant for the maintenance of the ICG-LAC as commitment to the MoU with FAO-ITGRFA as an international genebank, this needs immediate action of ICC-COGENT.

2. A consultative meeting can be organized by COGENT-ICC with ITGRFA for legal opinions and final recommendations with the participation of the policy makers of the ICG host countries to have a unified agreement in the amendment of the MoU.
3. To provide the data management training to the curators for upgrading the current program, which is already outdated, and germplasm data are not updated. A standard data management program must be used by all the ICGs for coherence.
4. Development of biosecurity protocol for protection of the germplasm exchange against the risk of pest incursion and disease outbreaks.
5. Skills development on Coconut Tissue Culture and Cryopreservation techniques to be adopted by EMRAPA in the germplasm exchange and cryoconservation of elite germplasm of the ICG-LAC.

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