



International Coffee Organization  
Organización Internacional del Café  
Organização Internacional do Café  
Organisation Internationale du Café

WP Board No. 894/01

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Projects/Common Fund

Executive Board  
21 - 24 May 2001  
London, England

### **Project proposal**

### **Enhancing use of coffee germplasm – an African perspective**

### **Background**

1. The attached project outline summarises a complete project document submitted on 2 April 2001 to the Executive Director by the International Plant Genetic Resources Institute (IPGRI). This represents a substantial revision to the initial project outline circulated in document WP-Board No. 880/00 Rev. 1. Copies of the full project in English are available on request.
2. IPGRI is an autonomous international scientific organization specializing in plant genetics operating under the aegis of the Consultative Group on International Agricultural Research (CGIAR).
3. A number of Member countries had previously expressed interest in this project, designed to conserve vital coffee germplasm resources in Africa, the continent of origin of coffee.

### **Action**

The Executive Board is requested to consider this project with a view to recommending its approval for submission to the Common Fund for Commodities.

## PROJECT OUTLINE

### I. Summary of project

**Project title :** Enhancing use of coffee germplasm - an African perspective

**Duration :** Five years

**Location:** Sub-Saharan African countries: Angola, Burundi, Cameroon, Côte d'Ivoire, Democratic Republic of Congo, Kenya, Madagascar, (Mauritius), Rwanda, Tanzania and Uganda.

**Nature of project:** Coffee quality improvement by the conservation of coffee genetic resources.

**Brief description:** The goal of the project is to contribute to the improvement of the welfare of coffee small-holders and the economies of many heavily coffee dependant countries in sub-Saharan Africa by enhancing the production of quality coffee in the region through conservation and use of available germplasm. The aims of the project are to enhance and coordinate the national and international evaluation of germplasm collections and to enhance coffee genetic resources conservation strategies in the region. The objectives are: (a) the application of standardized protocols in evaluation of coffee germplasm collections in multiple sites within the region and the provision of information and documentation to stimulate utilization of germplasm, and (b) the implementation of reliable and cost effective technologies to enhance the conservation of coffee genetic resources in the region, including identification of gaps within major collections, as well as *in situ* and on farm conservation to cater for long-term production improvement needs in the region.

The expected results of the project will be (i) well documented coffee germplasm collections in the region; (ii) promising materials evaluated in international multi-locations trials; (iii) mechanism for the exchange of information and materials; and (iv) effective conservation strategies in place including long-term seed storage facilities, *in vitro* genebanks and *in situ* reserves in more countries in the region. The beneficiaries will

be foremost the coffee growers (most of whom are small-holders), the coffee research institutions and ultimately the economies of the many debt-trapped countries in the region.

**Estimated total cost:** US\$ 13,088,045

**Financing from the Fund:** US\$ 5,150,909

**Co-financing EU:** US\$ 4,166,429 (to be requested)

**Co-financing CIRAD:** US\$ 223, 650

**Co-financing IRD:** US\$ 138,600

**Co-financing IPGRI:** US\$ 360,360

**Counterpart contributions:** US\$ 3,048,098

**Project Executing Agency:** International Plant Genetic Resources Institute (IPGRI)

**Supervisory Body:** International Coffee Organization (ICO)

**Collaborating institutions:** Institut National de café (INCA, Angola); Agricultural Research Institute of Burundi (ISABU, Burundi); Institut de Recherche Agricole pour le développement (IRAD, Cameroun); Centre National de Recherche Agronomique (CNRA, Côte d'Ivoire); Office National du Café (ONC, Democratic Republic of Congo); Coffee Research Foundation (CRF, Kenya); FOFIFA (Madagascar); (National Parks and Conservation Service – NPCS, Mauritius); Institut des Sciences Agronomiques du Rwanda (ISAR, Rwanda); Lyamungu Coffee Research Centre (Tanzania); National Agricultural Research Organisation (NARO, Uganda); African Coffee Research Network (ACRN), Interafrican Coffee Organisation (IACO); International Coffee Organization (ICO); The Coffee Research Network for East and Central Africa (CORNET) (ASARECA/CABI); Centre de Coopération Internationale de Recherche Agronomique pour le Développement (CIRAD) France; Institut de Recherche et Développement (IRD, France).

**Estimated starting date:** January 2002

## II. Project background

### A. Coffee genetic resources in Africa region: conservation and use

1. There is no doubt that concerted efforts in further genetic improvement of sub-Saharan Africa coffee is one major way to alleviate coffee production problems in the region. Considerable advances have already been made, including release and continuing enhancements of Ruiru 11 in Kenya, development of disease resistant *C. arabica* hybrids in Ethiopia, the results of *C. canephora* reciprocal recurrent selection programme in Côte d'Ivoire and selection of highly productive Robusta clones in Uganda. Arabica coffee variety improvement enhancing Catimor (Catura x Hybrido de Timor) is one of the significant achievements recorded in Asia and Latin America and replicated in East Africa. Continued progress in these and other similar programmes depends on coffee breeders having access to as wide a range of genetic diversity as possible.

2. The forests of West and Central Africa and southwestern Ethiopia as well as those of the neighbouring countries, are the centres of origin of the cultivated species of *Coffea*, and together with farmers fields growing traditional coffee varieties, are the ultimate sources of coffee genetic diversity. The forests of Madagascar and to a lesser extent the Mascarene Islands (Mauritius and Reunion) are the home of relatively isolated *Mascarocoffea* section of the genus characterized by low levels or even absence of caffeine. Deforestation and encroachment by agricultural activities, population pressures and economic hardships threaten all these reservoirs of great genetic diversity and, with them, comes the danger of significant erosion of the *Coffea* gene pool.

3. The conservation strategies that have received most attention are mainly *ex situ*, with the major world coffee collections representing wild West African species, the Eastern Africa species (mainly *C. arabica* and other diploids), and species of subgenus *Mascarocoffea*. These collections are primarily being conserved in field genebanks in Côte d'Ivoire (with over 8000 accessions), Ethiopia (1806 accessions), Cameroon (1552 accessions) and Madagascar (1282) (Dulloo *et al.*, 1998). Other genebanks holding relatively fewer accessions are in Kenya (634) and Tanzania (110). All these collections have their origins in early collection missions undertaken by ORSTOM (now IRD) IRCC, FAO and IBPGR (now IPGRI) in collaboration with national institutions in several African countries and each collection represents distinct variation unique to its sub region. All these collections are expensive to maintain and for a number of reasons are also highly at risk. Although *in situ* protection of *Coffea*, both in the wild and on farm, is a potentially important conservation approach, it has not received sufficient attention for a long time.

4. The main reason *Coffea* species have traditionally been conserved *ex situ* as living plants in field genebanks is that seeds of *C. arabica* and *C. canephora* exhibit intermediate storage behaviour while that of *C. liberica* is recalcitrant (intolerant of desiccation and exposure to low temperatures). The behaviour of other wild species is unknown, and it is thought that some could even be orthodox (Dulloo *et al.*, 1998). If found to be orthodox, many wild species could be conserved as seeds, making conservation of coffee germplasm more cost effective. The wild species are the most threatened in view of rapid destruction of natural forests which are their natural habitats. Recently, significant progress has been made with the conservation of

*Coffea* germplasm by including cryopreservation (storage in liquid nitrogen at  $-196^{\circ}\text{C}$ ) of coffee seeds, particularly for *C. arabica* (Dussert *et al.*, 1999), and use of *in vitro* slow growth and cryopreservation for medium to long-term conservation using zygotic or somatic embryos, apices and buds (Dussert *et al.*, 1997). Cryopreservation is presently the only available technique for long-term conservation of coffee germplasm. Other options of *ex situ* conservation include pollen storage under vacuum (Walyaro and Van der Vossen, 1997), although the techniques and their utilization need further investigation, and DNA banking. The latter is a potentially interesting technique although regeneration of whole units or use of particular genes is still impossible or extremely difficult (Adams and Adams, 1991). All of these methods have their respective advantages and disadvantages. Coffee pollen is known to conserve well (Charrier, pers. comm.) and has major advantages for germplasm exchange as disease free material. There is still much to be done in optimizing the conservation methods for coffee germplasm; the variation in response to different conservation techniques of different *Coffea* species demonstrates the importance of a combination of effective *ex situ* conservation strategies.

5. *In situ* conservation, although previously overlooked, remains an important component of the overall strategy for long-term conservation of the coffee gene pool. It is dynamic in the sense that it allows intimate interaction between species and biotic as well as abiotic factors, thus creating conditions ideal for the evolutionary process for various traits including pest/disease resistance and general adaptation. Genetic reserves in the form of protected areas and managed reserves offer the best opportunities for coffee conservation in the long term. Such protected areas are to be found in only a few countries in Africa, for example in Ethiopia and Madagascar. Over recent years, however, strategies for more effective *in situ* conservation have been developed and demonstrated for Mascarene *Coffea* in Mauritius (Dulloo *et al.*, 1998). As regards on-farm conservation of *Coffea* germplasm, which also plays an important role in conservation, very few examples have been documented except for some efforts being made in Ethiopia (Worede, 1997).

6. One of the major benefits of conservation is that it provides the only available reservoir that plant breeders can access for their crop improvement needs. Unfortunately, only a tiny fraction of the immense genetic variability existing in the wild is represented in various genebanks in the region. Further, very little of the genetic diversity contained in these collections has been exploited in coffee improvement programmes. It is most urgent to secure threatened wild germplasm in *ex situ* collections and/or *in situ*/on-farm, before it is lost to humankind and to allow its value to the coffee industry to be demonstrated and exploited. The main reason for this is that the breeding value of most such accessions is unknown, the bulk of the material within the collections having been neither sufficiently characterized nor evaluated and documented. These collections have also been insufficiently utilized because of inadequate staffing and the restricted absorptive capacities of many institutes due to general decline in breeding activities. For example, the hybridization programme of Mascarocoffea with *C. canephora* in Madagascar and the arabusta programme in Côte d'Ivoire, both aimed at developing low caffeine Robusta, have stalled. In the latter case this is also due to non-attractive marketing product and infertility problems experienced in production materials. There

is no doubt therefore that enhanced use of available coffee germplasm collections for breeding programmes can only be fully realized once the diversity has been thoroughly documented and analyzed for key features such as yield potential, cup and technological quality, resistance to pests and diseases and tolerance to adverse growing conditions such as nutrient/water differences under poor crop management.

### **III. Project goal**

7. The goal of the proposed project is to contribute to the improvement of the welfare of millions of coffee small-holders and the economies of many heavily coffee-dependant countries in the region by enhancing the production of quality coffee in sub-Saharan Africa through conservation and use of available germplasm.

### **IV. Development objective**

8. The development objective of the project is to support the characterization and evaluation of *ex situ* collections of both Arabica and Robusta coffee in a coordinated manner and provide the link for information, technology and materials that are consistent with the needs of coffee breeders, coffee farmers and other stakeholders in the region.

9. In the context of enhancement of coffee genetic resources and conservation strategies, the project will focus on identifying gaps within major collections, to cater for long-term breeding needs in the region. The economic development and the use of new and better varieties adaptable to local conditions are significant components for improving the livelihoods of poor people in coffee producing country.

### **V. Immediate objectives**

- To co-ordinate international and regional collaborative evaluation programmes of the existing coffee collections in the region, in order to identify sources of valuable key characters to be incorporated within the ongoing improvement programmes.
- To undertake documentation and improve access to information on coffee materials available in the African collection.
- To develop and/or assist in implementation of cost-effective and reliable technologies that will enhance conservation of coffee genetic resources in the region.
- To provide comprehensive supervision, coordination and follow up of the project.

## Logical Framework

**Title of project:** Enhancing use of coffee germplasm project

Estimated starting Date: *January 2002*

Estimated date of completion: *December 2006*

Date of present summary: *March 2001*

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
<p><u>GOAL:</u> Improve the welfare of coffee small-holders and economies of coffee-dependant countries.</p>	<ol style="list-style-type: none"> <li>1. New improved varieties of coffee made available to coffee farmers.</li> <li>2. Increased export value of African coffee</li> <li>3. Increase contribution to the GDP of coffee dependent countries in SSA</li> </ol>	<ol style="list-style-type: none"> <li>1. Seeds/germplasm distribution records of National Coffee Research institutes.</li> <li>2. ICO and FAO statistics</li> <li>3. Economic indicators reports of target countries.</li> </ol>	<ol style="list-style-type: none"> <li>1. Marketing policies are conducive for promotion of African coffee</li> <li>2. African coffee prices remain competitive on the world market</li> <li>3. International and regional consumption increases</li> </ol>
<p><u>PURPOSE:</u></p> <ol style="list-style-type: none"> <li>1. To co-ordinate evaluation programmes of the existing coffee collections in the region and develop documentation/information system</li> <li>2. To develop and or assist in implementation of cost effective and reliable conservation technologies</li> <li>3. To increase the use of coffee germplasm from <i>ex situ</i> collections</li> </ol>	<ol style="list-style-type: none"> <li>1. Research results showing increased use of coffee germplasm collections</li> <li>2. Genetic diversity readily accessible</li> <li>3. Database of coffee genetic resources set up</li> </ol>	<ol style="list-style-type: none"> <li>1. Reports of research institutions</li> <li>2. Number of accessions conserved in genebanks</li> <li>3. CD Roms made available and websites in place</li> </ol>	<ol style="list-style-type: none"> <li>1. High yielding varieties meet market requirements.</li> <li>2. Provided cost effective technologies are readily adoptable.</li> </ol>

<p><u>OUTPUTS:</u></p> <ul style="list-style-type: none"> <li>• Standardized protocols for sampling and rapid evaluation of key characteristics developed or improved.</li> <li>• Valuable coffee germplasm for use identified</li> <li>• Multi-location trials established</li> <li>• Methodologies for establishing core collection developed</li> <li>• Information and documentation system on coffee genetic resources established</li> <li>• Germplasm exchange mechanism for participating countries</li> <li>• Safe movement of coffee germplasm established</li> <li>• Improved management practices for coffee field genebanks in target countries</li> <li>• Medium and long-term storage facilities developed</li> <li>• Wild coffee population conserved <i>in situ</i></li> <li>• New coffee germplasm collected and conserved</li> <li>• Project experiences disseminated to wider audience</li> </ul>	<ul style="list-style-type: none"> <li>• Documented procedures for coffee evaluation made available to participating countries.</li> <li>• Number of accessions of valuable germplasm</li> <li>• Multi-location trials in each of the participating country</li> <li>• Core collection in at least 3 countries set up</li> <li>• Database system in place</li> <li>• Letters of agreement or MOUs established between participating countries</li> <li>• Guidelines on safe movement of coffee germplasm published</li> <li>• Three training programmes to counterparts in target countries</li> <li>• Coffee seed genebanks and cryobanks in place in three target countries</li> <li>• Coffee genetic reserves in two target countries established</li> <li>• Number of accessions of coffee germplasm collected</li> <li>• Dissemination workshop held.</li> </ul>	<ul style="list-style-type: none"> <li>• Workshop report</li> <li>• Reports of research institutions</li> <li>• Genebank records</li> <li>• PEA Project progress report</li> <li>• Project completion report</li> </ul>	<ul style="list-style-type: none"> <li>• Research capability of participating countries</li> <li>• Good management and agronomic practices are undertaken</li> <li>• Technologies developed are appropriate for target countries.</li> <li>• Efficient supervision coordination in germplasm exchange, improvement and institutional network</li> <li>• Agreement among participating countries for the exchange of germplasm for needs of the project.</li> </ul>
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<p><u>INPUTS/ACTIVITIES:</u></p> <ul style="list-style-type: none"> <li>• Evaluation workshop to finalize and standardize methodologies</li> <li>• To train technicians of participating countries on evaluation techniques</li> <li>• To evaluate germplasm collection, for quality and agronomic traits</li> <li>• To characterize genetic diversity for conservation and use of coffee germplasm</li> <li>• To specify the genetic control of targeted economically important trait based on conventional and molecular genetic analyses</li> <li>• To set up a coffee quarantine centre</li> <li>• To carry out multi-location trials</li> <li>• To assist in the establishment of evaluation of the selected materials in multi-location trials</li> <li>• To evaluate importance of Genotype x Environment interactions and adaptation of elite varieties to various agro-ecological conditions</li> <li>• A trial workshop will be held to identify criteria and establish procedures for developing core collections adapted to different aims including base and active collections.</li> <li>• To set up core collection for the three major coffee germplasm collection</li> <li>• To review and assess available information on coffee genetic resources held in collections</li> <li>• To hold an information workshop to prepare and agree on a system of documentation that caters for needs of the participating countries</li> <li>• To develop information system for coffee genetic resources in the region</li> <li>• To compile passport, characterization and</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluation workshop held at the start of project</li> <li>• Training workshop for staff of participating countries</li> <li>• Numbers of accessions of valuable coffee germplasm selected</li> <li>• Numbers of accessions of coffee germplasm characterized</li> <li>• Number of trait characterized for genetic control</li> <li>• Coffee quarantine centre set up under auspices of CIRAD</li> <li>• Multi-location trials at a minimum of 3 sites in 3 regions</li> <li>• Number of selected materials evaluated</li> <li>• Number of elite varieties determined</li> <li>• Workshop held</li> <li>• Core collection established</li> <li>• Needs assessment for documentation of coffee germplasm in each participating country done.</li> <li>• Information workshop held.</li> <li>• Documentation system in place.</li> <li>• Passport, characterization and evaluation data made available</li> <li>• Mechanism for fair and equitable sharing of coffee germplasm defined.</li> <li>• Guideline for safe movement of coffee germplasm published</li> <li>• Guideline for coffee germplasm management in field genebank published</li> <li>• Proper infrastructure for germplasm conservation in each participating country in place</li> <li>• Training workshop for staff of participating countries on germplasm management in field</li> </ul>	<ul style="list-style-type: none"> <li>• Participation at planning workshops</li> <li>• Progress reports</li> <li>• Number of accessions in genebanks</li> <li>• Project completion report</li> <li>• Publications</li> </ul>	<ul style="list-style-type: none"> <li>• Funding made available at required time</li> <li>• Effective project management and execution</li> <li>• Technical assistance compatible with local environment</li> </ul>
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<p>evaluation data from coffee field genebanks in the region of sub-Saharan Africa</p> <ul style="list-style-type: none"> <li>• To develop modalities to ensure fair and equitable sharing of benefits for use of genetic resources among member states</li> <li>• To develop guideline for safe movement of coffee germplasm materials including seeds, <i>in vitro</i> materials and pollen.</li> <li>• To review the management of three target coffee field genebanks in the region and formulate management guidelines for effective running of field genebank, including a standardized documentation system</li> <li>• To strengthen the physical infrastructure and provide assistance for maintenance of the collections in participating countries</li> <li>• To train technicians in field genebank management procedures in the three target collections</li> <li>• To train technician in cryopreservation techniques</li> <li>• To establish cryobanks in 3 target countries</li> <li>• To conduct investigations on long-term storage of coffee pollen and its utilization in exchange programmes</li> <li>• To conduct ecogeographic surveys in selected diversity rich areas of <i>Coffea</i> species</li> <li>• To carry out <i>in situ</i> conservation and set up genetic reserve</li> <li>• To carry out on-farm conservation studies using farmers participatory approach</li> <li>• To hold Dissemination workshop for share experiences with other countries in sub-Saharan Africa</li> <li>• Project management activities</li> </ul>	<p>countries on germplasm management in field genebanks held.</p> <ul style="list-style-type: none"> <li>• National staff trained</li> <li>• Cryobanks in three target countries established</li> <li>• Methods of pollen conservation and exchange developed</li> <li>• Distribution maps and status of wild coffee species in 2 diversity rich areas produced</li> <li>• Information on the regeneration of coffee in the wild obtained</li> <li>• On-farm conservation methods for farmers developed</li> <li>• Number of coffee genetic reserves established</li> <li>• Number of new accessions of coffee germplasm added to collections</li> </ul>		
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