INTERNATIONAL COFFEE ORGANIZATION
ORGANIZACIÓN INTERNACIONAL DEL CAFÉ
ORGANIZAÇÃO INTERNACIONAL DO CAFÉ
ORGANISATION INTERNATIONALE DU CAFÉ

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Projects Committee
2nd Meeting
29 September 2011
London, United Kingdom

Cooperation with the International Coffee Genome Network (ICGN)

Background

1. In November 2010, the Executive Director a.i. circulated document ED-2105/10 requesting Members, in consultation with their research institutions and coffee sectors, to send him all relevant data and research on the coffee genome including documents and reports on existing projects and proposals and past or ongoing research. Members were also invited to send their views on proposals already submitted to the ICO and to suggest donors to implement this type of initiative.

2. This matter will be discussed during the meeting of the Projects Committee on 29 September 2011 to review the different initiatives and work being carried out, building on existing expertise and findings, to establish priorities for the future and explore potential sources of financing.

3. Copies of responses received to date are attached. Submissions should be sent in English as this is the language used by the international scientific research community.

Action

The Projects Committee is requested to consider this document.

Responses received from Members:

Colombia

For a number of years the Federation, through the National Coffee Research Centre (Cenicafé), has developed various advanced strategies for controlling pests and diseases and improving coffee quality attributes. In the context of studies on the coffee genome, Coffee Berry Borer (CBB) and its control through *Beauvaria bassiana,* Cenicafé has identified the sequences of 32,000 genes in the *Coffea arabica* species and has prepared genetic and physical maps that permit the characterization of resistance to diseases, factors related to production, and environmental interaction.

The following link provides more detailed description of these developments: http://www.cenicafe.org/modules.php?name=Genoma_del_Cafe&lite=0.

Databases for publications relating to the coffee genome are available at the Cenicafé *Alberto Machado Sierra* Documentation Centre. The following link provides on-line consultations, as well as around 30 related search requests: http://www.cenicafe.org/cgi-bin/wxis1?IsisScript=consulta.xis&isisdb=cenic&expression=genoma&format=1&desple=30.

Over the past six years Cenicafé has developed a Genomics research programme centred on *Coffea arabica* accessions and varieties that have been either preserved or bred in Colombia. The main purposes of the programme so far have included:

- The identification of molecular markers useful in the preparation of a genetic and physical map of this species, and the application of these markers in the characterization of coffee genetic resources, in order to recognize suitable materials for breeding purposes and to define core collections for the preservation of the genetic diversity.

- The identification of genetic markers and genes involved in the plant response to pathogens and pests, in particular Coffee Leaf Rust (CLR) and Coffee Berry Borer (CBB), using genomics to understand the genetics and physiology of the causal agents of these important problems in Colombia: the fungus *Hemileia vastatrix* and the insect *Hypothenemus hampei*.

- The improvement of biological control strategies through the characterization of the diversity and pathogenic activity of the fungus *Beauveria bassiana*, a natural enemy of the CBB.

- The development of new genes that could be used in genetic control strategies against the main limiting biotic problems in Colombia.

- The determination of the interaction between genetic factors and the environment in the quality and metabolites present in coffee, and how this defines the diversity of specialty coffees.

- The development of a Bioinformatics and Computational Biology platform that supports all the information and analysis requirements for the project and that enables the interaction of Cenicafé data with resources around the world.

For an ICO initiative on coffee genomics, Cenicafé is interested in participating with its human resources, technical and data analysis capacities in coffee genomics and related areas, within the scope of the proposed projects presented to ICO in the following areas:

- Comparative genomics for the preservation and characterization of *Coffea arabica* genetic resources, including the parental species *Coffea eugenioides* and *Coffea canephora*, as well as other *Coffea* species of interest including *C. liberica*.

- Wide phenotypic characterization (known as 'Phenomics') for the study of the interaction of genomes and the environment, focused on cup quality, productivity and response to climate change.

- Transcriptomics, Proteomics and Metabolomics to identify metabolic pathways that explain phenotypic responses and support breeding programmes for the development of new varieties together with genomics information.

- Deep genomic characterization of coffee pathogens and pests associated with limiting biotic problems of coffee around the world, including Coffee Berry Disease, Tracheomycosis, Pink Disease, Berry Blotch and American Leaf Spot, Root Nematodes and others.

- Metagenomics for understanding the interactions between coffee and the microorganisms associated with it, in relation to disease onset, biological control, nutrient assimilation and adaptation to the environment.

- Bioinformatics to strengthen data storage, processing and availability capabilities.

Costa Rica

The Coffee Institute of Costa Rica (ICAFE) has not yet carried out studies in the field of coffee genomics; we are only familiar with aspects related to basic techniques, the use of apparatus and codification to which we have access as part of the training at the Agronomic Institute of Campinas (IAC), São Paulo, Brazil. We consider this subject to be of great importance in seeking a solution for problems relating to pests and diseases in our country's coffee growing activities, and we hope that in the future the ICAFE may have the necessary basic equipment to enable us to develop our own studies.

Ecuador – See attached table (Annex II).

France – See attached letter (Annex III).

Haiti

The National Coffee Institute of Haiti, in June 2011, informed that the coffee species grown in Haiti is *Coffea Arabica* L., tetraploid (2n = 4x = 4 x 11 = 44 chromosomes) var. Typica at 80% and other cultivars such as Caturra, Caturai, which is found mainly in areas of Thiotte (South-east Haiti) where fertilizers are used.

PROMECAFÉ

In Central America, changes in coffee production methods to achieve improved cup quality, greater adaptability and resistance to pests and diseases, have meant that genetic improvement activities are essential for obtaining cultivars with improved characteristics.

Most traditional varieties grown in Latin America have a very narrow genetic base. This characteristic, which is favourable for aspects such as homogeneity, is not so in regard to the susceptibility to a variety of diseases and low adaptability to specific agro-ecological conditions.

The Tropical Agricultural Research and Higher Education Center, CATIE, houses a collection of coffee varieties that offers a wide range of genetic diversity, making it a strategic asset for future genetic improvement programmes, which by virtue of its aims is recognized as a public good.

During past decades, the international coffee collection has suffered significant losses for three main reasons:

1. **Age of the existing collection**: many of the accessions (57.5%) were introduced before 1970 and are now more than 40 years old.
2. **Cultivation method**: the cultivation method was similar to the method used in commercial plantations and was the same for wild and cultivated accessions. A significant percentage of the valuable wild genotypes is currently represented by only one or two individuals.
3. **Flooding**: the collection is sited on level ground, characterized by cemented soil layers at a depth of 30 – 80 cm.

Currently, PROMECAFÉ, in collaboration with CATIE, is sponsoring an initiative to rescue the CATIE coffee collection based on renovation and relocation to restructure it into a base collection and an active collection, facilitating appropriate management in accordance with the different categories of the materials conserved. This initiative is developed in a programme complying with the general guidelines established for the formulation of the Regional Climate Change Strategy. The first stage of the programme, set out in the project proposal entitled 'Renovation of CATIE's international coffee collection', was presented by PROMECAFÉ and approved by the International Coffee Council at its Session in September 2007 with a recommendation to secure funding for its implementation.

The renovation and relocation of the CATIE coffee collection will permit its restructuring into a **base collection** (mainly wild genotypes) and an **active collection** (selections, landraces and modern varieties), facilitating appropriate management in accordance with the different categories of the materials conserved. Rather than simply multiplying each individual in the collection, it is proposed to apply a rational strategy, which gives top priority to the multiplication of highly valuable materials and those at risk of erosion and permits the elimination of materials which represent redundant genetic information. The knowledge basis on which these decisions can be taken is available as a result of a comprehensive characterization of the entire coffee collection carried out during the last ten years. This strategy will significantly reduce the costs of managing the collection while at the same time increasing long-term conservation security.

ECUADOR

GENEALOGY AND PRIMARY PHENOTYPIC CHARACTERISTICS OF COFFEE VARIETIES AND HYBRIDS GROWN IN ECUADOR

Varieties and hybrids / Date of introduction in Ecuador	Genealogy and primary phenotypic characteristics						
	Place of origin / Genealogy	**Height of plant**	**Colour of young sprout**	**Potential yield of the plant**	**Agro-ecological adaptability**	**Resistance to disease**	**Cultivars**
PURE ARABICAS							
Typica / 1830 in Jipijapa Canton, Province of Manabí	Ethiopia (Africa).	Large	Golden brown	Low	Wide	Vulnerable to coffee leaf rust (CLR)	Sumatra, Villalobos, Blue Mountain and Pache
Bourbon / 1956	Island of Reunion (formerly Bourbon) near Madagascar, off south-eastern Africa.	Large	Green	High	Wide	Vulnerable to coffee leaf rust (CLR)	Red Bourbon Yellow Bourbon
Caturra / 1956	State of Minas Gerais, Brazil, known as a mutant of Bourbon (Monroig s.f.).	Small	Green	High	Wide	Vulnerable to coffee leaf rust (CLR)	This variety is classified as red Caturra or yellow Caturra according to the colour of the mature fruit.
Pacas / 1966	El Salvador, considered a mutant of the Bourbon variety.	Small	Green	High	Wide	Vulnerable to coffeee leaf rust (CLR)	
Mundo Novo / 1956	Municipality of Mundo Novo, State of Bahia, Brazil, discovered in 1943 (IBC 1981). Probable origins in a natural cross between Sumatra and Bourbon varieties.	Medium	Green	Medium	Restricted	Vulnerable to coffee leaf rust (CLR)	
Catuaí / 1976	State of São Paulo, Brazil, originating in an artificial cross between Mundo Novo and Caturra varieties in 1949 (IBC 1981).	Mediium	Green	High	Wide	Vulnerable to coffee leaf rust (CLR)	Red Catuaí Yellow Catuaí
Villalobos / 1956	Costa Rica, considered a mutant of the Typica variety (INIAP 1973).	Small	Golden brown	High	Wide	Vulnerable to coffee leaf rust (CLR)	
San Salvador	El Salvador. Considered a mutant of the Typica variety (INIAP 1973).	Small	Golden brown	High	Wide	Vulnerable to coffee leaf rust (CLR)	
Pache / 1996	Guatemala (Colindres 2008). Considered a probable mutant of Typica (Ordóñez 1991).	Very small	Green Golden brown	High	Restricted	Vulnerable to coffee leaf rust (CLR)	Pache 01 Pache 02
Geisha / 1980	Discovered in Abyssinia, (south-western Ethiopia) in 1931 (SCAP 2011).	Large	Golden brown	Low	Restricted	Vulnerable to coffee leaf rust (CLR)	

ECUADOR (Contd 1)

GENEALOGY AND PRIMARY PHENOTYPIC CHARACTERISTICS OF COFFEE VARIETIES AND HYBRIDS GROWN IN ECUADOR

Varieties and hybrids / Date of introduction in Ecuador	Genealogy and primary phenotypic characteristics						
	Place of origin / Genealogy	Height of plant	Colour of young sprout	Potential yield of the plant	Agro-ecological adaptability	Resistance to disease	Cultivars
COFFEE HYBRIDS							
H. Timor / Used since 1959 by the Tropical Research Institute - Coffee Rust Research Centre (IICT-CIFC) in Oeiras, Portugal to create the Catimor and Sarchimor hybrids (Bettencourt 1982). Introduced in Ecuador from Costa Rica in 1971, (INIAP 1971).	Discovered in the Timor Islands in 1927. Probably originating in a natural cross between ***Coffea arabica*** and ***Coffea canephora*** (Bettencourt 1981).	Large	Green	Low	Restricted	Presents genes resistant to coffee leaf rust, nematodes and coffee berry disease (CBD)**:** a disease of which there are no reports in America, caused by the fungus ***Colletotrichum cofeanum*** var. virulans) (Eskes 1989).	
Icatú / 1985	The Icatú hybrid is the result of a cross between ***Coffea arabica*** and ***Coffea canephora*** in development since 1950 by the 'Instituto Agronómico de Campinas', Brazil (IBC 1981, Orozco 1990). The aim of developing the Icatú hybrid was to improve the characteristics of Arabicas (Orozco 1990). In phenotypic terms, the Icatú lines are similar to those of Mundo Novo.	Large	Green	Medium	Restricted	Presents genes resistant to coffee leaf rust (CLR) (REDETEC 2002); as well as to coffee berry disease (CBD) (Carvalho 1976).	
Catimor / There are two primary selections in Ecuador: *Catimor CIFC* comprising lines from the Tropical Research Institute - Coffee Rust Research Centre (IICT-CIFC) (Oeiras, Portugal) and *Catimor C-86* comprising lines from the grupo 86, of the Tropical Agriculture Research and Higher Education Center (CATIE) (Amores *et al*. 2004).	Resulting from a cross between the Timor hybrid and the Caturra variety (Bettencourt 1982).	Small	In the Catimor lines developed by the CIFC, the sprouts are predominantly green, while in the Catimor C-86 lines they are predominantly golden brown.	High	Restricted	Resistant to coffee leaf rust (CLR).	Catimor 01 Catimor 02

ECUADOR (Contd 2)

GENEALOGY AND PRIMARY PHENOTYPIC CHARACTERISTICS OF COFFEE VARIETIES AND HYBRIDS GROWN IN ECUADOR

Varieties and hybrids / Date of introduction in Ecuador	Genealogy and primary phenotypic characteristics						
	Place of origin / Genealogy	Height of plant	Colour of young sprout	Potential yield of the plant	Agro-ecological adaptability	Resistance to disease	Cultivars
COFFEE HYBRIDS							
Sarchimor/ Sarchimor line C-1669, which was introduced in Ecuador in 1985, has good adaptability, especially in the dry zones of Manabí, El Oro and Loja.	Resulting from a cross between the Timor hybrid and the Villa Sarchi variety, developed by the Tropical Research Institute - Coffee Rust Research Centre (IICT-CIFC)', Oeiras-Portugal (Quijano y Gil 2009, IHCAFÉ 2004).	Small	Golden brown	High	Wide	Resistant to coffee leaf rust (CLR)	Sarchimor 02
Cavimor / Various Cavimor lines were introduced in Ecuador in 1985 (INIAP 1985).	Resulting from a cross between Catuaí and Catimor. This cultivar has been monitored under varying agro-ecological conditions and has the potential for high yields in subtropical zones. The plant is larger than the Catimor variety.	Medium	Green Golden brown	High	Restricted	Resistant to coffee leaf rust (CLR)	Cavimor 01 Cavimor 02

Sources: IBC 1981, Eskes 1989, Orozco 1990, Bettencourt 1981.

France

ANNEX III

cirad
LA RECHERCHE AGRONOMIQUE
POUR LE DÉVELOPPEMENT

Montpellier, July 18, 2011

Y/R : Document ED 2105/10
O/R : DIRBIOS/2011/123

Coopération avec le Réseau international
sur le génome du café (ICGN)
[illegible]

Subject : ICGN/OIC – September 2011

Dear Sir/ Madam,

This letter is to confirm the strong support of the French research institutions (CIRAD and IRD) involved in coffee research to the propositions done by the International Coffee Genomics Network (ICGN).

Both institutions are already deeply involved in coffee genomics and research partnerships with several ICO members. In particular, with funding from the French Agency ANR (Agence Nationale de la Recherche), CIRAD and IRD in association with another French institutes (Genoscope-CEA) and several international collaborators are combining their scientific resources and expertise to sequence, assemble, and annotate the entire genome of Coffea canephora. The specific goals of the project are i) to produce enough sequences to reach a high genome coverage, ii) to generate a good genome assembly with a majority of the genome anchored to chromosomes, and iii) to perform a first annotation and whole-genome analyses. All generated data will be freely available to the coffee community.

The coffee genome sequence will be used to decipher the genetic and molecular bases of important biological traits in coffee that are relevant to growers, processors, and consumers. This knowledge is fundamental to allow efficient use and preservation of coffee genetic resources for the development of improved cultivars in terms of enhanced quality, yield, and resistance with reduced economic and environmental costs.

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In the next few years, both institutions would be very interested to participate in an international initiative aiming at improving the conservation, characterisation, and use of the world's coffee gene pool for varietal development that meet future demand in a world of changing farming systems and climate. In particular, we could organise specialised training course and host scientists helping them to access and exploit a large amount of genomic and related data. We consider that thousands of undiscovered genes can potentially benefit coffee productivity and quality and the processes to decipher their functions are complex—requiring cutting-edge biotechnology, phenotyping methods, and bioinformatics. An individual institution can cope with only a few at a time. If we are to exploit the coffee genome adequately in a timely manner, a global research effort is needed, integrating the strengths of public and private organizations and facilities from high-tech laboratories to farmers' fields. The ICO, through existing centers and research networks like ICGN as a basis for wider partnerships, is ideally placed to lead this effort.

Please let me know if you require additional information.

I look forward to hearing from you.

Sincerely,

Daniel Barthélémy
Scientific Director Biologic Systems

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