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联合国粮食及农业组织

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Продовольственная и сельскохозяйственная организация Объединенных Наций

Organización de las Naciones Unidas para la Agricultura y la Alimentación

COMMITTEE ON COMMODITY PROBLEMS

JOINT MEETING OF THE FOURTH SESSION OF THE SUB-GROUP ON BANANAS AND THE FIFTH SESSION OF THE SUB-GROUP ON TROPICAL FRUITS

Rome, 9 – 11 December 2009

PROJECT PROPOSAL FOR SUBMISSION TO THE COMMON FUND FOR COMMODITIES: INTERNATIONAL *MUSA* TESTING PROGRAMME – PHASE IV: EVALUATING BANANA CULTIVARS (INCLUDING LANDRACES, CULTIVAR SELECTIONS AND HYBRIDS) FOR AGRONOMIC PERFORMANCE, HOST REACTION TO PESTS AND DISEASES AND POST-HARVEST CHARACTERISTICS IN DIVERSE ENVIRONMENTS

Project summary

Title	International *Musa* Testing Programme - Phase IV: Evaluating banana cultivars (including landraces, cultivar selections and hybrids) for agronomic performance, host reaction to pests and diseases, and post-harvest characteristics in diverse environments
Goal	To increase the productivity and reduce the (financial and environmental) costs of banana production to improve the sustainability of banana productions systems and farmers' livelihoods
Overall objective	The targeted deployment of alternative banana cultivars that are well adapted to local conditions (including climatic/soil conditions, pest and disease pressure, and consumer/market requirements)
Specific objectives	1. To evaluate, with input from farmers, a set of promising landraces and improved cultivars over two production cycles in 15 agro-ecologically diverse sites for agronomic performance, host reaction to major banana pests and diseases and post-harvest characteristics, including nutritional value; 2. To obtain a better understanding of the interactions between banana, its major pathogens and the environment, towards the development of more robust farmer recommendations and increased efficiency of banana breeding programmes; 3. To identify a subset of promising landraces and improved cultivars, that are well adapted to local needs and conditions, for farmers testing and deployment in target regions.
Expected impact	The livelihoods (food security and income) of small-holder banana-dependent poor populations will be improved because of more cost-effective, less vulnerable banana production through the deployment of better adapted banana cultivars
Duration	July 2010 - June 2015 (5 years)
Location/countries	Global in scope; Multi-location trials at 15 sites (to be identified during the project)
Coordinating agency	Bioversity International, Commodities for Livelihoods, France Lead project investigator: Dr. Inge Van den Bergh (i.vandenbergh@cgiar.org)
Project partners	Evaluating institutions (depending on identified trial sites) Other research institutes and laboratories (soil analysis, pathogen diagnosis) Private laboratories (in-vitro multiplication) ProMusa, the Global Banana R&D Network Breeding programmes: CARBAP, Cameroon; CIRAD, France; DPI, Australia; EMBRAPA, Brazil; FHIA, Honduras; IITA, Uganda; INIVIT, Cuba; ITSC, South Africa; NARO, Uganda; NRCB, India; TBRI, Taiwan; IAEA, Austria; TNAU, India; IBP, Cuba
Estimated budget	Approx. USD 2 million (over 5 years)

1. Introduction and problem statement

Banana is a staple food and an important source of income for millions of poor households across the world. Banana growers - the majority of them small-scale farmers - are however faced with ever-increasing pest and disease problems. They see their - often already meagre - income decline, due to decreasing productivity and increasing costs for pest and disease control. At a global level, the most important constraints include the fungal diseases Black leaf streak and Fusarium wilt, the viral disease Banana bunchy top and root-attacking nematodes.

Bananas produced for international trade are the most pesticide-intensive of the major tropical food crops. According to a 1995 IUCN report (IUCN 1995), the average use of pesticides on banana plantations in Costa Rica was as high as 44 kg of active ingredients per hectare per year, compared to an average of 2.7 kg/ha/year for most crops in industrialised countries. Not only are these pesticides extremely harmful to the environment and the health of the workers, they are also beyond the reach of poor farmers who cannot afford their high cost, which may represent 20-35% of the total production costs. The cost of fighting Black leaf streak alone can be as high as US$1200 per hectare per year.

Pest- and disease-resistant cultivars are seen as the most sustainable alternative to help small-scale farmers in the fight against pests and diseases. Over the years, new cultivars have been developed by crop improvement programmes. Whilst often excellent in terms of yield and resistance, these new cultivars often possess altered cooking and post-harvest qualities that need to be investigated before introduction into the market. Moreover, malnutrition and nutrient deficiencies are affecting large populations in developing countries; and diet diversification based on the introduction of cultivars with higher nutritional value is seen as an important component of any nutrition improvement strategy. Global efforts have so far given too little attention to this aspect of cultivar evaluation.

In addition, changing climatic conditions are bringing about new challenges, including prolonged periods of drought and severe flooding, higher and more extreme growing temperatures, more and stronger typhoons, and modified pest and disease pressures, all effecting the crop’s performance. The response of the crop to these interacting environmental conditions needs to be investigated, and more tolerant and resilient cultivars need to be identified.

Providing farmers access to pest-and disease-resistant cultivars, well adapted to the local growing conditions and with good post-harvest characteristics, constitutes an important component of any integrated approach to maintain farm productivity. Such ‘elite’ cultivars can be improved hybrids produced by breeding programmes, but also include superior landraces and cultivar selections. Before release to farmers and promotion of such cultivars in a country, they need widespread, in-depth evaluation in different parts of the world, to investigate their performance under a wide range of conditions.

2. Objectives and rationale

This <u>project aims</u> to increase the productivity and reduce the (financial and environmental) costs of banana production with the goal of improving both the sustainability of banana production systems and farmers’ livelihoods.

The <u>overall objective</u> of the proposed work is the targeted deployment of alternative banana cultivars that are well adapted to local conditions (including climatic and soil conditions, pest and disease pressure, and consumers/market requirements).

The <u>specific objectives</u> are:

1. To evaluate, with input from farmers, a set of promising landraces and improved cultivars

over two production cycles in 15 agro-ecologically diverse sites for agronomic performance, host reaction to major banana pests and diseases and post-harvest characteristics, including nutritional value;

2. To obtain a better understanding of the interaction between banana, its major pathogens and the environment, towards the development of more robust farmer recommendations and increased efficiency of banana breeding programmes;

3. Per target region, to identify a subset of promising landraces and improved cultivars, that are well adapted to local needs and conditions, for farmers testing and deployment.

The expected outputs are:

1. The agronomic performance, host reaction to major banana pests and diseases and post-harvest characteristics, including nutritional value, of a set of promising landraces and improved cultivars will have been evaluated with framers' input over two production cycles in 15 agro-ecologically diverse sites;

2. A subset of promising landraces and improved cultivars, that are well adapted to local needs and conditions, will be identified for farmers testing and deployment in target regions, including plantain-based production systems in West Africa and Latin America, East-African highland banana-based systems in East Africa, and dessert banana-based systems in Asia, Latin America and parts of Africa;

3. A set of promising landraces and improved cultivars will be available at the ITC (international collection) for the benefit of the international *Musa* research-for-development community;

4. Standard protocols for germplasm evaluation will be published as Technical Guidelines;

5. National researchers will be trained in germplasm evaluation protocols and disease diagnosis;

6. The results will be available to researchers in the form of an online database, and a cultivar overview will be published for the benefit of researchers, extension workers and banana growers;

7. The global *Musa* Germplasm Information System (MGIS), documenting the ITC collection and other banana genebanks, will be updated with new information to stimulate the use of banana cultivars;

8. A better understanding of the interaction between banana, its major pathogens and the environment will allow growth modelling and global mapping, which can be used for prediction purposes and targeted cultivar deployment;

9. Five MSc students will be able to complete their degree during the course of the project.

The project is expected to have a positive impact on the livelihoods, food security and income of small-holder banana-dependent poor populations because of more cost-effective, less vulnerable banana production through the deployment of better adapted banana cultivars.

3. Related projects and previous work

The study will build on the experience from the first three phases of the International *Musa* Testing Programme (IMTP), a world-wide collaborative effort coordinated by Bioversity International to evaluate elite *Musa* cultivars in different environments and under variable pest and disease pressure. The IMTP was established in 1989 to evaluate germplasm from the FHIA

(Fundacion Hondureña de Investigaciön Agricola) breeding programme in Honduras for resistance to Black leaf streak disease. Four years later, three hybrids were recommended for release, and these clones have since been distributed to more than 50 countries worldwide (D. R. Jones 1994; D.R. Jones 1994). In the mean time, new cultivars from more breeding programmes had been developed, and IMTP phase II and III were initiated (in 1996 and 2001, respectively), building on the success of phase I. Testing was expanded to include also Fusarium wilt and nematodes, and more cultivars were recommended for release (Orjeda 2000).

The results of the previous phases have provided valuable insights into the degree of resistance of different cultivars. In addition, the programme has provided the partner institutions involved in the IMTP trials with a diverse set of germplasm. This has in several cases resulted in successful deployment of new cultivars nationally. The somaclonal variant ‘Tai Chiao No. 1’ is just one example of the successful deployment of these new cultivars: from 1992 to 2001, between 1.6 and 3.0 million plantlets of ‘Tai Chiao No. 1’ were planted on 800 to 1500 ha of land infested with Fusarium wilt in Taiwan each year, representing about 75% of total infested production area in Taiwan (Hwang and Ko 2004). In Tanzania, more than 800,000 plants of introduced hybrids are now grown by half a million farmers (De Weerdt 2003), while over 16,000 ha in Cuba (over 15% of total banana production area) were planted with FHIA hybrids, offering farmers benefits of more than USD400/ha/yr (INIBAP 2006).

Since IMTP III was initiated in 2001, new cultivars that in turn need multi-location testing have been released from breeding programmes. During a survey conducted with major stakeholders in 2005, an overwhelming 90% of the respondents felt that the IMTP trials are useful, and 86% indicated that they would like to see a fourth phase conducted in the future (Van den Bergh 2006).

In addition, new disease threats have emerged: a virulent strain of the Fusarium wilt pathogen is spreading through Asia, while Xanthomonas bacterial wilt and Banana bunchy top are ravaging banana production in Africa. Screening of landraces and improved cultivars to these diseases is seen as a top priority. To be able to, for instance, assess the potential impact of the introduction of the virulent strain of the Fusarium wilt pathogen in Africa, there is an urgent need to know the reaction of African cultivars that are so important for sustaining livelihoods and generating income in this region.

In addition, as mentioned above, global cultivar evaluation efforts have so far not looked much at post-harvest characteristics and organoleptic features, which are crucial to determine a cultivar’s acceptability in the market. When ‘Goldfinger’ (FHIA-01), a hybrid resistant to Black leaf streak, was released in Australia, market acceptance was erratic due to its unreliable taste and ripening. On the other hand, FHIA-01 was well received in the cooler highlands of East Africa. It was later shown that the flavour and texture of the fruit develops better under cooler subtropical conditions than in the tropics (Smith et al. 1997). A re-assessment of the cultivar for agronomic and post-harvest characters could identify if a niche market would be possible in subtropical Australia.

There is also a wealth of information in the IMTP that has not been fully exploited. Multi-site trials provide for an ideal experimental design to understand how pest/disease and site conditions interact to affect the performance of each cultivar. Quantification of the Genotype x Environment x Pathogen interaction will permit the results in each site to be put into context and allow a more robust evaluation of materials, determining the disease resistance and environmental preferences for each cultivar with greater confidence.

The current project thus seeks to evaluate in multi-location trials promising landraces and newly developed cultivars to major banana pests and diseases, including newly emerging pathogens, for agronomic performance and yield, and for post-harvest and organoleptic characteristics, including nutritional value. This will eventually lead to the quantification of the potential of each cultivar and targeting of germplasm introduction to the areas where the abiotic and biotic conditions are most appropriate, taking into account local market requirements.

4. Project components

The first year of the project will be devoted to the precise planning and preparation of the evaluation trials. This will include, among others, germplasm selection and introduction into ITC, partner identification and site selection, expert revision of evaluation protocols, training of partners and germplasm multiplication. The field sites will be planted early in the second year. Data collection will start in the second year and continue over the second, third and fourth year in order to cover at least two full production cycles. Data compilation and analysis, as well as interpretation and writing up of the results will be done during the last year of the project.

Component 1: Preparation phase (1 year)

Multi-location trials can be quite complex to manage and thus require detailed planning of all the activities and careful coordination between the different project partners. The objective of the first project component is to make all the necessary preparations and arrangements to allow a smooth establishment of the trials in the second year (component 2). The expected outputs of component 1 are:

1.1. A set of promising landraces and improved cultivars will be available at the ITC for the benefit of the international *Musa* research-for-development community;

1.2. Standard protocols for germplasm evaluation will be published as Technical Guidelines;

1.3. National researchers will be trained in germplasm evaluation protocols and disease diagnosis.

1.4. Two MSc students will have finished their degree (Lessons Learnt of IMTP I, II, III; and Targeted Site Selection).

Activities:

1.1. At the start of this fourth phase of IMTP, the major strengths and weaknesses of the programme will be reviewed with partners of the first three IMTP phases, in order to build on experiences from the past and provide lessons learnt and guidelines for the new phase.

1.2. The different national collections and banana breeding programmes will be invited to send to the ITC a set of germplasm they would like to include in the fourth phase of IMTP. The conditions for the use of the germplasm will be discussed, a Material Transfer Agreement will be signed between the provider and Bioversity International and the materials will be sent to the International Transit Collection, accompanied by a standardized information sheet. For a tentative list of germplasm from breeding programmes, see Annex A.

1.3. The received germplasm will be virus indexed at one of the accredited virus-indexing centres to ensure the health status of the materials.

1.4. Fifteen sites will be selected on the basis of their climatic conditions, altitude, soil type, pest and disease pressure and other site-specific criteria, as well as the presence of a reliable partner institution. Ideally, the selected sites will comprise some areas that are very suitable for banana production, but also sites that cover a wide range (and possibly include extremes) of environmental and growing conditions, including abiotic stress (e.g. drought) and major pests and diseases. Exploration of existing databases, supported by additional surveys where needed, will provide data for a specific GIS analysis to select the most suitable sites for the evaluation trials.

1.5. To allow a meaningful comparison of the results of the different sites, it is of crucial importance that all partners use the same protocols for the set-up and maintenance of the trials and for the data collection. Detailed guidelines for evaluation of agronomic performance and host reaction have been published in the framework of the previous phases of IMTP. A group of experts (including pathologists, agronomists, nutritionists) will meet at a workshop to review the existing protocols and update them where needed. Partners in the evaluation trials will receive training in trial design, data collection, abiotic stress evaluation and disease diagnosis. Field log books and electronic data collection sheets to ensure a uniform data collection and allow easy data compilation into a common database will be developed.

1.6. The capacity of the ITC to multiply materials to sufficient numbers for the planned trials is limited. Therefore, the ITC will provide 5 in-vitro plants of each cultivar to a private in-vitro laboratory to multiply each cultivar to 1500 plantlets (15 sites x 100 plants per cultivar per site).

Timing: July 2010-June 2011

Component 2: Implementation phase (3 years)

The implementation phase is the core of the project, where the performance of a set of promising *Musa* germplasm will be evaluated in multi-location trials. The expected outputs of component 2 are:

2.1. The agronomic performance, host reaction to major banana pests and diseases and post-harvest characteristics, including nutritional value, of a set of promising landraces and improved cultivars will have been evaluated over two production cycles in 15 agro-ecologically diverse sites;

2.2. The results will be available to researchers in the form of an online database, and a cultivar overview will be published for the benefit of researchers, extension workers and banana growers;

2.3. The global *Musa* Germplasm Information System (MGIS), documenting the ITC collection and other banana genebanks, will be updated with new information to stimulate the use of banana cultivars.

Activities:

2.1. The plantlets will be sent out to the respective site partners, accompanied by the required import permits and phytosanitary certificates. A Material Transfer Agreement will be signed between Bioversity International and the recipient of the germplasm.

2.2. The plantlets will be hardened in the greenhouse until they are ready for field planting.

2.3. Baseline data on banana production and consumption patterns will be collected in the target regions for ex-ante impact analysis. A stakeholder analysis will be performed.

2.4. Soil analysis will be done at the respective field sites. The pests and diseases present in the field will be accurately diagnosed. Baseline data and historic data of the field site will be collected.

2.5. The selected sites will be prepared for planting, including land clearance and preparation, preparation of planting holes, etc., following a standardized experimental design. The plantlets will be transferred to the field, taking into account the local growing season.

2.6. During the course of the trials, the following datasets will be collected at regular times during the trial, based on the standardized protocols: climatic and edaphic data, disease pressure, agronomic performance, disease symptoms, yield and post-harvest characteristics. Samples will be sent to recognized plant pathology laboratories for accurate pathogen identification.

2.7. The data will be recorded in a standardized field log book, and uploaded into a shared database.

2.8. Regular field visits by the project coordinator will be carried out to ensure the correct implementation of the trials, and a mid-term workshop will be organized to discuss progress, problems encountered and potential solutions.

Timing: July 2011-June 2014

Component 3: Data analysis, impact assessment and up/out-scaling (1 year)

The objective of the third component is to fully exploit the wealth of data that will be collected during the course of the multi-location trials. The expected outputs are:

3.1. A better understanding of the interaction between banana, its major pathogens and the environment which will allow growth modelling and global mapping for prediction purposes and targeted cultivar deployment;

3.2. A subset of promising landraces and improved cultivars, that are well adapted to local needs and conditions, will be identified for farmers testing and deployment in target regions, including plantain-based production systems in West Africa and Latin America, East-African highland banana-based systems in East Africa, and dessert banana-based systems in Asia, Latin America and parts of Africa.

Activities:

3.1. All data will be compiled into the shared database, and a detailed Genotype x Environment x Pathogen analysis will be performed.

3.2. Growth and varietal performance will be modelled and mapped out.

3.3. The results will be published in different formats (website, cultivar overview, peer-reviewed publications) and disseminated to researchers, extension workers and farmers.

3.4. An economic analysis and impact assessment of the deployment of a selection of the best performing cultivars will be carried out, for different regions, taking into account the local environmental conditions, the specificities of the production systems and the consumer/market requirements. The project results will be tested against the baseline data collected in the target region at the start of the trials.

3.5. A final workshop will be organized to discuss project results and outcome, and reflect on post-project activities.

3.6. Opportunities for scaling up and scaling out will be discussed with local stakeholders, including farmers, farmers' organizations and extension services. The project will take into account differences between social groups within a community, differences between households within a group and differences between members of a household. Special attention will be paid to who makes decisions about crops/cultivars to be planted, and who benefits from improved crop production. Gender issues will be addressed, as women often play a crucial role in farming practices.

Timing: July 2014-June 2015

5. Benefits and beneficiaries

Small-scale banana growers, struggling to make both ends meet in areas of high-disease pressure where banana productivity is below the potential, will be the primary beneficiaries of the project. The deployment of high-yielding, resistant cultivars with good potential under the specific local conditions is expected to increase farm productivity and decrease farm inputs costs, and thus have a positive impact on both the caloric intake and the farm income of many poor people, with corresponding gains in health and improved livelihoods.

An impact assessment of the Green Revolution has shown that productivity gains from improved rice and wheat cultivars allowed global food production to increase dramatically with only modest increases in area planted to food crops and with relatively slow growth in the use of inputs such as fertilizer and irrigation (Evenson and Gollin 2003). Similarly, diffusion of new banana cultivars among small-scale farmers is expected to contribute to increased productivity of banana - a staple food for millions of rural poor and a source of income for millions of households. Results of an impact assessment survey of diffusion of new banana cultivars among small-scale farmers in north-western Tanzania have indeed shown that superior cultivars outyielded the local cultivars by an average of 40% (Smale and Tushemereirwe 2007).

The improved disease resistance of new cultivars is expected to give farmers increased yields without the high cost and negative environmental impact of pesticides. A study showed that a cultivar with resistance to Black leaf streak disease can have a comparative advantage in terms of farmer gains over fungicide treatment of 10:1 during normal periods of supply and 5.5:1 in periods of scarcity (Ortiz and Vuylsteke 1994). In the Seychelles, farm profit from growing new cultivars was double that obtained from native cultivars (Sechrest, Stewart, and Stickle 1999).

New cultivars for niche markets also have the potential of fetching higher prices than the local cultivars. In cooler parts of Australia, the price of ‘FHIA-01’ reached US$10-20 per 13-kg carton, which is about double that of ‘Cavendish’ (the standard commercial cultivar) in the subtropics (Sechrest, Stewart, and Stickle 1999).

Dissemination of new cultivars could lead to new employment opportunities, for instance when villagers set up a system of nurseries to raise and harden in-vitro plantlets locally, as is already done in the Philippines. In this country, small processing businesses have also trialed different processing methods for newly introduced cultivars, which turned out to be more profitable than processed products of the traditional cultivars.

The availability of high-yielding, disease-resistant banana cultivars and good knowledge about how pest/disease pressure and site conditions interact to affect the performance of each cultivar will also allow farmers to be better prepared for newly emerging challenges. These may include, amongst others, the emergence of new pests and diseases, the spread of existing pests and diseases to new areas, the development of more virulent strains of existing pests and diseases and changing environmental conditions, as those expected to arise from climate change.

Banana scientists in general, and breeders in particular, will obtain invaluable information for future research. They will benefit from the broad scale of the evaluations and the international publicity generated for their best hybrids. The programme will build a strong research network and help researchers from NARSs to link their research activities with scientists in international and advanced research centres.

6. Institutions involved and responsibilities

The Commodities for Livelihoods programme of Bioversity International will be the lead organization. Bioversity has a longstanding experience from the previous IMTP phases, and can build on its regional networks in Asia, Africa and Latin America to closely collaborate with national partners. The test sites and implementing agencies will be identified during the preparation phase of the project, based on criteria outlined in activity 1.4. The partners will be responsible for the actual implementation of the evaluation trials, whilst Bioversity will coordinate the trials between the different partners in the various sites and guarantee the standardization of protocols. Bioversity will also ensure the smooth collaboration between the germplasm collections and breeding programmes that will provide the cultivars for evaluation, the ITC and the evaluating institutions. Bioversity's regional networks will supply the necessary enabling environment for germplasm and data sharing. ProMusa, the Global Programme for *Musa* Improvement for which Bioversity provides the secretariat, will provide the scientific networking structure for collaboration.

7. References

De Weerdt, J. 2003. *Adoption of superior banana cultivars in the Kagera Region: Accomplishments and constraints*. KCDP / EDI Ltd, Bukoba, Tanzania.

Evenson, R.E., and D. Gollin. 2003. Assessing the Impact of the Green Revolution, 1960 to 2000. *Science* 300, no. 5620 (May 2): 758-762. doi:10.1126/science.1078710.

Hwang, S.C., and W.H. Ko. 2004. Cavendish banana cultivars resistant to Fusarium wilt acquired through somaclonal variation in Taiwan. *Plant disease* 88, no. 6: 580-588.

INIBAP. 2006. *INIBAP Annual Report 2005*. INIBAP, Montpellier, France.

IUCN. 1995. *Evaluation of the Social and Environmental Impact of the Banana Expansion in Sarapiqui, Tortuguero and Talamanca*. International Union for the Conservation of Nature.

Jones, D. R. 1994. International *Musa* Testing Program Phase I. In *The Improvement and Testing of Musa: a Global Partnership*, 12-20.

Jones, D.R. 1994. Distribution of Recommended FHIA Hybrids. In *The Improvement and Testing of Musa: a Global Partnership*, 21-22. INIBAP, Montpellier, France.

Orjeda, G. 2000. *Evaluating bananas: a global partnership. Results of IMTP Phase II*. INIBAP, Montpellier, France.

Ortiz, R., and D. Vuylsteke. 1994. Plantain breeding at IITA. In *The Improvement and Testing of Musa: a Global Partnership*, 130-156.

Sechrest, L., M. Stewart, and T. Stickle. 1999. A synthesis of findings concerning CGIAR case studies on the adoption of technological innovations. *Rome: CGIAR Impact Assessment and Evaluation Group* 109.

Smale, M., and W.K. Tushemereirwe. 2007. *An economic assessment of banana genetic improvement and innovation in the Lake Victoria region of Uganda and Tanzania*. International Food Policy Research Institute.

Smith, M.K., S.D. Hamill, P.W. Langdon, and K.G. Pegg. 1997. Selection of new banana varieties for the cool subtropics in Australia. In *I International Symposium on Banana in the Subtropics 490*, 49-56.

Van den Bergh, I. 2006. Highlights from a survey (International *Musa* Testing Programme). *InfoMusa* 15, no. 1-2: 35-39.

8. Tentative costs and financing

Budget in USD	Component 1	Component 2			Component 3	Total
	Year 1	Year 2	Year 3	Year 4	Year 5	
I. Vehicles, machinery and equipment (1)	0	67,500	7,500	7,500	0	82,500
II. Civil works (2)	0	30,000			0	30,000
III. Materials and supplies (3)	0	60,000	45,000	45,000	0	150,000
IV. Personnel						
Site managers and field workers (4)	0	198,000	198,000	198,000	0	594,000
Local consultancies (5)	0	30,000	30,000	30,000	0	90,000
V. Technical assistance and consultancy						
Project Lead Investigator (6)	48,750	48,750	48,750	48,750	48,750	243,750
Project Programme Assistant (7)	15,000	15,000	15,000	15,000	15,000	75,000
Regional Coordination (8)	33,750	33,750	33,750	33,750	33,750	168,750
MSc studies (9)	60,000	0	0	0	40,000	100,000
International consultancies (10)	40,000	30,000	15,000	15,000		100,000
VI. Duty travel (11)	0	15,000	15,000	15,000	0	45,000
VII. Dissemination and training						
Workshops and stakeholder consultations (12)	90,000	0	0	0	60,000	150,000
Publications (13)	10,000	0	0	0	20,000	30,000
VIII. Operational costs						
Administrative support and use of facilities	11,900	21,120	16,320	16,320	8,700	74,360
Overheads (8%)	23,800	42,240	32,640	32,640	17,400	148,720
Subtotal	333,200	591,360	456,960	456,960	243,600	2,082,080
IX. Supervision, monitoring and evaluation			To be completed by CFC			
X. Contingencies			To be completed by CFC			
Grand total						

(1) Equipment for 15 sites, such as computer, camera, GPS, basic meteorological equipment, etc.
(2) Upgrading of field sites, including access road, irrigation system, store, etc.
(3) Office and field supplies, including chemicals and fertilizers, for 15 sites.
(4) Salary local site managers and local field workers for 15 sites.
(5) Local consultancies, including plantlet hardening at local village nurseries and soil analysis at local laboratory for 15 sites.
(6) Salary and benefit costs of the Lead Investigator.
(7) Salary and benefit costs of the Programme Assistant.
(8) Salary and benefit costs of three Regional Coordinators.
(9) MSc scholarships, including bench fees, research funds, thesis and monthly stipend.
(10) International consultancies, including virus indexing at accredited virus-indexing centre, plantlet multiplication at in vitro laboratory and disease diagnosis at specialized laboratory.
(11) Field visits, including travel in economy class, accommodation, per diem (UN rates) and visa costs.
(12) Start-up and final project workshops and local stakeholder workshops, including travel in economy class, accommodation, per diem (UN rates), visa costs and workshop-related costs.
(13) Open-access publication of evaluation protocols and project results and outcomes.

Annex A. Tentative list of germplasm from breeding programmes.

Donor institution	Name	Type	Genome	Reasons to be included in IMTP	Status
DPI	DPM25	Mutant of Dwarf Parfitt (AAA, Cavendish)	AAA	– Resistant to Foc STR4 – Equal to industry standard Williams in every agronomic trait measured – Consistently lower incidence of Fusarium wilt	Received at ITC
CIRAD	MU-916	AA cv x AA-AA cv	AAA	– Highly resistant to BLS, Sigatoka – Resistant to Foc R4 and R. similis	Received at ITC
	MU-920	AA cv x AA-AA cv	AAA	– Highly resistant to BLS, Sigatoka – Resistant to Foc R4 and R. similis	
TBRI	Formosana	Cavendish type	AAA	– Resistant to Foc R1 and R4 – High yield	Received at ITC
	GCTCV-215	Cavendish type	AAA	– Highly resistant to Foc R4 – Resistant to Foc R1 – Good yield	
IBP	IBP 5-61	Gros Michel mutant	AAA	– Highly resistant to Foc – Reduced plant stature – Shorter vegetative cycle	Received at ITC
	IBP 5-B	Gros Michel mutant	AAA	– Highly resistant to Foc – Reduced plant stature – Increased number of fingers per bunch	
	IBP 12	Gros Michel mutant	AAA	– Highly resistant to Foc – Reduced plant stature – Increased number of fingers per bunch	
INIVIT	INIVIT P-06-13	Mysore mutant	AAB	– Resistant to Foc, BLS and Moko	SMTA received, material being prepared for sending
	INIVIT P-06-30	Mysore mutant	AAB	– Resistant to Foc, BLS and Moko	
	INIVIT PB-2003	Saba somaclonal variant	ABB	– Resistant to BLS and Moko	
	Selección P-INIVIT	FHIA-21 mutant (dwarf)	AAAB	– Resistant to Foc, BLS and Moko	
EMBRAPA	YB 42-07	Yabgambi nº 2 X M53	AAAB	– Highly resistant to Foc R1 – Resistant to Sigatoka	Negotiating MTA conditions
	PA 42-44	Prata Anã X M53	AAAB	– Highly resistant to Foc R1 – Resistant to Sigatoka	
	Bucaneiro (T12)	Lowgate hybrid	AAAA	– Highly resistant to Foc R1 – Resistant to Sigatoka	
	Japira	Pacovan x M53	AAAB	– Highly resistant to Foc R1 – Resistant to Sigatoka	
ITSC	PKZ	Somaclonal variant of FHIA-01	AAAB	– Very tolerant to Foc R4 – Believed to be tolerant to Foc R1 and BLS – Bunch looks and tastes like Cavendish – Quite tolerant to cold temperatures	Negotiating MTA conditions

				– Acceptable when cooked green	
CARBAP		Triploid cooking types		– Resistant to BLS	Negotiating
		Plantains		– Resistant to BLS	
IITA		16 hybrids			Negotiating
FHIA					Negotiating
NRCB					Negotiating