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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: MITIGATING THE THREAT AND PREVENTING THE SPREAD OF FUSARIUM WILT TROPICAL RACE 4

Title:		Mitigating the Threat and Preventing the Spread of Fusarium Wilt Tropical Race 4
Proponent:		Bioersity International, Commodities for Livelihoods programme (CfLP) Lead Project Researcher: Dr Agustin B. Molina a.molina@cgiar.org Los Banos, Philippines.
Potential Partner Institutions:		
ASIA:	Philippines:	Bureau of Plant Industry
		University of the Philippines at Los Banos
		Lapanday Fruits and Development Corp
	China:	Institute of Fruit Tree Research
		Guangdong Academy of Agricultural Sciences
	Malaysia/Indonesia:	Malaysian Agricultural Research and Development Institute
		Universiti Putra Malaysia Indonesia Tropical Fruit Research Institute
India:	National Research Centre for Bananas	
Thailand:	Asia and Pacific Plant Protection Commission c/o FAO Regional Office for Asia and the Pacific	
AFRICA :	East/ West/ Central and Sub-Saharan Africa:	Disease management framework for SS Africa
		Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)
		The Conference of African and French leaders of agricultural research institutes (CORAF).
		South African Development Community (SADC)
		CARBAP
		National Agricultural Research Organisation (NARO) Kenya Institute for Tropical and Subtropical Crops (ITSC) South Africa
LATIN AMERICA:	Belize, Costa Rica, Dominican Republic, Ecuador, El Salvador, Mexico, Nicaragua, Panama, Venezuela	International Regional Organization for Plant and Animal Health (OIRSA)
	All Region	the Plantain and Banana Research and Development Network for Latin America and the Caribbean (MUSALAC)
	Costa Rica	Corporación Bananera Nacional (CORBANA)
Advanced Research Institutes:		University of Stellenbosch, South Africa Wageningen University, the Netherland Queensland Department of Primary Industries, Australia University of Florida Mycothèque de l'Université Catholique de Louvain (MUCL), Belgium
Estimated Funding:	CFC	US\$ 3.6 million
Duration:		July 2010-June 2014 (4 years)

Background/Rationale:

Throughout history, few plant disease epidemics have devastated production of an agricultural commodity as severely as Fusarium wilt of banana, caused by *Fusarium oxysporum* f. sp. *cubense* (Foc). In the early 1900s, banana export relied almost entirely on the cultivar Gros Michel. Gros Michel is a very good cultivar in terms of bunch and fruit characteristics, but it is extremely susceptible to Fusarium wilt. The notorious “Panama” disease wiped out whole production areas (Ploetz, 1992; Stover, 1962) and caused estimated financial losses of around US\$400,000,000 to the banana industry (Ploetz, 2005). Using a conservative conversion rate, this would be at least \$2.3 billion in 2000 figures, and would be even greater if costs were included for unemployment, displacement, unrealized income and expenditures to maintain social and political stability in the affected regions. If not for the introduction of Fusarium wilt-resistant Cavendish bananas, the international banana export trade (today worth more than US\$5 billion per annum) could have been destroyed, as there were (and still are) no alternative means to control the disease.

But the devastating threat of Fusarium wilt has returned. Whilst the Cavendish plantations in Central America remain unaffected by *Foc* race 1 that destroyed Gros Michel in the 1950’s, the recent occurrence of a virulent strain in Asia gives cause for grave concern. Known as ‘tropical race 4’ (TR4), this strain of *Foc* has caused epidemics in Cavendish in the tropics different from those less severe infections previously reported in the subtropics. The devastating impact of TR4 on Cavendish plantations in Asia was first observed in Taiwan in the late 1960s, which eventually caused a significant reduction of production to just 10% of former levels, and had caused significant increases in production costs rendering its exports much less competitive. In the early 1990s, the establishment of thousands of hectares of Indonesian and Malaysian Cavendish commercial plantations failed due to severe epidemics of *Foc*.

In addition, Fusarium wilt also severely affects many other cultivars planted for food and income by small-scale farmers in most banana-growing countries of the world, which accounts for about 85% of the world’s production. As such, the disease affects the livelihoods and income of millions of the rural poor.

Recent confirmation of the occurrence of *Foc* TR4 causing epidemics in Cavendish farms in China (2004) and the Philippines (2008), has renewed serious concerns regarding its destructive potential in the tropics, where most bananas for export and local consumption are produced. It now threatens the 400 million-dollar banana export industry of the Philippines, currently the second largest supplier of the global market after Ecuador. It is equally causing alarm to the predominantly Cavendish-based banana production of China, which is presently the third largest banana producer of the world after India and Brazil.

Although tropical race 4 is so far found only in Asia and Australia, it continues to spread rapidly within the Asian region (Molina *et al.*, 2008; 2009), threatening for instance banana production in India - the world’s top banana producing country - and may eventually spread to South America and the Caribbean, and to Africa. There, it could have a great impact on Cavendish bananas grown for export, and on bananas and plantains planted by small-scale farmers. Tropical race 4 thus poses a serious threat to a multibillion dollar industry and to the food security of millions of poor farmers.

The alarm raised by the occurrence of TR4 epidemics in Asia has prompted global stakeholders to prioritize actions to mitigate the threat of this disease. The Banana Asia Pacific Network (BAPNET¹), a Bioversity International-coordinated regional platform of banana R&D collaboration in Asia, has given this work a high priority, particularly in countries where epidemics are already occurring. Funded by the Australian Centre for International Agricultural

¹ <http://bananas.bioversityinternational.org/en/partnerships-mainmenu-34/bapnet-mainmenu-108.html>

Research (ACIAR), an important initial project to mitigate the threat of this disease is underway. This work aims to improve the understanding of the distribution of *Foc* TR4 in Indonesia, Papua New Guinea, and Australia for quarantine and prevention of spread purposes; and for prospecting disease management tactics that will tackle problems of small-scale growers. This effort is complemented by NARS-initiated surveys in other countries in Asia. The need for a concerted global R&D mitigating program was also raised by Bioversity International during the FAO/CFC IGG meeting in China in November 2007.

Simultaneously realizing the potential threat of TR4 to the huge Cavendish industry of Latin America, Bioversity's banana R&D network in Latin America (MUSALAC²) has embarked on an awareness campaign about this threat. Raised awareness will help prevent the introduction of this pathogen into this very important region where Cavendish is vital for global trade, and plantain is an essential food for the local people.

In Africa where bananas are produced predominantly by smallholder banana growers for food and other local uses, growers are also concerned, as their local cultivars may be at risk, if or when TR4 reaches their continent. Africa is already facing the spread of banana Xanthomonas wilt and banana bunchy top disease which has prompted the organization of a banana disease management initiative for Sub-Saharan Africa. This initiative grew out of a workshop in Arusha, Tanzania, among 15 banana-growing countries and international organizations (FAO, IITA, Bioversity) and scientists from advanced research institutes in India, Australia and Belgium.

The magnitude of the problem and the need for a concerted global R&D mitigating program prompted Bioversity International to convene an international banana symposium through its ProMusa programme³, in partnerships with the International Society of Horticultural Sciences and regional partners, (China, September, 2009) to address the TR4 problem and formulate a global R&D plan of action to mitigate this threat. More than 300 symposium participants including many noted international banana scientists, industry and government representatives came up with the following recommendation: **“Continental action plans to limit the movement of Fusarium wilt pathogens and to prevent the entry of TR4 into Africa and the Americas need to be developed or further refined, and supported by effective public awareness campaigns, reliable diagnostic methods, and strict quarantine policies and procedures.”**

It is thus an opportune time to invest on a project that would mobilize international, regional and national stakeholders to build global readiness and strengthen the knowledge base for the quarantine and management of Fusarium. Such an effort should focus on global alliance building, key research results and pilot capacity building. These activities would mitigate current damages caused by the disease which is currently is found in Asia and pre-empt serious production constraints to the very important industry for export and local food in other countries of Asia, in Latin America and in Africa where Foc tropical race 4 is already found.

Project Goal and Summary:

In helping to ensure the long-term sustainability of the banana industry, the twin-pronged goal of the project is to:

1. mitigate the threat of Fusarium wilt of banana with emphasis on *Foc* tropical race 4 that is already causing severe epidemics in some countries in Asia
2. prevent *Foc* TR4 spreading to other Asian countries and other regions

² <http://bananas.bioversityinternational.org/en/partnerships-mainmenu-34/musalac-mainmenu-105.html>

³ ProMusa is a community of scientists working on bananas and plantains (*Musa* spp.) to meet the needs of resource-poor smallholder banana farmers in developing countries.- <http://www.promusa.org/>

The grant will support the activities of a global task force to plan and oversee the efforts in quarantine and surveillance. The grant will also support targeted research activities to make surveillance and quarantine more effective and to build a toolbox for *Foc* management. Coordinated by Bioversity International, the project will count on the concerted participation of partners from research institutes within existing regional networks coordinated by Bioversity, and scientists from advanced laboratories within the framework of ProMusa. It will also seek participation of government and non-government organizations, and the banana industry. It will build upon the existing activities and initial research outputs in Asia and elsewhere by having an upscaled program with global significance. The goal of the project will be achieved by:

- strengthening the global alliance to respond to the threat of *Foc* TR4;
- mapping the global distribution of the various pathogenic forms of *Foc*, with special emphasis on TR4 to enable us to implement a rational basis for quarantine;
- identifying, validating and adapting available and emerging disease management strategies, including conducting enabling research;
- raising awareness of the threat;
- developing human capacities to reinforce containment and prevention.

The expected impact of the project will be reduced losses in areas with existing epidemics and reduced risk, or total prevention of disease invasion, in still unaffected places. This will help ensure the long-term sustainability of the banana industry. It will help to safeguard the source of foods and livelihoods of millions of smallholder banana growers, and the important source of employment and revenues of foreign exchange of exporting countries that supply cheap and nutritious fruits to the global market. Scientific knowledge and materials such as the *Foc* international collections that will be generated in this project will underpin follow-up research to further improve our ability to sustainably manage *Foc*.

Project Specific Objectives:

1. To determine the global agro-ecological distribution of *Foc* races as a basis for developing programmes to manage and prevent further spread to new territories through measures such as quarantine.
2. To establish international collections of *Foc* isolates, accessible to researchers for further upstream studies that will enhance success in developing tools for crop-breeding and *Foc* disease management.
3. To develop mitigating measures that will tackle disease problems in areas where *Foc* TR4 is already causing epidemics, and provide ready options to cope with and to contain the disease in case of occurrence in places where it is not yet found.
4. To create awareness, capacity and programmes to prevent *Foc* TR4 introduction and spread, and a ready capacity to contain *Foc* TR4 in places where it is not yet found.
5. To improve knowledge and understanding relating to *Foc* and its epidemiology and management, such as epidemiology of *Foc* to improve capabilities to manage *Foc* by conducting research enabling research.

Project Activities and Outputs

Activity 1: *Understanding the global agro-ecological distribution of the pathogenic forms of *Foc* with special focus on TR4*

The project proposes to carry out a comprehensive survey and characterization of *Foc* pathogenic forms to determine its global distribution, aimed at developing national, regional and global, strategies for disease exclusion, containment and management. Focus of surveys and characterization will be the major banana growing countries in Asia, where TR4 has not yet been reported, Latin America and the Caribbean, and East and West Africa. While the focus of this work will be on TR4, our work will also provide a good understanding of the extent of distribution and damage of other races, such as race 1, which is also causing serious damage on susceptible local cultivars grown for local markets. Surveys and sampling will be done by national partners. Related information on specific geographic locations (determined by GPS), level of disease incidence, cultivar(s) affected, and other related agro-climatological conditions will be determined for all samples. Samples will be sent to an advanced research laboratory partner for characterization according to their Vegetatively Compatible Groups (VCGs), as a preliminary technique of identifying *Foc* races. The samples will also be kept and maintained as a part of an international *Foc* collection.

Expected Outputs. A **technical map** of global distribution of various races and VCGs of *Foc*, of the banana varieties that they affect and of the agro-climatic locations in which they occurred. **Technical information** on the global pathogenic variability of *Foc* will be published and circulated for further use by research and development communities. A collateral important output will be the establishment of a strengthened and enriched **international repository** of *Foc* strains that may be used by other scientists in upstream research, such as pathogenic variability and genomic studies and other basic studies that will eventually improve abilities to sustainably mitigate and manage this disease.

Activity 2. *Developing disease mitigating tactics and strategies to reduce damage and sustain banana production in affected areas and provide coping-preparedness in unaffected places*

An inventory of disease management measures and strategies that are being studied by current activities in Indonesia (ACIAR project), and those that have been reported developed and used by commercial companies in the Philippines, Taiwan, South Africa, India (for race 1), and elsewhere will be consolidated. These will be further validated, adapted and improved accordingly in TR4 affected countries. These will include cropping system modifications, soil amendments, clean seed systems and cultivar deployments. Proven disease mitigating tactics and strategies will be documented and made available to wider stakeholders for adoption or further refinement and adaptation.

A very important component of this activity will be the evaluation of TR4 resistance and susceptibility to TR4 of important cultivars that are grown by smallholder farmers in Asia, Latin America (plantain) and Africa (East-African? highland bananas). This information is critical and still not yet generally determined. This activity aims to generate information on the resistance/susceptibility traits of important cultivars to enable us to deploy appropriate cultivar options for disease management in affected areas, and increase preparedness, assess and reduce risks in places like India, Africa, and Latin America where TR4 is not yet present. These varieties will be field evaluated in countries in Asia where TR4 is present. Concurrently these varieties will be evaluated in screenhouses against isolates of TR4 to develop a protocol for rapid resistance evaluation. Resulting information will also guide *ex ante* impact assessments of the spread of the disease to other regions.

Mechanisms of spread or resurgence and suppressiveness will be studied in several sites using not only *Foc* TR4, but also race 1 in Gros Michel and apple banana, and race 2 in bluggoe.

Expected outputs. An **inventory of validated disease mitigating management options** that will be adopted or further refined. This will include individual control tactics and/or integrated disease management systems, presented in technical reports, manuals and other publications. Such control tactics will include eradication and prevention of spread measures, cultural and cropping practices of disease suppression, biological control approaches, and use of resistant cultivars. A specific important output is a **catalogue of important cultivars** from all regions with their tested reactions to TR4. This information will be extremely important for disease mitigation through cultivar deployment, and it will also be valuable information for breeders. A **better understanding of cultivar susceptibility to *Foc* TR4** will be another key output. A **specific list of research themes** that can be distributed in Asia, Africa and Latin America will guide the work.

Activity 3. *Developing and implementing a strategy to prevent spread of *Foc* TR4 to areas and continents where it is not yet found*

This Project Activity area will focus on strategic activities that will promote prevention of intra- and intercontinental movement and spread of TR4. This will include implementing programmes of raising banana stakeholders' awareness of the threat posed by *Foc* to the banana industry. It will also involve capacity building of relevant stakeholders, like regulatory bodies (quarantine), and extension officers to implement effective preventive measures. Global risk analyses will also be carried out to generate guidance for governments, industry players, policy makers and researchers in investing and implementing a sustainable preventive programme. Organizing multi-stakeholder meetings and workshops for a coordinated programme design and implementation will be an essential component of this activity. A special coordinating task force or committee will be formed primarily to design and guide in implementing an intercontinental *Foc* quarantine and containment programme.

Expected Output: Heightened stakeholder awareness of the threat posed by *Foc* in Latin America and Africa, will result in concerted prevention measures, such as creating and implementing effective quarantine regulations. **Personnel technical capacities** will be improved for accurate and early disease diagnosis, for identifying potential dispersal routes, and for coping and containment measures. **A regional/global *Foc* TR4 prevention platform** created to sustainably steer the prevention program. A global **strategy steering committee** for *Foc* TR4 quarantine and public awareness to reduce the spread of TR4 will combine regional and national strategies. **Training** on *Foc* awareness and **enhanced awareness** will also be key outputs within this activity area. A further output will be **enhanced global capacity** to diagnose and monitor the spread, location or distribution of *Foc* VCGs and races.

Activity 4. Develop new management options by identifying and filling critical knowledge gaps in the epidemiology and disease management of *Foc*, including a clearer understanding and implications of its pathogenic variability and virulence.

Strategic research will help generate improved management practices. Epidemiological studies will clarify the roles of key environmental, soil and host factors that influence the incidence, development and spread and survival of *Foc*. The role of soil health in *Foc* soil suppressive mechanisms will be studied, including organic matter, soil amendments, soil antagonists and other microflora. This project will investigate the mechanisms responsible for disease virulence, and determine if these observed differences are due to any influence of soil bio-physical properties. This will be linked to optimization studies to improve the efficiency under field conditions, of biological control agents identified in previous studies in Asia and Latin America that were effective in the screenhouses but less successful in the field.

Parallel studies shall be carried out to understand *Foc* races in terms of VCG virulence relative to various cultivars, to enhance appropriate deployment of cultivars. Standard protocols of early screening techniques will be validated with field results. Advances in molecular characterizations and diagnostics have already been developed by advanced laboratory partners within ProMusa.

These tools will be further optimized with the availability of a broader reference set of *Foc* strains generated in Activity 1. They will be validated and refined in conjunction with the other field activities in the region, fast tracking their development and application in managing the disease. When developed, these diagnostic tools will be primarily useful in implementing preventive and eradication measures and conducting of extensive and accurate surveys of races.

Expected output: Research outputs of this project will help fill the critical knowledge gaps in *Foc* etiology and epidemiology, and management. **Enhanced knowledge** on pathogen survival, and mode of dispersal, conditions that affect disease development and a **better understanding** of the disease-suppression mechanisms of suppressive soils, including the interactions of biological, physical, and chemical properties, will contribute to a **better formulation and implementation of disease management strategies**. Similarly, an improved understanding of the concept of *Foc* races will allow for the **development of a range of diagnostic reference strains**, which will be important in cultivar deployment, quarantine policy enforcement, and breeding. **Inoculation and screening techniques** that will be developed will be useful to plant pathologists and breeders. It is expected that these research outputs will **catalyze further R&D** within the international scientific community.

Estimated Budget Summary:

Item	Amount [US\$ '000]
Contracted project activities with partners	2000
Capacity building. workshops, public awareness campaigns, alliance building	750
Program Coordination	500
Overheads	350
TOTAL	3600