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Cacao Genetic Resources: Policy Options for Enhanced Exchange and Benefit-Sharing

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ABSTRACT

Conservation of cacao genetic resources and the facilitated access and sharing of derived benefits are key issues in ensuring that the genetic diversity contributes to the development of improved planting materials and addresses urgent priorities such as adaptation to climate change (particularly drought and high temperatures), pest and diseases and ensuring high quality and diversity of flavours in the cocoa production of tomorrow. The Global Strategy for the Conservation and Use of Cacao Genetic Resources, published by CacaoNet October 2012, provides a framework to ensure that cacao diversity provides direct benefits to the millions of small-scale farmers around the world.

There are only 2 international collections of cacao germplasm and they are maintained at CATIE in Costa Rica and at the Cocoa Research Centre (CRC) in Trinidad and Tobago with materials available in the public domain to all *bone fide* users under the Article 15 of the International Treaty on Plant Genetic Resources for Food and Agriculture (the ITPGRFA). The accessions are distributed using the Standard Material Transfer Agreement (SMTA) of the Treaty, which includes an Access and Benefit-Sharing (ABS) conditions. The International Cocoa Quarantine Centre at Reading (ICQCR), UK ensures the safe movement of cacao germplasm between countries and regions. The rest of cacao genetic diversity is maintained in an estimated 35 national collections with over 24,000 accessions, in farmers' fields and in the wild, outside the scope of the multilateral system of access and benefit sharing created by the ITPGRFA and the application of Article 15 agreements like those signed by CATIE and CRC . As a result, access to those resources is subject to other national laws and policies, including those implementing the Nagoya Protocol for access and benefit sharing (which is a protocol to the Convention on Biological Diversity (CBD).

There is a lot of diversity in *ex situ* collections and in farmers' fields but their use in breeding is not optimised. And the lack of clear institutional legal and policy frameworks is an important constraint. The paper describes the current situation of exchange of cacao germplasm for conservation, research and crop improvement to enhance production and the key the constraints. It identifies incentives for partners to facilitate access to germplasm and the fair and equitable sharing of the benefits in a clear and transparent manner. It proposes approaches for stimulating the use of cacao genetic resources and ensure the involvement of decision-makers in formalizing agreements.

1. Key Issues and Challenges

Good quality locally-adapted cocoa planting materials are required, regardless of country, region or farming system. The conservation of cacao[1] genetic resources and availability of those resources pursuant to international and national access and benefit sharing rules are critical for improving planting materials to address urgent priorities such as adaptation to climate change (particularly drought and high temperatures), pest and diseases and high quality and a diversity of flavours in cocoa production. These issues are at the heart of the implementation of the Global Strategy for the Conservation and Use of Cacao Genetic Resources (the Global Strategy hereafter), published in 2012 by the Global Network for Cacao Genetic Resources (CacaoNet) (CacaoNet 2012).

The key challenges in ensuring the conservation and optimum use of diversity in *ex situ* collections, *in situ* and in farmers' fields are the facilitated access of cacao genetic resources, the willingness of countries to share materials due to unclear or restrictive policies, the development of mutual benefiting terms and conditions between providers and recipients/users of that genetic diversity.

2. Centres of Diversity and Plant Collecting

The pioneering work of Russian scientist Nikolai Vavilov between 1924 and 1934 collecting PGRFA and developing the concept of "centers of origin and diversity" of the world's major crops led to the first genebanks being established. It also catalysed a wide range of scientists collecting seeds for conservation and use in crop improvement (Pistorius R. 1997). Following the work of Vavilov, the centre of origin and diversity of cacao was identified as being in South America and later on introduced in Central America for cultivation (Motamayor *et al*, 2002). The genus *Theobroma* includes 22 species which may have great importance as gene reservoirs for cacao improvement. From the broad genetic groupings of Criollos, Forasteros and Trinitarios, several cacao genetic clusters were identified building on the work of Motamayor *et al* in 2008.

Several collecting missions of cacao germplasm resulted in the establishment of the 2 international *ex situ* collections. The International Cocoa Genebank maintained by the Cocoa Research Centre (CRC) of the University of the West Indies in Trinidad and Tobago was established in 1982 and consolidated earlier collections from several sites in Trinidad including including the Imperial College Selections (ICS) of F.J. Pound from his exhaustive survey in Trinidad and Tobago between 1930-1935 and accessions from other national collections and numerous missions to collect primary germplasm from the centre of origin of cacao. In 1943, the cacao *ex situ* collection at the *Centro Agronómico Tropical de Investigación y Enseñanza* (CATIE) in Costa Rica was created and in 1978 formally established as an International Cocoa Collection.

In 1985, the International Cocoa Quarantine Centre (ICQC) at Reading, UK was established. Most of the germplasm in the ICQC today comes from the international collections of CATIE and CRC with material also received from national collections. In addition to the ICQCR, the United States Department of Agriculture (USDA) in Miami offers quarantine facilities for regional transfers.

Between 1920 to date, more than 35 *ex situ* collections have been established with approximately 25,000 accessions maintained in field collections (CacaoNet 2012). But the current global system of exchange relies mainly on the 2 international cacao collections, maintained at CATIE and CRC and safe exchanged through the ICQCR.

[1] This document refers to "cacao" for the plant and the unprocessed seeds of the species *Theobroma cacao* and to "cocoa" once the seeds, commonly known as "beans", are harvested, fermented and dried.

3. The Loss of Diversity and Urgent Need to Safeguard and Exchange

The Green Revolution in the 50's and 60's lead to development and diffusion of improved varieties of wheat, maize and other crops. The wide spread adoption of those crops led to the decisions by farmers and national programs to discontinue using a range of local farmers varieties, with the result that the number of varieties used in those agroecosystems was reduced. A commonly cited statistic concerns India where there were about 30,000 rice varieties in use prior to the Green Revolution and today around ten constitute the main production (Subramanyachary, P. 2012).

The realization in the mid-70s of massive loss of diversity called for the urgency to collect, safeguard and study crop genetic diversity. This lead to the creation of the most important international collections including those of the CGIAR system (formerly the Consultative Group on International Agricultural Research).

In support of this major effort to collect and safeguard crop genetic diversity around the world, the International Undertaking on Plant Genetic Resources (the International Undertaking thereafter) was adopted in 1983 by the FAO Conference as the instrument facilitating the exploration, safeguard and exchange of threatened genetic resources for food and agriculture, indispensable for crop genetic improvement. At the heart of the International Undertaking was the principle that "PGR are a heritage of mankind and should be available without restriction, for use for the benefit of present and future generations" (FAO 2017). Later on, other international instruments were developed that supplanted the International Undertaking as explained in Section 5.

4. Interdependence and Centres of diversity

Today's agriculture production and development of improved crops relies on genetic diversity from different countries and regions. This interdependency is described by Khoury *et al* indicating the linkages between the primary regions of diversity of food crops and the current importance of crops in terms of calories for each country and region. It also describes the level of cultivation of foreign crops in countries. When looking at the primary and secondary centers of diversity in South and Central America and more specifically countries such as Brazil, Colombia, Ecuador and Peru, these countries' agriculture and development depend on several crops that originated far away from the Amazon basin that connects them and where cacao originated from. Crops such as rice have their centre of diversity in Asia, wheat in the Middle-East, coffee in Africa, and banana in South-East Asia where the richness of diversity needed for their continued improvement still exist today.

Furthermore, cacao diversity moved from its centre of origin around the world from the 17th century onwards as it was introduced to other parts of the world. The second half of the 18th century with the establishment of chocolate manufacturing in Europe and an increase in consumption in North America saw an explosion in demand for cacao to be cultivated particularly in West Africa.

Today's vast majority of cocoa production is outside of its native centre of origin, with over 70% in West Africa and less than 20% in the Americas (ICCO 2014-2015 production information). Therefore, much of the cacao grown in the rest of West Africa has a narrow genetic base. As a consequence, it is important for sustainable production in the future in West Africa to ensure availability and use of a wider range of cacao genetic diversity; efforts to support such uses through breeding programmes are continuing.

5. Legal and Policy Frameworks to Facilitate the Exchange of PGRFA

The Convention on Biological Diversity (CBD) at the Rio summit in 1992 underscore the sovereign rights of countries to regulate access to their natural resources, including genetic resources.

In 1994, as an interim measure, to provide internationally sanctioned policy support for the continued maintenance and use of a number of key international PGRFA collections that were not covered by the

CBD, a number of organizations signed with FAO on the understand that they were holding them "in trust for the benefit of the international community." CGIAR Centres signed such agreements. So did CATIE and CRC, placing their cacao collections under the auspices of FAO.

In pursuit of a longer term policy support for the conservation, sustainable use of PGRFA and benefit sharing, a process was launched to revise/update the International Undertaking bring it into line with the CBD. This lead to the adoption (2001) and coming into force (2004) of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) whose Secretariat is hosted by the FAO. This legally binding instrument, replacing the 1983 International Undertaking, covers all plant genetic resources for food and agriculture (PGRFA). The Treaty creates the multilateral system of access and benefit-sharing (MLS). The MLS includes PGRFA of 64 crops and forages listed in Annex 1 of the ITPGRFA that are: i) under management and control of contracting parties and in the public domain, ii) voluntarily included by natural and legal persons in contacting parties, and iii) held in by international institutions that have signed agreements with the governing body of the ITPGRFA pursuant to article 15 of the ITPGRFA. Cacao is not among the crops listed in Annex 1 of the ITPGRFA. However, it was agreed by the Second Session of the Governing Body of the ITPGRFA that international institutions that host ex situ collections of materials that are not 'Annex 1' crops and forages should make those materials available using the same Standard Material Transfer Agreement that has been adopted for distributing Annex 1 crops. A number of international organisations have signed agreements with the Governing Body, including all the CGIAR Centres with PGRFA collections, and CATIE and CRC. These collections are referred to as "Article 15 collections". The ITPGRFA's MLS was developed to reflect that fact that countries in the world are already highly interdependent on PGRFA, and that facilitated access and exchange of materials is extremely important for all actors involved in agricultural research and development, including plant breeding. It includes monetary benefit sharing to be in line with the CBD and increasing levels of awareness about the importance of benefit-sharing generally. But both access and benefit sharing under the ITPGRFA are approached multilaterally, to reflect that fact that PGRFA of many crops and forage are already widely distributed around the world, and their continued use is essential for food security. For more information on the Treaty, see: http://www.fao.org/plant-treaty/en/

All other cacao collections fall outside of the Treaty and access to those resources is subject to whatever national regulations host countries have in place, including national laws implementing the CBD and its Nagoya Protocol (if they are contacting parties to those agreements). Some countries have agreed that collection holders have the right to provide non-annex 1 materials using the SMTA. For example CIRAD (Montpellier and French Guyana) and USDA (Puerto Rico), voluntary make cacao genetic resources in their collections available under the SMTA.

Today the main international policy and legal frameworks currently regulating access and benefit-sharing related to the exchange of cacao genetic resources are

- The International Treaty on Plant Genetic Resources for Food and Agriculture (Treaty) and its precursor the International Undertaking on Plant Genetic Resources adopted in 1983.
- The Convention on Biological Resources (CBD) adopted in 1992 and the Nagoya Protocol on Access and Benefit-Sharing (ABS) adopted in 2014.

There are, in addition, regional agreements related to access and benefit sharing, but we do not list them here.

6. Accessing International and National Cacao *Ex situ* Collections

The distribution of cacao germplasm from the international collections at CATIE, CRC via the ICQC is under the framework of the ITPGRFA, in accordance with Article 15 agreements, using the Standard Material Transfer Agreement (SMTA). The ICQCR also uses its own MTA for material received from other

collections, requesting donor genebanks to agree for the material to be passed on to a third party. When the 2 international cacao collections were formed, no international laws and few national laws explicitly addressed the issues. If material has been accessed in international collections prior to 1 January 2007 with permissions to make that material internationally available for purposes consistent with those under the ITPGRFA they considered as part of the in-trust collections covered by the Article 15 agreements. Products of research on such materials are also distributed under the SMTA. .

Anyone who receives cacao germplasm under the SMTA, must pass it on with the SMTA. It has very clear rules on ABS for the providers and recipients of crop germplasm including cacao:

Rules for the providers of germplasm:

- Access must be expeditious and free of charge, or at minimum cost.
- All available passport data and other associated available non-confidential descriptive information must be made available.
- Access to PGRFA under development is at the discretion of the developer during the period of development.
- Provider must periodically inform the Treaty's Governing Body about transfers with SMTAs.

Rules for the recipient of germplasm:

- Materials must be used or conserved only for research, breeding and training for food and agriculture.
- Intellectual Property Rights (IPRs) that limit access to material in the form received must not be claimed.
- If for conservation, the recipient must make material and related information available to users, using the SMTA.
- Further transfer must also be subject to the SMTA and notified to the Treaty Governing Body.

If a new cacao variety is commercialized incorporating material accessed with an SMTA and the further availability is restricted, the recipient is required to make a payment to the Treaty benefit-sharing fund of 1.1% of the sales of the product less 30% of the gross income resulting from the commercialization of the product (i.e. net rate of 0.77%). For more information about the SMTA, see: http://www.fao.org/3/a-bc083e.pdf

Beyond the MLS, there is not currently an internationally harmonized approach to access, using and sharing benefits derived from Cacao germplasm. Pursuant to CBD and Nagoya Protocol, countries are putting in place their own systems for regulating access, developing agreements and so on. Many countries are still in the process of developing such systems, so what rules apply and how to develop agreements is uncertain in many countries. And of course, it is not part of the architecture, logic or rationale of the Nagoya Protocol for countries to adopt internationally harmonized measures with respect to certain crops or classes of materials (e.g. PGRFA). There is a theoretical possibility pursuant to article 10 of the Nagoya Protocol to develop multilateral approached to benefit sharing, but there has not been significant discussion of such options to date at the level of the Conference of Parties. For many collections around the world, a number of institutions are involved and need to be consulted when it comes to exchanging cacao germplasm. The situation is often made more complex as a result of the fact that Ministries of Environment and Agriculture need to be coordinating closely on issues related to access and benefit sharing for cacao, and in many (perhaps most) countries, these agencies are not working closely together on these issues. Furthermore, among the users of cacao germplasm – science, research and development organizations - there are generally low levels of awareness regarding ABS regulations, national permitting requirements, evolving international frameworks. The situation has therefore resulted in fragmented approaches, informal exchanges of germplasm and lost opportunities for

partnerships and benefit sharing. With the exception of CATIE, CRC, USDA and CIRAD, there is little international exchange of germplasm. Access to national cacao germplasm is becoming progressively more complex and restrictive.

The following section discusses how the creation of an internationally-distributed research and development consortium can help overcome these challenges.

7. Potential benefit of Global Collaboration, including Cacao Germplasm Exchange

The incentives to share germplasm differ depending on perspective and position of the potential providers be they international genebanks, countries of primary or secondary diversity, producing countries, public research and development organizations, companies or farmers. They will be linked to their needs and what they think are appropriate benefits that should be shared with them.

The pre-requisite for a long-term solution in facilitating access to a broad range of cacao genetic diversity is the full implementation, in mutually supportive ways, of the ITPGRFA, the CBD and the Nagoya protocol. Ultimately a lot is based on trust (which requires transparency), on a shared sense of purpose (research and development partnerships involving movements of materials and related information in furtherance of shared objectives), on shared benefits (directly with providers) and on a clear understanding of the national interest. Novel options need to be considered for the sharing of germplasm with incentives for the providers, including national programmes and smallholder growers.

One such approach would be to develop internationally distributed research and develop consortia which pulls together a broad range of potential providers and users (noting that often a single farmer, community, country or organization is both a provider and a user) with common interests to address challenges associated with the conservation of cacao germplasm and enhancement of cacao R&D chains. Members of such a consortia can develop agreements that recognize and build on the different incentives that could motivate actors to join in such and effort. One or more agreements for the exchange of materials and benefit-sharing could be developed for use of materials in the consortia, in compliance with applicable national and international laws.

A consortium approach should also ensure that diversity is available now and for the future and would ensure collecting (filling gaps), conserving and characterising. Funding support is needed for these activities and the industry and countries interested in accessing materials, and ensure that benefits are shared with all.

Recent CacaoNet consultations have proposed to construct a global programme, taking into consideration the narrow genetic base of materials in West Africa and Asia, the wealth of diversity in Latin America and the Caribbean (LAC) and the urgent need to increase productivity. Such a global programme should spell out clearly the conditions for participation in a research consortium, what is needed to unlock genetic diversity for screening and pre-breeding and share research results and products and what might be the needs of the consumers and the industry.

There are many benefits that can be generated for both the providers and users of cacao germplasm through global collaboration such as the following. Many of these are previsedin the texts of the ITPGRFA and the Nagoya Protocol (Annex 1). Enhanced collaboration on cacao research could give rise to some or all of the following benefits:

- Participation in the definition of consortium research priorities and resource allocation
- Partnerships and technology transfer
- Generation and sharing of information related to shared materials.
- Support for germplasm characterization and information management systems

- Support for collecting of threatened materials and conservation in national genebanks
- Technologies, procedures and methods to conserve, improve and breed cacao
- Healthy germplasm and use of plant quarantine services, including the development of local and national quarantine facilities, reducing the spread of cacao pests and diseases.
- Evaluated germplasm to be included in national selection trials
- Enhanced breeding populations to be provided to researchers and farmers communities
- A network of evaluation trials and standard methodologies created in a participatory manner
- Support for communities to be involved in breeding trials and selecting promising materials
- Collaborative breeding programmes at regional and global level
- Improved materials for use by farmers worldwide
- Collaborative responsiveness to global or regional threats
- New opportunities for funding and collaboration
- Sharing of monetary benefits generated by commercial uses of improved germplasm

Meanwhile CacaoNet will continue to collaborate with national collections, FAO and the International Treaty to promote the placing of cacao germplasm collections in the public domain through designation under the Treaty. It will assist in clarifying the legal status of cacao collections, including formal roles and responsibilities of national cacao research institutes in conserving and developing cacao germplasm collections.

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