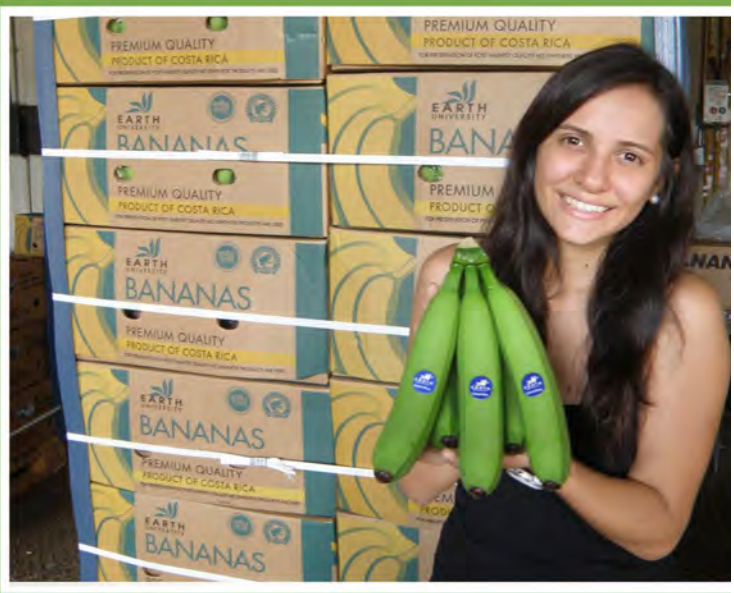
EARTH International Banana Congress

Sustainable Banana Production

Plant Breeding, Food Security, Agronomy Management and Carbon Neutrality

Tribute to Dr. Phil Rowe



EARTH University

Las Mercedes, Guácimo, CR

July, 2013

Content

International Banana Congress

Sustainable Banana Production: Plant Breeding, Food Security, Agronomy Management and Carbon Neutrality

Tribute to Dr. Phil Rowe

Organizing Committee

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JULY, 2013

Las Mercedes de Guácimo, Limón, Costa Rica

Campus, Las Mercedes, July 2013

Prologue

It is a great honor for EARTH University to host this International Banana Congress: "Sustainable Banana Production: Breeding, Food Security, Agronomy Management and Carbon Neutrality.

It is important to note that this conference was made possible but the willingness of scientists and professors of prestigious universities and research institutes from five continents, which have agreed to share their knowledge and experiences with the international banana and plantain community. In short we have a high-level academic program, thanks to all the speakers of the Congress who are the heart of this event.

The spirit of this conference is to pay a tribute to Dr. Phil Rowe, whom has dedicated much of his life to the genetic improvement of bananas and plantains. Today, his hybrids are distributed in five different continents and are playing an important role in food security and nutrition for the neediest populations, especially in Africa and Pacific Asia.

It is worthwhile remembering that the hybrids developed by DR. Phil Rowe played a key role in food security of the Cuban people during the special period (in which the Russian Government had to cut off aid to Cuba). With no doubt this is a concrete example of food security using improved hybrids. In addition, with the replace of susceptible varieties with FHIA hybrids resistant to Sigatoka has allowed Cuba's Government in saving more than $3 million in imported fungicides.

In this event there will be a special tribute to Professor Moisés Soto, who has formed three generations of agronomists specializing in banana in Latin America and the Caribbean; it has been and honor for EARTH University and Banana Industry in having their professional services.

The idea of this conference is to further create a banana scholarship and the owner (winner) of the scholarship would a son or daughter of fieldworker of a banana plantation, so as he/she can obtain a first level education in the only university which has banana plantation for exportation, professors and professional with distinct specialization in banana crop.

Finally, I would like to thank my students at EARTH whom have strongly supported me in this organization and development of this great conference.

Respectfully,

Luis Ernesto Pocasangre Enamorado Ph.D.
International Banana Congress Coordinator, EARTH
Director of Department of Investigation, EARTH University, Costa Rica

Academic Programme
International Banana Congress
Sustainable Banana Production: Plant Breeding, Food Security, Agronomic Management and Carbon Neutrality
Tribute to Dr. Phil Rowe

First day 29 July, 2013		
Section I Auditorium Emory Cocke		
Time	Subject	Speaker/Leader
7:30-9:30 AM	Registrations	Organizing committee
9:30 – 9:40 AM	Minute of Silence in Honor of Dr. Phil Rowe Welcoming speech and Logistics of the Event	Prof. Luis Pocasangre
9:40- 9:50 AM	Congress Inauguration	Prof. Edgar Alvarado Dean of EARTH University
9:50-9:55 AM	Withdrawal from Main Table and Start of Event	
9:55- 10:15 AM	Semblance for Dr. Phil Rowe	Dr. Ramiro Jaramillo
10:15-10:30 AM	Tribute to Dr. Phil Rowe/Launching the Phil Rowe Scholarships	Luis Pocasangre/ Rowe family
Section I: Plant breeding and Management of Pests and Diseases Auditorium Emory Cocke		
10:30-11:15 AM	Current Status of Plant Breeding and Impact of the FHIA Hybrids in Africa	Keynote Speaker: Dr. Rony Swennen, IITA Banana Breeder/ Professor of Catholic University of Leuven, Belgium
11:15-11:45 AM	Coffee break	
11:45-12:15 AM	Importance of the INIBAP, IDRC and FONTAGRO on Banana Plant Breeding in Latin America and the Caribbean	Dr. Nicolás Mateo & MSc. Ramiro Jaramillo Former Directors of INIBAP /CGIAR and International Agriculture Consultant
12:15-12:45 PM	Banana Breeding Programme at Embrapa: Challenges and Opportunities	Dr.Edson Perito Amorn Leader of plant breeding programme of Embrapa Cruz das Almas, Bahia Brasil
12:45-2:00 PM	Lunch at EARTH Cafeteria	
2:00-2:15 PM	Recognition to Prof. Moisés Soto	EARTH Students
2:15-3:00 PM	Phil Rowe's Legacy: Enabling Sustainable Banana Production with Disease- and Pest-Resistant Hybrids	Keynote Speaker: Dr. Randy Ploetz, University of Florida, U.S.A
3:00-3:45 PM	The Current Status of Panama Disease Research in Africa and the Importance of the FHIA Hybrids in Food security	Prof. Dr. Altus Viljoen, University of Stellenbosch, South Africa
3:45-4:15 PM	Coffee Break	

4:15-4:45 PM	Strategic Actions to Prevent Entrance and Early Detection of Tropical Race 4 of *Fusarium oxysporum f.sp.Cubense* in Latin America y el Caribe	Dr. Miguel Dita, Regional Coordinator of Bioversity International for LAC
4:45-5:30 PM	Black Sigatoka (*Mycrosphaerella fijiensis*): Status and Impact on Plantain and Banana Production in The Antilles	Dr. Luis Perez Vicente, INISAV-Cuba
5:30-6:00 PM	Plenary Discussion of the First Day	EARTH's Students
6:00-6:00PM	Acto Cultural: Tribu International Group	EARTH´s Students

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Second day- Field day 30 July, 2013 Library		
Time	Subject: Field visit	Speaker/Leader
8:00-12:00 AM	Visit to Banana Plantation	Prof. Moisés Soto, EARTH University
	Visit to Organic Banana Project	Prof. Roque Vaquero, EARTH University
	Visit to the Banana Packing Station	Prof. Luis Pocasangre, EARTH University
	Visit to Banana Ripening Center	Prof. Carlos Demerutis, EARTH University
12:00-2:00 PM	Lunch at the EARTH Cafeteria	
Section ll: Food Security		
2:00-2:45 PM	Role of FHIA Varieties to Food Security and Livelihoods of Small Scale Farmers Facing many Biotic Production Constrain in Asia	Keynote Speaker: Dr. Agustín Molina, Coordinator of Bioversity International for Asia Pacific
2:45-3:30 PM	Breaking the Paradigm: Cavendish Cultivars are Not Sterile	Dr. Juan Fernando Aguilar, Leader of the banana and plantain plant breeding programme, FHIA Honduras
3:30-4:00 PM	Coffee Break	
4:00-4:45 PM	Impact of FHIA Hybrids for Food Security in Cuba	M. Sc. José Manuel Alvarez, Former Director of the Musa Program in Cuba
4:45-5:15 PM	Plenary Session and Discussion	EARTH Students

Third day 31 July 2013		
Section lll: Carbon Neutrality and Agronomic Management		
Time	Subject	Speaker/Leader
8:30-9:15 AM	Carbon Neutrality in Banana Crop: EARTH University	Prof. Edmundo Castro EARTH, University
9:15-10:00 AM	Good Agricultural Practices for Sustainable Banana Production	Prof. Moisés Soto
10:00-10:30 AM	Trends in Sustainable Production: Carbon Neutrality, Environmental and Social Responsibility	M.Sc. Arístides Rosales, Manager SERAGRINT, Integrated Agroenvironmental Services, SRL
10:30-11:00 AM	Coffee break	
11:00-11:30 AM	Current Status of Subtropical Sustainable Banana Production in Brazil	M.Sc. Luiz Lichtemberg Epagri, Santa Catarina, Brazil
11:30-12:00 AM	Production and Commercialization of Subtropical Bananas en Brazil	Eliane Mueller, Administrative Manager, ASBANCO, Santa Catarina, Brazil
12:00-12:45 PM	Current Status of the Tropical Race 4 of Panama Disease in China: Basic Research and Management of Pathosystem	Dr. Yi Ganyun, Vice-president of Academic Science, Guangdong Province, Republic of China
12:45-2:00 PM	Lunch	
2:00-2:30 PM	Ecosystems Services of Free-living Soil Nematodes in Banana Plantations	Prof. Dr. Howard Ferris, University of California, Davis, USA
2.30-3.00 PM	Sustainable Management of Plant-Parasitic Nematodes in Commercial Banana Plantations	Prof. Luis Pocasangre, EARTH, University
3:00-3:30 PM	Coffee Break	
3:00:-4:00 PM	Studies on Endophytic Fungi and Biocontrol of phytonematodes of Banana	Dra. Alexandra zum Felde, University of Kassel, Germany
4:00-4:30 PM	Establishment of a Banana Ripennng System for Alternative Markets: Costa Rica Study Case	Prof. Carlos Demerutis, EARTH University
4:30-5:30 PM	Plenary Session and End of Congress	EARTH Students

Abstracts

Abstracts

SECTION I

PLANT BREEDING AND MANAGEMENT OF PESTS AND DESEASES

Current Status of Plant Breeding and Impact of the FHIA Hybrids in Africa

Prof. Dr. Rony Swennen, Breeder and Banana Technologist, Catholic University of Leuven e IITA, Africa.

The Great Lakes Zone in East Africa (Uganda, Rwanda, Burundi, Western Kenya, Western Tanzania and Eastern DR Congo) produces nearly 20% of the global banana production. In this very highly populated area, between 0.5 to 1 kg of bananas are consumed per person per day. 4 million households depend on these bananas, which consist of cooking and beer bananas (85%), dessert bananas (10%) and plantains (5%). Bananas are the backbone of a farming system where up to 60 other crops are intercropped. These bananas suffer especially from nematodes and weevils, and Panama disease, and very recently from bacterial wilt.

In the early nineties millions of people were killed during the genocides in Rwanda and Burundi. At the same time millions of people fled to neighbouring countries, one of them being Tanzania. These refugees were welcomed in the Kagera region, one of the major banana producing regions in Tanzania. While the international community focussed on aiding the refugees, the Belgian and Tanzanian government focussed on supporting the local hosts, which are banana farmers.

First 24 banana varieties and hybrids were imported in 1994 from the International Transit Centre, Belgium. Their selection was made thanks to knowledge gathered during the International Musa Testing Programme overseen by Bioversity International, with some of the testing sites in Uganda and Burundi, and with a similar agro-ecology as the Kagera region. Farmers selected 14 varieties and hybrids and these were multiplied at the project site and many villages. More than 50 demonstration fields and multiplication fields were installed. By 2002 nearly 2.5 million suckers were distributed of which 2/3 came from farmer-to-farmer distribution. While the local varieties produced bunches ranging from 5 to 20kg, the introduced varieties and hybrids ranged from 5 to 50kg. In 2009 a second phase was started involving different components, one of them being again the mass multiplication of the 4 most popular introduced varieties and hybrids, 3 of them being

FHIA hybrids. By the end of 2012 more than 2 million suckers were multiplied by local communities with bunches weiging up to 198 kg. A florishing local trade was established with daily shipments by boat. As more than 0.5 million people raised their income threefold thanks to those hybrids, this achievement was recognized by the United Nations through an award in 2010. Hence the painstaking breeding effort by Dr. Phil Rowe who created these hybrids, has changed the life of many farmers and consumers in Eastern Africa.

Bananas can also be improved by genetic engineering and two field tests were executed. That process will be discussed as well. While genetic engineering offers much prospects for the future, this Kagera case shows that some FHIA hybrids are part of the solution today.

Importance of the INIBAP, IDRC and FONTAGRO on Banana Plant Breeding in Latin America and the Caribbean.

Dr. Nicolás Mateo, Agronomía y Fisiología, Ex Director de INIBAP.

Dr. Ramiro Jaramillo, Agronomía, Suelos y Diversidad Genética, Ex Director de INIBAP

Investments in research and development of producing countries and of organizations and universities that cooperate with them are very significant. Less known, however, is the critical and catalytic role played by bilateral and multilateral cooperative organizations, which have sustained their investments over time, facilitating research, training and dissemination of knowledge. In this presentation, three such organizations are highlighted: IDRC (International Development Research Centre - Canada), INIBAP (International Network for the Improvement of Banana and Plantain) and FONTAGRO (Regional Fund for Agricultural Technology), which have funded and driven projects and programs that enhance the strengths and capacities of producing countries and guided achievements and impacts in genetics, productivity, agronomic management, sanitary practices and value chains.

IDRC began supporting projects in the region early on (1978) and over time, financed projects in several countries, in the breeding program of the FHIA led by Dr. Phil Rowe and at INIBAP, both in international trials and in knowledge management and dissemination activities. The release and evaluation of genetic materials from FHIA was facilitated by the support of IDRC, its contribution to banana and plantain research in the region can be estimated conservatively at CAD $ 5.85 million (unadjusted). The initial vision and philosophy of INIBAP as an independent organization, focused on the distribution (in close collaboration with the International Transit Centre at the Catholic University of Leuven) and evaluation of hybrid and superior cultivars (with direct support from CIRAD's Virus Indexing Center) in various environments; in information systems that would effectively and efficiently connect the global scientific community and regional networks to facilitate cooperative work. The subsequent incorporation of INIBAP into the CGIAR decreased flexibility and visibility. The International Musa Testing Program (IMTP) was financed from various sources, highlighting, however, the estimated contribution of $ 2.5 million made by the United Nations Development Programme (UNDP).

FONTAGRO is a unique and competitive fund (its capital is around $100 million), created by the countries of the region and sponsored by both the IDB (Inter-American Development Bank) and IICA (Inter-American Institute for Cooperation on Agriculture). It has funded about 70 consortia with close to $60 million, provided by the Fund, related organizations and countries alike. The banana sector has had a

strong demand in calls and achieved funding for 7 projects with a contribution from the Fund estimated at $ 2.1 million.

The investments of the countries, research institutes and universities have been considerable; also IDRC, INIBAP and FONTAGRO have played a catalytic role in facilitating significant progress as we will see reflected in this Congress. But challenges also persist and low current investments in traditional breeding leave the dream of Dr. Rowe, to achieve a substitute for Cavendish, still unachieved.

Banana Breeding Programme at Embrapa: Challenges and Opportunities

Dr. Edson Perito Amorim, Programa de Mejoramiento Genético de Embrapa, Brasil.

The banana crop plays important economic and social roles worldwide being cultivated in more than 80 tropical countries, mainly by small growers. Brazil is the fifth worldwide producer, with 6.97 million tons produced in 2011 in approximately 487 thousand hectares. India, the largest producer, harvested 31.89 million tons from 844 thousand hectares during the same period. The main cultivars grown in Brazil are 'Prata Anã - AAB', 'Pacovan - AAB', 'Maçã - AAB', 'Grande Naine' (AAA, Cavendish) and 'Terra - AAB'. They are very susceptible to black leaf streak (Mycosphaerella fijiensis) and, except for 'Terra' and 'Silk', are also susceptible to Sigatoka leaf spot (Mycosphaerella musicola). 'Grande Naine' and 'Terra' are resistant to Fusarium wilt race 1 (*Fusarium oxysporum f. sp. cubense*), 'Silk' is highly susceptible and the remaining cultivars moderately susceptible. Nematodes, especially Meloidogyne spp. and Radopholus similis, and the banana weevil borer (Cosmopolites sordidus) are also responsible for high yield losses since most cultivars used by growers are susceptible. As to virus diseases, until now, only banana streak viruses (BSV) and the Cucumber mosaic virus (CMV) were registered on banana in Brazil. Another very important disease is Moko bacterial wilt, caused by Ralstonia solanacearum race 2; all cultivars used in Brazil are susceptible to this disease.

The search for cultivars resistant to pests and diseases through germplasm selection or the generation of new cultivars via hybridization is considered the most efficient means of control. Such improved cultivars may provide higher yield and a decrease in production costs due to decreased use of control methods and lower costs for crop management, thus increasing the net income of the producer in general. Banana breeding started at Embrapa in 1976, based mainly on the improvement of (AA) diploids, which are then crossed with triploids (Prata type and Silk) and tetraploids (Prata type and Silk hybrids), generating AAB triploid and AAAB tetraploid hybrids of the Prata and Silk types. The objective of the breeding program is to develop high yielding genotypes, with shorter plant stature, shorter cycle and resistance to main pests and diseases, and with fruits having the flavor of either Prata or Silk bananas.

Throughout its 36 years, the banana breeding program at Embrapa has recommended the following cultivars: Caipira (AAA), Thap Maeo (AAB), Prata Graúda (AAB), Prata Baby (AAB - Nam), Pacovan Ken (AAAB), Japira (AAAB), Vitória (AAAB), Preciosa (AAAB), Tropical (AAAB), Maravilha (AAAB), Caprichosa (AAAB), Garantida (AAAB), and Princesa (AAAB) many of which obtained by crosses with improved diploids developed by the program. The most important cultivators in Brazil, Prata Anã and Pacovan were also recommended by Embrapa Cassava and Fruits at the end of the 1980s from a selection of superior genotypes.

Phil Rowe's Legacy: Enabling Sustainable Banana Production with Disease- and Pest- Resistant Hybrids.

Dr. Randy Ploetz, Fitopatólogo, Universidad de Florida.

Phil Rowe faced enormous challenges when he came to Honduras in 1969. Panama disease had destroyed Gros Michel plantations throughout the region and the trades had converted to the problematic Cavendish subgroup. Phil's charge was to develop a replacement for Cavendish, should problems on it arise after it was grown on a large scale. Ideally, this replacement would retain the superior post-harvest qualities of Gros Michel fruit, would resist Panama disease and Sigatoka leafspot, and would yield as well as Cavendish. The enormity of that task should be clear to all who study this crop, and it is unfortunate that some measure the success of Phil's program by his failure to produce an export-ready cultigen with the above attributes.

Phil made two major contributions to banana improvement. First, he developed disease- and pest-tolerant hybrids that could be used as pollen parents and which were crucial to the success of the FHIA breeding program. Clearly, the productive FHIA cultigens would not have been produced without SH3142, SH3362, SH3437 and other male parents; they enabled the introgression into hybrid lines of tolerance to Panama disease, the Sigatoka leafspots and nematodes without undesirable fruit traits and agronomic qualities that were associated with previous male parents.

Second, Phil produced cultigens that addressed the needs of a wide array of banana producers and consumers. His high-yielding, disease-tolerant hybrids include the plantain-like FHIA21 AAAB, the AAB dessert-type bananas FHIA01 (Goldfinger) AAAB and SH3640 AAAB, the cooking bananas FHIA03 AABB and FHIA25 AAB, and FHIA23 AAAA, which comes close to meeting the difficult and very high standards of the export trades.

This meeting and the banana hybrids that Phil produced are testaments to his achievements and the value that his colleagues place on contributions he made to banana improvement. Specific disease and pest attributes will be discussed for the most important products of Phil's career.

The current status of Panama disease research in Africa and the importance of the FHIA hybrids in food security

Prof. Dr. Altus Viljoen, Fitoprotección, Universidad de Stellenbosch, Sudáfrica.

Banana is considered an essential source of food and income to millions of Africans. The crop has been introduced hundreds of years ago, and has since been cultivated mainly for cooking and beer brewing. The more recent popularity of sweet, desert-type bananas as fresh fruit for local and export markets, however, has led to the introduction of pests and diseases in planting material which now threatens continued production throughout the continent. One such a disease is Fusarium wilt (Panama disease), caused by the soil-borne fungus *Fusarium oxysporum* f. sp. *cubense* (Foc). Foc was first discovered in Africa in 1924 following attempts by United Fruit Company to move their production of export bananas to Sierra Leone, Nigeria and British Cameroon. From there the disease was spread in infected planting material to neighboring countries throughout West Africa. A second introduction occurred in East Africa during the 1950s; this time potentially from the Indian subcontinent, from where varieties such as 'Pisang Awak', 'Sukari Ndizi' and 'Silk' were introduced. Desert bananas in both West and East Africa are affected by Foc races 1 and 2. Reports of Fusarium wilt affecting East African Highland bananas (EAHB-AAA) and plantains (AAB) have not been confirmed. From countries where Cavendish bananas are cultivated (South Africa and the Canary Islands), only VCG 0120, representing Foc 'subtropical' race 4 (STR4), has been reported. The origin of Foc STR4, however, is still unknown. In an attempt to manage Fusarium wilt and other banana diseases on the African continent, and to increase yields, several banana varieties produced at FHIA had been evaluated. FHIA-01 and FHIA-18 were resistant to Foc STR4; and FHIA-1, FHIA-17, FHIA-21, FHIA-23 and FHIA-25 resistant to Foc race 1. FHIA-17 and FHIA-23 also showed good resistance to black Sigatoka (*Mycosphaerella fijiensis*) and were reported to tolerate the banana weevil. In South Africa, SH-3640 and a natural mutation of FHIA-01 were highly tolerant to Foc STR4. Despite their clear value to the African banana industry, none of the FHIA material was adopted as replacement for existing varieties. The most significant threat to future production in Africa is Foc 'tropical' race 4 (TR4), which has as yet only been reported from Asia. With the expansion of Cavendish banana production in Southern Africa and the poor regulation of quarantine organisms, the introduction of Foc TR4 into the continent might devastate future production. For this reason EAHB, plantains and numerous other banana varieties are now being evaluated for resistance on the Asian continent.

Strategic Actions to Prevent Entrance and Early Detection of Tropical Race 4 of *Fusarium oxysporum f.sp.cubense* in Latin America y el Caribe

Dr. Miguel Dita, Coordinador de Bioversity International para LAC.

Fusarium wilt of banana (*Fusarium oxysporum* f. sp. *cubense* - Foc), known as Panama disease, has historically been the most destructive disease of this crop. Foc Race 1 seriously impacted the export banana industry in Latin America and Caribbean (LAC), formerly based on the variety 'Gros Michel'. The solution was to replace 'Gros Michel' with resistant Cavendish varieties. The emergence in Southeast Asia of the tropical race 4 (TR4), which severely attacks Cavendish varieties, caused alarm bells to ring because Foc TR4 also affects a large group of varieties (about 50), many of which are essential for food security and income generation of small producers. In the absence of resistant Cavendish varieties, management options for Foc TR4-free areas such as LAC are to: a) prevent the pathogen reaching the production area and b) build capacity for the early detection and handling of possible outbreaks of the pathogen. Bioversity International, its MUSALAC network partners, the National Plant Protection Organization (NPPO) and the International Regional Organization for Animal Health (OIRSA) have been developing a strategic prevention plan and regional training to identify Musaceae quarantine pests, with emphasis on Foc TR4. The plan includes at least 9 countries in the region and the development of a contingency plan. This paper provides details of the strategic actions for the prevention of entry and early detection of Foc TR4 in LAC and highlights key aspects of plant protection and qualified laboratories for the molecular detection of Foc TR4.

Black Sigatoka (*Mycrosphaerella fijiensis*): Status and Impact on Plantain and Banana Production in The Antilles.

Dr. Luis Pérez Vicente, Epidemiology, INISAV, Cuba.

Musaceae are of great importance from the economic, social, cultural and environment standpoint in the Antilles, where they form an important component of the gross domestic product of the countries. Black Sigatoka (SN) is the most damaging disease of *Musa* and considered among the 10 diseases that threaten global food security. The first report in the Antilles was in Cuba (1991), followed by Jamaica (1995), Florida (1998), Haiti (1999), the Dominican Republic (2006), Trinidad and Tobago (2003), Bahamas (2004), Grenada (2006), St Vincent & Grenadines (2009), Guyana (2009), St. Lucia (2010), Martinique (2011), Guadalupe (2012) and Dominica (2012; probably previously present). Its emergence in most countries has lead to a rise in production costs, declining export volumes and fruit quality, abandonment of farms by producers who could not afford the costs, a change in consumption habit because of the adoption of clones with partial resistance (in Cuba, Dominican Republic and Jamaica) and has had a strong impact on the GDP and the environment of the countries in question. Among the factors that influence the effectiveness of SN management in the region, there are legislative issues, lack of funding due to institutional and organizational problems, topography and size of farms, high rainfall, dependence on chemical inputs, the lack of training on disease and alternative management measures, inadequate infrastructure and environmental regulations (Guadeloupe and Martinique). The disease is managed by integrating cultural measures (nutrition, irrigation systems), removal of affected leaves, fungicide treatments both programmed and with the support of weather warning systems and monitoring of disease resistance. In production systems for local consumption, the use of partial resistance clones is most effective for disease management. Among the clones used today are FHIA 01, 02, 03, 17, 18, 21 and 25.

SECTION II

FOOD SECURITY

Role of FHIA Varieties to Food Security and Livelihoods of Small Scale Farmers Facing many Biotic Production Constrain in Asia.

Agustín Molina, Coordinator of Bioversity International in Asia Pacific.

Bananas, both dessert and cooking types, are very important sources of foods and livelihoods of millions of people in Asia, the center of diversity of the genus *Musa.* In this region, the crop is challenged by various devastating diseases and other production constraints, many of which are not present in other regions. Banana breeding to alleviate these constraints has been tried in the region and elsewhere with modest success.

The breeding programme of Chiquita Brands, eventually donated to the *Fundacion Hondurena de la Invenstigacion Agricola* has successfully produced varieties that are high yielding and resistant to several major diseases. However, these varieties did not meet acceptability in the export market of Latin America. Named as FHIA varieties, seven of these were included in the International Musa Testing Programme (IMTP) of Bioversity International (International Network for the Improvement of Bananas and Plantain) in Asia for yield performance, resistance to important diseases, and acceptability to local market. All the tested FHIA varieties were resistant to Black Leaf Streak (*Mycosphaerella fijiensis*), and in various degrees showed resistance to BBTV relative to some popular local varieties. FHIA 17, 23, and 25 produced big size bunches in all countries where these were tested. However, due to the availability and market acceptability of diversed local banana cultivars grown by farmers, FHIA varieties in spite of their positive traits have not so far been widely adopted in Asia. However, FHIA 17 and 23 are potential alternative of the local and popular dessert bananas that are susceptible to BBTV. FHIA 18, 21 and 25 are potential varieties for banana chips, and are now produced in some niche local markets. The potential of the FHIA varieties has become more relevant with the recent epidemics and spread of Fusarium Wilt Tropical Race 4 in Asia. Most of these varieties are resistant to TR4, relative to many dessert bananas grown by small-scale farmers in Asia.

Breaking the Paradigm: Cavendish Cultivars are Not Sterile.

Dr. Juan Fernando Aguilar, Programa de Mejoramiento Genético de Banano y Plátano, FHIA, Honduras.

Since its foundation in 1890, the export banana industry has relied on one or two clones for production and for that reason, now, need to do 40-52 fungicide applications per year to control Black Sigatoka, at a minimum cost of $ 1500/ha/year.

From 1960-2003, there have been several reasons why conventional breeding to develop Cavendish hybrids resistant to Black Sigatoka has not been used. The initial reason was that in 1962, Simmonds reported that Cavendish varieties have female sterility. Subsequently, Stover and Buddenhagen (1986), in their article "Banana breeding: polyploidy, disease resistance and productivity", reported the results of the evaluation of female fertility of Cavendish banana varieties. The authors reported that pollination of a few hundred clusters of Valery and other Cavendish clones with diploid pollen produced no seeds. From these results, the authors concluded that: "the apparent sterility of the seed of Cavendish varieties (without any investigation to determine or overcome blocks) precludes its use as female parents in conventional breeding programs."

The scientific community accepts these observations as fact and did no additional tests as commercial export banana varieties are triploid and parthenocarpic. The triploid condition causes these varieties produce many sterile ovules and the parthenocarpic process allows the development of fruit without fertilization of the ovules, this information was interpreted by the scientific community as a conclusion, which was not confirmed by other assessments. Thus, it became impossible for our program to propose projects that aim to conventionally breed Cavendish varieties, as theoretically you cannot make the crosses.

In 2002, based on this potential limitation, the first aim of the FHIA program was to determine female fertility rates of Cavendish varieties to outline strategies for improvement. Female fertility of commercial varieties of Cavendish was determined by pollinating 20,000 bunches with pollen from 10 male parents. As a result of these crosses 186 seeds were generated. Embryos of only 40 of these seeds could be rescued, from which 20 hybrid plants were developed.

These results demonstrates that though female fertility of Cavendish group varieties is very low, they cannot be classified as sterile, as cited in the scientific literature up to the present time. The tetraploid hybrid plants that were developed contain three complete sets of chromosomes from the mother and one set of chromosomes from the male parent. This allows for the possibility that tetraploid females gametes produce diploid genomes with two Cavendish genomes which, upon

fertilization by haploid gametes from resistant diploid hybrids, generate second-generation triploid hybrids with 66% Cavendish.

To date, FHIA has developed two tetraploid females, products of crosses between two varieties of Cavendish, these females are now being propagated and crossed with a diploid hybrid that transfers resistance to Black Sigatoka, to finally produce second generation triploid Cavendish hybrids that are resistant to Black Sigatoka.

Cavendish banana growers need to support the development of new Cavendish hybrid or clones that are resistant to Black Sigatoka. Until 2011, developing a transgenic banana was thought to be the only option, as Cavendish varieties were considered sterile, but now FHIA has Cavendish type tetraploid females and diploid males with Black Sigatoka resistance to develop second generation triploid Cavendish.

Impact of FHIA Hybrids for Food Security in Cuba

M.Sc. José Manuel Álvarez, Ex Director del Programa de Musáceas, Cuba.

Banana and plantain crops have great social importance in the diet of Cubans, representing over 50% of starchy crops produced in the country. Cuba's geographical position makes it very vulnerable to hurricanes and tropical storms, which have increased in number and intensity.

Similarly, periods of drought have intensified and have become more frequent. Average annual rainfall does not exceed 1200 mm per year, grouped in two periods: May-June and September-October, and irrigated plantations do not exceed 25% of the total area planted with bananas. In Cuba, Black Sigatoka is controlled with 18 treatments at a cost of $314.10 USD/ha/production cycle in chemicals and agricultural aviation services.

In relation to the makeup of banana clones grown on the island, in 1990, when Black Sigatoka was introduced, there were 30 thousand hectares of Cavendish with a production of 244 000 tonnes. Of this total, 16,856 ha were protected.

The first FHIA hybrids began to be multiplied in 1992 and in 2004 the area planted with them was 16416 ha, with an excess of 322,700 tonnes produced without the use of chemical fertilizers or chemical control of the Black Sigatoka, while areas with Cavendish were reduced to 470 ha, and maintain a similar level when currently protected using aerial chemical control.

This change in the clonal structure and the use of high-density technologies has helped to achieve higher production levels and yields and a savings of over US$3 million a year by concepts of fungicides and agricultural aviation use.

SECTION III

CARBON NEUTRALITY AND AGRONOMIC MANAGEMENT

Carbon Neutrality in Banana Crop: EARTH University

Prof. Edmundo Castro, Carbon Neutral, EARTH University.

With a Greenhouse Gases (GHG) emission of 556.27 tonnes of CO2e emitted in 2012, the EARTH's banana production continues its efforts to reduce and eliminate its carbon footprint in its 323 ha to promote the carbon neutrality of its operations as a contribution to greening banana activity.

The effort, promoted in 2008 as a corporate initiative to further improve the environmental quality in the banana industry, started as a challenge to account for the consumption of emission sources categorized as direct, indirect and other indirect, in which the institution has full or partial control of in its operations. The ISO 14064-1 regulations were used to develop an inventory of emissions, accounting for the quantities of fuels and fossil inputs used in the production and packaging of bananas within the physical scope of the institution.

Accounting, conducted as a GHG information system, contains management procedures and electronic data records, allowing automatic recording of emissions to annually update the inventory.

The effort of accounting and registration of emissions is accompanied by actions directed towards the organization itself, by initializing efforts to reduce and eliminate GHG emissions. As a reduction action, the organization uses the rachis and by-products to feed animal and produce organic fertilizer, and maintains a cover crop in the growing area to promote symbiotic nitrogen fixation and a dynamic and active soil microenvironment. In addition, the 67 ha of forest plantations containing native tropical species eliminate 20 tonnes CO2/ha on average.

Good Agricultural Practices for Sustainable Banana Production

Moisés Soto, Professor of EARTH University

The criterion of sustainability has been indispensable in the International Bananas Market, as consequence of a production towards to environmental care, with social and economical criterions very clear about equity, stability and resiliency of the crop. To reach this goal it´s needed to do Good Agriculture Practices (GAP) and Good Manufacturing Practices (GMP) that are consider fundamental aspects for the worker health, environmental impact and it´s crop mitigation, climate change affection, traceability and inequity for the product.

Recently, the markets as started to worry for the Carbon Footprint of banana cultivation, mitigation and the possibility to reach Carbon Neutral.

The main objective of Costa Rica´s banana activity during the last 20 years has been looking forward to a cleaner production, for this reason the farmers had created through CORBANA the Environmental Banana Commission (EBC), which is in charge of the implementation and fulfillment of the objectives. For this reason most of the banana farms are certified as ISO-14001, SA 8000 Eurep gap and Global gap for example: ‘’Fair Trade’’ and ‘’ Rain Forest Alliance’’, and some farms are preparing to certify as Carbon Neutral overtaking the actual commercial criterions.

The reduction of the 40% of agro-chemical consumption in banana commercial farms is a compromise that Costa Rican banana producers had take. The control of pests and diseases with biotechnology has been increasing in the last years and it´s expected to reduce the use of the pesticides in the same way. The sustainable bananas production in Costa Rica is an unquestionable fact.

Trends in Sustainable Production: Carbon Neutrality, Environmental and Social Responsibility

M.Sc. Arístides Rosales, Manager of SERAGRINT.

At the end of the 1990s, the pressure to banana sector received from the internationally supported socio-environmental movement became unstoppable. It was then that banana producers started to consider establishing policies and commitments that would prove plantation efforts to incorporate environmental responsibility in operations and to improve their image among different interest groups.

Banana growers in Costa Rica took the lead, considering internationally recognized standards as models for the management of on-farm activities, along with the implementation of good agricultural practices, environmental management, quality management, social responsibility, measuring of the carbon footprint and more recently, integrated systems which combine sustainability with the above listed components.

Regulations such as GLOBAL G.A.P. have been implemented and have certified 98% of the banana plantations in Costa Rica. This example is being replicated throughout the global banana industry, and constitutes one of the best-established protocols and is most recognized standards by the demanding consumer markets for fresh fruit markets.

The great challenge for the sector is to continue working on incorporating schemes in line with social and environmental responsibility as models of true development that link the banana production to a more prosperous and above all a more solidary society.

Current Status of Subtropical Sustainable Banana Production in Brazil

M.Sc. Luiz Lichtemberg, Banana Production, Epagri, Brazil.

Banana cultivation in subtropical environments of Brazil occupies 123,600 hectares, with a production of 2,442.8 thousand tons of bananas a year, i.e. 24.6% and 33.3% of the country's total, respectively. This production is located in the states of São Paulo, Santa Catarina, Paraná, Rio Grande do Sul and southern Minas Gerais and Mato Grosso do Sul. Mainly small farmers with family farms are involved in this type of banana production. Here we discuss the current climatic problems in the zone, the organization of banana producers, the technologies used, the sustainability of the activity, technological gaps, trade opportunities, the comparative advantages of bananas produced in the subtropics of Brazil, and anticipated changes due to climate change. The presence of the crop in subtropical zone of the South and Southeast of Brazil is possible as 56.75% of the Brazilian population live in the area and due to the proximity of important markets (Argentina and Uruguay). Furthermore, despite the climate, crop productivity is higher than the national average. The low use of agrochemicals is feasible thanks to climatic constraints to pests and the use of collective monitoring systems and cultural practices. In Santa Catarina, for example, spraying against Black and Yellow Sigatoka is done 5-7 and 2-3 times per year, in the North and South of the State, respectively. Climatic zoning scenarios that predict increased air temperatures in the region, the expansion of areas suitable for growing bananas in the Brazilian subtropics are forecast.

Keywords: climate zoning, temperatures, frost, rain, Sigatoka.

Production and Commercialization of Subtropical Bananas en Brazil

Eliane Mueller, AdministrativeManager de ASABANCO, Brasil.

Banana fruit is the second most consumed by the Brazilians, which is why it is of extreme importance in the social power of the low-income population and on the question of the jobs generated in the production.

The state of Santa Catarina is located in the south of the country, which has a subtropical climate, where it is cultivated in 80 municipalities with a total of 668.003 tonnes. Banana production in Corupá stands out because of its quality and its high concentration of brix degrees and Santa Catarina bananas are known for its characteristic sweetness in the subtropical climate. The production of the State is grown exclusively by family farmers that are driving the strength of the associative practices causing the union of the sector that suffers most from the large fluctuation of the price of the fruit at certain times of the year, mainly due to the bad weather.

According to the FAO global average consumption of banana is of 9 kg per person, unlike the Brazilian that consumes on average 29 kg per person per year. The Brazilian production of 98% is consumed in the domestic market capital as highlighting the major consumer centers. Regardless of the fact that Brazil is a world producer of bananas, their participation in the international market is still small. In recent years, the country has exported less than 2% of what it does produce. Exports are basically aimed to Mercosur, concentrating its sales to Argentina and Uruguay.

Part of the production of Santa Catarina is marketed in the domestic market and for the states of Paraná, San Paulo, Rio Grande do Sul, Rio de Janeiro, Mato Grosso and close to 15% for countries of the Mercosul mainly Argentina and Uruguay. The largest consumer market is the state of São Paulo, where wholesalers are basically concentrated in CEAGESP, whose mission is to facilitate the marketing, distribution and storage products.

Ecosystems Services of Free-living Soil Nematodes in Banana Plantations

Prof. Dr. Howard Ferris, Departamento de Entomología y Nematología, Universidad de California.

The community structures of assemblages of soil organisms and, therefore, their ecosystem functions, respond to spatial and temporal changes in plant diversity, to subsidies of organic matter, and to heterogeneity of the soil environment. The connectance complexity of the soil food web channels resource flow through sequential chains of trophic interactions, with resources diminishing at successive trophic exchange. The effect of resource distribution among organisms enhances their abundance, biomass, and physiological activity. As a consequence, when other factors are not limiting, it increases their contributions to ecosystem services such as mineralization of nutrients and regulation of opportunistic species. The organisms that contribute to any ecosystem service and that are similar in their behavioral and physiological attributes can be considered to comprise a functional guild. The importance of species diversity within a functional guild is that the myriad soil microhabitats can be optimally exploited and that functional complementarity of the guild in space and time is at a maximum. The keys to soil health and the management of sustainable systems require maintenance of the flow of energy to the functional guilds of soil organisms at each trophic level and to provide a conducive environment for their survival and activity.

Sustainable Management of Plant-Parasitic Nematodes in Commercial Banana Plantations

Dr. Luis E. Pocasangre, Director of Investigation, EARTH University

The main constrain of the root system of commercial banana plantation is related to plant parasitic nematodes (PPN) and the most destructive and responsible for production losses is the burrowing nematode *Radopholus similis.* The conventional way to manage plant parasitic nematodes is with 2 or 3 application of nematicides per year. However with this treatment the majority of banana plantations are reaching the economical thresholds of 10,000 PPN/ 100g roots. This situation indicates that not only the control is inefficient, but also the problem of is not focus just in the population of plant parasitic nematode and we have to consider other factor such as: root health, necrotic index, plantation vigor as well as the population of free living nematodes (FLN), which can play a natural biocontrol of plant parasitic nematodes. In additions, the constrain of nematodes is increasing in old banana plantation in comparison with new plantations, so that we have to renovate old plantation starting for places where are more infested. The management of plant parasitic nematodes with organic amendments reduces the population of nematodes and increases the health of the root system. However the cost of control is more expensive than the use of nematicides. On the other hand when we break down the monoculture and increase the diversity of species in the system increase the number of free-living nematodes and decrease the number of plant parasitic nematodes. The results of the conventional banana farm of EARTH in comparison with organic farm in intercropping with legumes and fruits trees indicate that the population of free living was just 183 FLN/ 250 g soil in comparison with 644 FLN in banana with legumes and 500 FLN in banana with legumes and fruit trees. Regarding to plant parasitic nematodes the conventional farm registered 26,356 PPN in comparison with 9,466 bananas with legumes and just 6,400 PPN in banana with legumes and fruit trees. It is also important to stress that in conventional farm the main PPN was *Radopholus similis* and in organic farms *Helicotylenchus multicinctus* and followed by *Meloidogyne* spp. Regarding to root health the organic system reported lower necrotic index than conventional reaching 17.5% for banana with legumes, 17,6% for banana legumes and fruits trees in comparison with 23.2% in conventional farms.

Studies on Endophytic Fungi and Biocontrol of phytonematodes of Banana

Dra. Alexandra z. Felde, Universidad de Kassel.

Endophytic fungi - fungi that live inside plant tissues without causing symptoms of disease - have long been studied and many have proven to be beneficial to their host plants - either protecting the plants from pests and/or disease or promoting the growth (PGPE) and health (PHPE) of the hosts. Exactly how individual endophytes achieve this is still not completely understood, nor are the effects of multiple inoculations. All the while, the search for novel beneficial or mutualistic endophytes continues to be the aim of many studies.

I would like to present to you the results of one such study, where fungal endophytes from the roots of banana plants were isolates, identified and their nematode-controlling properties studied - both in the laboratory (*in vitro*), in the greenhouse (*in vivo*) and in the field. I would also like to introduce a few concepts that emerged from this study: namely the concept of *in planta* suppression, of transfer of suppression from generation to generation and of endophyte cocktails - which may or may not be the solution to effective biological nematode control in banana plantations.

The study started in the Motagua Valley of Guatemala, where regular monitoring of nematode populations in banana plants (by Del Monte Fresh Fruit, who own and manage the banana plantations) allowed areas of nematode suppression to be identified. Endophytic fungi were isolated from these and other areas, and a selection of endophytes identified as *Fusarium oxysporum* and *Trichoderma atroviride* isolates were tested for nematode antagonistic effects *in vitro* and *in vivo*. After these trials, vegetative compatibility tests (VCG) were done with the *F. oxysporum* isolates to eliminate the possibility that these isolates represented potential pathogens. Once their non-pathogenicity had been established, field trials were set up in Costa Rica, while the effect of multiple inoculations were tested in the greenhouse.

While all these trials proved the nematode control effect of the isoalted endophytes, we were never able to duplicate the incredible nematode control levels seen in the field in Guatemala. It is therefore my firm belief that there is still a lot to be learned by studying systems where nematode suppressive plants have been identified - and that these sites represent the most promising sources of effective biocontrol agents.

Establishment of a Banana Ripening System for Alternative Markets: Costa Rica Study Case

Prof. Carlos Demerutis, Post-Cosecha, Universidad EARTH

The marketing of mature banana in producing countries has a very particular condition, since while it's true they are green fruit growers of excellent condition for the international market; however they have lacks of mature fruit quality in different local markets.

This was due mainly to a lack of proper controlled maturation processes, coupled with the use of lower quality fruit aesthetics. Generally there is the concept that just brings this fruit to warehouses where ethylene gas is applied to achieve the maturation of a batch of freshly harvested bananas.

Some companies choose to purchase controlled maturation chambers and look for internationals distributors, but the high cost of it, as the lack of timely supplies makes them leave the idea. So is common to see in Latin American companies that are dedicated to mature bananas, errors in the construction of maturation warehouses', in the use of appropriate packaging, in the arrangement of the fruit, and especially in the absence of a proper conditioning before and after to the fruit.

Therefore, in this conference we will try to provide a viable alternative for proper controlled maturation of banana production in these areas, using a type of inexpensive camera and efficient maturation process.

Presenter Profiles

Nombre: Prof. Dr. Randy Ploetz
Institución: University of Florida
País: U.S.A.
Especialidad: Fitopatología de cultivos tropicales.
Estudios:
PurdueUniversity
1974 – B.Sc. en Fitopatología.
1984 – M.Sc. en Fitopatología.
University of Florida
1986-Ph.D. en Fitopatología

El Dr. Ploetz, es una autoridad mundial en enfermedades de frutas tropicales. Desde 1990 ha trabajado en más de 34 países y ha escrito más de 300 publicaciones además de editar varios libros, entre ellos: Fusarium Wilt of Banana, Compendium of Tropical FruitDiseases y Diseases of Tropical FruitCrops.

Dr. Ploetz is a world authority on tropical fruit diseases. He has been working in more than 34 countries since 1990, and has written more than 300 publications as well as edited several books of which some of them are: Fusarium Wilt of Banana, Compendium of Tropical Fruit Diseases and Diseases of Tropical Fruit Crops.

Nombre: M.Sc. Arístides Rosales
Institución: SERAGRINT
País: Ecuador
Especialidad: Agro-negocios Ambientales
Estudios:
Universidad de Costa Rica
M.Sc. en Gerencia Agro-empresarial.

Rosales es asesor experto en implementación de sistemas para la calidad, gestión ambiental y responsabilidad social en el sector exportador bananero para el mercado europeo. Además realiza inventarios de gases de efecto invernadero en fincas bananeras de Costa Rica, con la finalidad de certificaciones Carbono Neutralidad.

Rosales is an expert adviser in the implementation of systems for quality, environmental management, and social responsibility in bananas enterprises. He also accomplishes inventories of greenhouses gases in banana plantations in Costa Rica, for carbon neutrality certifications.

Nombre: Dra. Alexandra zum Felde
Institución: Universidad de Kassel
País: Alemania
Especialidad: Protección vegetal
Estudios:
McGillUniversity
1999 - B.Sc. en Environmental Biology and Organic Agriculture
Universität Bonn
2002 - M.Sc. en AgriculturalSciences and Resource Management in theTropics and Subtropics
2008 – Dr. agr. en Phytopathology and Nematology - SoilEcosystemsResearch

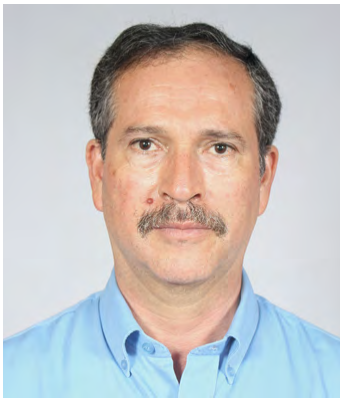
Alexandra es investigadora del Departamento de Agro-ecosistemas de los Trópicos y Sub-trópicos en la Universidad de Kassel en Alemania. Ha realizado trabajos en América, África y el Medio Oriente, entre ellos los estudios pioneros sobre suelos supresivos de fitonematodos en Latinoamérica.

Alexandra is a researcher in the Department of Agro-Ecosystems of the Tropics and Sub-tropics at Kassel University in Germany. She has worked in America, Africa and the Middle East. She also has done pioneering studies on suppressive soils of plant parasitic nematodes in Latin America.

Nombre: Dr. YiGanjun
Institución: Academia de Ciencias Agrícolas de la Provincia de Guangdon
País: República de China
Especialidad: Biotecnología y control biológico.

Ganjun, junto con su equipo, ha realizado diversas investigaciones sobre el cultivo de banano. Entre ellas, conservación de Germoplasma y micro propagación de bananos y plátanos. Entre sus mayores logros el Dr. Yi ha logrado establecer la mayor colección de campo de Musáceas en el mundo. Ha estado trabajando en desarrollar estrategias de manejo de la raza tropical 4, haciendo enfoque en el control biológico.

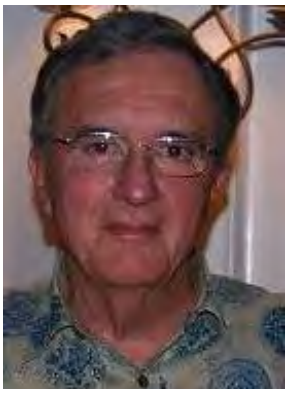
Ganjun, and his team, has been working in several investigations with bananas production, such as conservations of Musa germplasm and micro-propagation. One of his major accomplish is to establish the largest banana worldwide field collection in the world. Dr. Yi also has been working with developing strategies to control the damage of Fusarium wilt in the fields.



Nombre: Dr. Juan Fernando Aguilar
Institución: FHIA Honduras
País: Guatemala
Especialidad: Mejoramiento genético.

Líder del programa de Mejoramiento Genético de la Fundación Hondureña de Investigacion Agrícola. La FHIA es el programa de mejoramiento que ha liberado la mayor cantidad de híbridos a nivel mundial. El Dr. Aguilar tiene gran experiencia en el mejoramiento de bananos exóticos o especiales, banano de exportación y plátanos.

Program LeaderBreeding of the Honduran Foundation forAgriculturalResearch. FHIA has been the breeding program thathas releasedas manyhybridsworldwide.Dr.Aguilarhas a large experience in exotic or special banana breeding, exportbananasand plantains.



Nombre: Dr. Nicolás Mateo
Institución: INIBAP
País: Costa Rica
Especialidad: Agronomía y Fisiología.

Fue Director General de INIBAP y Director General de FONTAGRO. También fue Investigador y Ejecutivo del IDRC del Gobierno de Canadá, y contribuyó al programa de mejoramiento de banano y plátano de la FHIA.

He was the INIBAP Director and CEO of FONTAGRO. He was also Executive IDRC Research of the Government of Canada, and he contributed to the FHIA's improvement banana and plantainprogram.

Nombre: M. Sc. Luiz Lichtemberg
Institución: Epagri
País: Brasil
Especialidad: Agronomía de Bananos subtropicales
Estudios:
1974 – Fruticultura e IngeniereiaAgrícola
1981 – M. Sc. En Agronomía. Universidad Federal do Rio Grande do Sul

Experto en producción y manejo de banano subtropicales. Lichtemberg ha establecido la colección de musáceas más completa en Brasil y ha logrado seleccionar cultivares de tipo Prata Ana con tolerancia al frío en los subtropicos.

Expert in subtropical banana production and management. Lichtemberg has established the most complete collection of Musa in Brazil and he has selected cultivars such as the type Prata Ana, which has cold tolerance in the subtropics.

Nombre: Prof. Dr. Rony Swennen
Institución: Universidad Católica de Leuven e IITA, África
País: Bélgica
Especialidad: Fitomejorador y Biotecnólogo de musáceas
Estudios:
M Sc Faculty of Bioscience Engineering

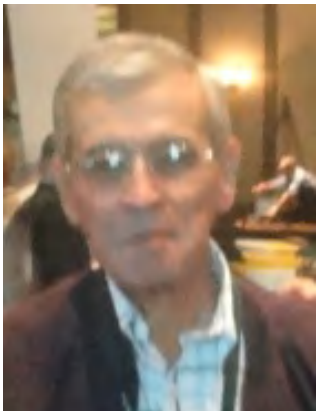
Swennen se hizo cargo de la dirección del Laboratorio de Mejoramiento de Cultivos Tropicales en 1990. Centrado en la mejora de los medios de subsistencia de agricultores en los trópicos mediante una Agricultura sostenible. También estuvo a cargo de la INIBAP en Bélgica. Es profesor de Ingeniería de Biociencias de la Universidad Católica de Leuven.

Swennentookovertheleadership of theLaboratory of Tropical CropImprovement in 1990. Focused on the improvement on the livelihood of subsistencefarmers in thetropicsthroughsustainable agriculture. He wasalso in charge of the INIBAP in Belgium. He teachesBioscienceEngineering at CatholicUniversity of Leuven.

Nombre: Prof. Dr. Altus Viljoen
Institución: Universidad de Stellenbosch
País: Sudáfrica
Especialidad: Fitoprotección

Profesor titular y director del Departamento de Protección Vegetal de la Universidad Stellenbosh. Su trabajo se basa en metodologías clásicas y moleculares para entender el comportamiento del hongo Fusarium. Ha realizado investigaciones en el área de producción de micotoxinas en granos y cereales. Autor y coautor de numerosas publicaciones científicas.

Professor and Director of the Department of Plant Protection at Stellenbosch University. His works are based on classical and molecular methods to understand the behavior of the fungus Fusarium. He has conducted research in the area of production of mycotoxins in grains and cereals. Authorand co-author of numerous scientific publications.



Nombre:M.Sc.Ramiro Jaramillo
Institución: INIBAP
País: Colombia
Especialidad: Agronomía, suelos y diversidad genética

Fue el primer coordinador Regional para América Latina y el Caribe de INIBAP, y Director ejecutivo de la UPEB. Una de sus contribuciones científicas y técnicas se destaca el mapa de suelos bananeros de Costa Rica, además de apoyar el mejoramiento genético de banano y plátano de la FHIA.

Jaramillo was the first Regional Coordinatorfor Latin America and the Caribbean INIBAP and UPEBCEO. One of their scientific and technical contribution shighlights the banana soil map of Costa Rica, in addition to support the genetic improvement of banana and plantain at FHIA.

Nombre: Prof.Dr.Howard Ferris
Institución: Universidad de California, Davis
País: U.S.A.
Especialidad: Ecología de suelo y Nematodos

Howard es una autoridad mundial en ecología de suelos y conocedor de las relaciones e interacciones que se dan entre los nematodos de vida libre y fitoparásitos. Es autor y coautor de más de 200 artículos científicos publicados en diferentes revistas. Howard ha formado parte de proyectos de bioprospección de la diversidad de nematodos, proyectos de calidad y salud de suelos bananeros.

Howard is an expert on soil ecology and he has a large experience with relationships and interactions that occur between free-living nematodes. He is author and co-authored more than 200 articles published in various scientific magazines. Howard has served on bioprospect projects nematode diversity, quality and health projects of banana soils.

Nombre: Eliane Cristina Müller
Institución: Gerente administrativa de ASBANCO
País: Brasil
Especialidad: Administradora de fincas bananeras
Estudios:
Ciencias Biológicas, Facultade da Jangada

Directora Administrativa de la Asociación de Bananicultores de Corupá (ASBANCO), Brasil. ASBANCO es la mayor asociación bananera de todo Brasil que apoya los productores en campo, comercialización y defensa de sus intereses.

Chief Administrative for the Association of Banana Growers in Corupá (ASBANCO), Brazil. ASBANCO is the major banana association in Brazil. They give support to the farmers in the field, commercialization and defense of their interests.

Nombre: Dr. Miguel Dita
Institución: Bioversity International
País: Brasil
Especialidad: Fitopatólogo

Actualmente está actuando como Investigador y Coordinador Regional para el Caribe Commodity Systems y el Programa de Recursos Genéticos del Bioversity International América Latina ytiene experiencia en Agricultura Tropical, con énfasis en Fitopatología. Sus áreas de interés son: la planta y la salud del suelo, la interacción planta-patógeno, resistencia a las enfermedades, y uso de la biodiversidad agrícola para el diseño y los sistemas de producción en el trópico.

Currently is a Researcher and Regional Coordinator for Latin America and Caribbean Commodity Systems and Genetic Resources Programme of Bioversity International. He has experience in Tropical Agriculture with emphasis in Plant Pathology and has worked in different countries, His areas of interest are: Plant and soilhealth, Plant-pathogen interaction; disease resistance, and use of agrobiodiversity for designing and production systems in the Tropics.

Nombre: Dr. Agustín Molina
Institución: Bioversity International
País: Filipinas
Especialidad: Fitopatólogo

Líder del grupo de fitopatología en ChiquitaBrands. Cuenta con una amplia experiencia en Sigatoka, Fusarium y manejo agronómico del cultivo de banano. En la actualidad es Coordinador Regional de Biodiversity International para Asia Pacífico con sede en Filipinas.

Phytopathology Group Leader in Chiquita Brands. He has experience in Sigatoka, Fusarium and agronomic management of banana cultivation. Today is International Biodiversity Regional Coordinator for Asia Pacific, in the Philippines.

Nombre: Dr. Edson Perito Amorim
Institución: Embrapa
País: Brasil
Especialidad: Mejoramiento genético

Líder del programa de mejoramiento genético de bananeras de Empraba. Perito cuenta con una amplia experiencia en mejoramiento genético, biotecnología, genética cuantitativa, marcadores moleculares, bioestadística y biométrica. Es responsable de la disciplina de Genética de Poblaciones en la UEFS y ha sido profesor del curso de Recursos Genéticos Vegetales de la UFRB.

Program Leader banana breeding Empraba. Perito has a large experience in breeding, biotechnology, quantitative genetics, molecular markers, biostatistics and biometrics. He is responsible for the discipline of population genetics at UEFS and he has taught the course for Plant Genetic Resources at UFRB.

Nombre: Dr. Luis Perez Vicente
Institución: INISAV
País: Cuba
Especialidad: Epidemiología y Cuarentena de plagas y enfermedades

Consultor internacional de la FAO. Especialista en epidemiología y cuarentena de plagas y enfermedades en banano, plátano y otros cultivos. Actualmente se encuentra trabajando en una prospección de la diseminación de la Sigatoka negra en el Caribe. También trabajó en el Instituto de Investigaciones de Sanidad Vegetal de Cuba como investigador titular.

Luis is a FAO International Consultant. He is an specialist in epidemiology and quarantine pests and diseases in banana, and other crops. He is currently working on a survey of the spread of black Sigatoka in the Caribbean. He also worked in the Research Institute of Plant Protection of Cuba as a research fellow.

Nombre: M.Sc. José Manuel Alvarez
Institución: Programa de Musáceas en Cuba.
País: Cuba
Especialidad: Curador de banano en Cuba

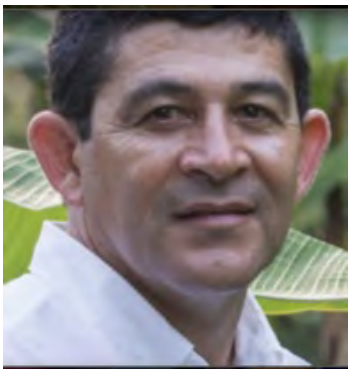
Alvarez impulsó la introducción de los híbridos de la FHIA en Cuba. Los híbridos con los que ha estado trabajando han contribuido con el desarrollo en la seguridad alimentaria del pueblo cubano. En la actualidad existen más de 15000 ha de los híbridos de la FHIA plantados en la isla.

Alvarezpromoted theintroduction ofFHIA hybridsinCuba. The hybridswith which it hasbeen workinghave contributedto the developmenton food securityof the Cuban people. Nowadays,there are more than15,000 haofFHIA hybridsplantedon the island.

Nombre: Dr. Franklin Rosales
Institución: INIBAP
País: Honduras
Especialidad: Fitomejorador
Estudios:
M Sc en Agronomía – Universidad Estatal de Nuevo México
Doctorado – Cría de plantas – Universidad Estatal Oklahoma

Rosales, junto con su equipo de trabajo, desarrolló la variedad Goldfinger y otras variedades de gran importancia en el sector bananero. Contribuyó en el programa de germoplasma de banano en la FHIA. Aportó en varias investigaciones para descubrir variedades que fueran resistentes a enfermedades como Mal de Panamá y sigatoka.

Rosales, along with his team developed the variety Goldfinger and other varieties of great importance in the banana sector. Contributed with the banana germplasm program (FHIA). He brought in several investigations to find varieties that are resistant to diseases such as Panama disease and Sigatoka.



Nombre: Prof. Luis Pocasangre
Institución: Universidad EARTH
País: Honduras
Especialidad: Patógenos de suelos y salud radical de bananos
Estudios:
Dr. en Nematología y Fitopatología.
M.Sc. en Fitomejoramiento.
B.S. en Agronomía

Director de investigación en la Universidad EARTH.. El Dr. Luis ha sido responsable de la coordinación de los proyectos de investigación internacional para el Desarrollo de Banano y Plátano en la región de LAC. También es responsable de los Programas Internacionales de Prueba para MUSA.

The experience of Dr. Luis is notable in the development of banana culture around the world. Luis has been responsible for the coordination of banana an plantain research projects of the International Network for the Improvement of Banana and Plantain at the Regional Office for Latin America and the Carribean INIBAP/LAC and also responsible of the International MUSA Testing Programme (IMTP) for Latin America.

Nombre: Prof.Moisés Soto
Institución: Universidad EARTH
País: Costa Rica
Especialidad: Agronomía del cultivo de banano
Estudios:
Ingeniería en Agrónomía, Universidad de Costa Rica

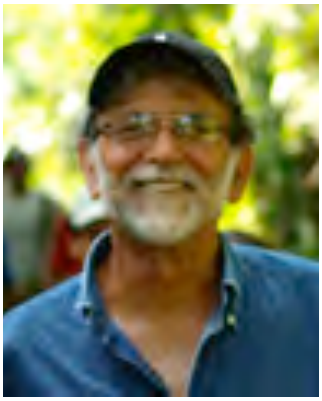
Bautizado como el gran intelectual del banano, el Ing. Moisés Soto ha realizado grandes contribuciones al desarrollo de la actividad bananera a nivel mundial. Don Moisés se ha destacado como mejorador de las prácticas del cultivo de banano a nivel internacional y como empresario bananicultor. En la actualidad Don Moisés se dedica a la enseñanza de clases del cultivo de banano en la Universidad EARTH y la Universidad de Costa Rica.

Baptized as the great intellectual of banana, Ing. Moisés Soto has realized big contributions to the development of banana activity around the world. Mr. Moisés has been pointed out as breeder of the practices of the cultivation of bananas at the international level and as an entrepreneur bananicultor. At the present time Don Moisés is dedicated to the teaching of classes of the banana crop in the EARTH University and the University of Costa Rica

Nombre: Prof. Edmundo Castro
Institución: Universidad EARTH
País: Costa Rica
Especialidad: Carbono Neutro

Profesor y líder de la unidad de Carbono Neutralidad en la Universidad EARTH, Costa Rica. Asesor de empresas agrícolas en el sector privado y público para reducir emisiones de gases de efecto invernadero.

Professorand leader of Carbon Neutrality Unit at EARTH University, Costa Rica. He is also an agricultural enterprises advisor in the private and public sector to reduce emissions of the greenhouse gasses.



Nombre: Prof.Roque Vaquero
Institución: Universidad EARTH
País: Honduras
Especialidad: Riego y drenajes

Vaquero ha aportado en diversas investigaciones en la FHIA, trabajó en ChuiquitaBrands. Sus áreas de interés se relacionan con la investigación e implementación de prácticas y tecnologías que promueven el uso apropiado de los recursos de suelo y agua. Actualmente imparte el curso de Riego y Drenaje en la Universidad EARTH y es asesor de la empresa agro comercial de la misma.

Vaquero has contributed in several investigations at FHIA and he also worked in Chuiquita Brands. His áreas of interest are related to the research and implementation of practices and technologies that promote the appropriate use of land and wáter resources. Currently He teaches the Irrigation and Drainage course at EARTH University and he is the agro commercial company adviser.

Nombre: Prof. Carlos Demerutis
Institución: Universidad EARTH
País: México
Especialidad: Manejo Poscosecha frutas tropicales

Experto en el área de manejo postcosecha. Se ha desempeñado como consultor internacional para la UNDP. Fue profesor del departamento de Biotecnología de la Universidad Autónoma Metropolitana de México y es miembro de la sociedad mexicana para las ciencias de horticultura. Trabajó como consultor en la organización de las naciones unidas para la agricultura.

Expert in the area of post-harvest handling. He has served as an international consultant for the UNDP. He was profesor of the Department of Biotechnology of the Autonomous Metropolitan University of Mexico and a member of the Mexican Society for Horticultural Science. He workedas a consultantin the Food and Agriculture Organitation.

Organizer Profiles

Nombre: Eddie Ochoa Moreno
Institución: Universidad EARTH
País: Ecuador
Estudios:
2009: New Hope Solbery High School, PA, USA
2013: Candidato a Lic. Ing. Agrónomo.
Universidad EARTH, Costa Rica
E-mail:
eochoa@earth.ac.cr

Estudiante de cuarto nivel de la Universidad EARTH, proviene de familia agrícola, dedicada al negocio del banano orgánico por más de 20 años. Realizó experiencia laboral en banano y cacao durante 4 meses en la finca La Victoria de Pepe Encalada en Ecuador, y realiza su Proyecto de Graduación en control de fitonemátodos y salud radical.

He is a forth year student in EARTH University, comes from a farming family who dedicates to organic banana business for over 20 years. He did work experience in banana and cocoa during 4 months on Pepe Encalada's La Victoria farm in Ecuador, and he is doing his Gradution Proyect in phytonematodes control and radical health.

Nombre: B.Sc. Juan Luis Yaque Martínez
Institución: Universidad EARTH
País: Guatemala
Estudios:
2009: Perito Agrónomo, Instituto Adolfo V. Hall. Chiquimula, Guatemala.
2013: Lic. Ing. Agrónomo, Universidad EARTH, Costa Rica.
E-mail:
jyaque@earth.ac.cr / yaque_0904@hotmail.com

Yaque es estudiante de cuarto nivel en la Universidad EARTH. Realizó estudios previos en ciencias agrícolas. Entre sus experiencias figura la asistencia en investigación en cultivos tropicales con el Dr. Luis Pocasangre, cursos académicos sobre el cultivo de Banano con el profesor Moisés Soto y el desarrollo del Proyecto de Graduación: Aplicación de Lixiviados de chira de Banano para el control de Sigatoka negra en Plátano.

Yaque is currently a senior attending at EARTH University. He studied agricultural science before EARTH. Among his experiences include assistance in research on tropical crops with Dr. Luis Pocasangre, academic courses about the cultivation of Bananas with Professor Moisés Soto and the development of his Graduation Project: Application of Bananas florescence lixiviation to control Black Sigatoka in Plantain.

Nombre: Paula Ochoa Moreno
Institución: Universidad EARTH
País: Ecuador
Estudios:
2010: Marcel Laniado de Wind, Ecuador
2014: Candidata aLic. Ing. Agrónomo.
Universidad EARTH, Costa Rica
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mochoa@earth.ac.cr

Ochoa tiene experiencia en la parte de producción de cultivos tropicales y producción de fincas integradas orgánicas. Posee un conocimiento básico de banano, y es conocedora de la administración de fincas de banano convencional y orgánico en países como Ecuador y Costa Rica.

Ochoa has experience in production area of organic tropical crops, she comes from a farming family. She has a basic knowledge about banana production and administration in Ecuador and Costa Rica. Ochoa will work for the next 4 months with Dr. Yi Ganyun at the Academy of Science in Guangdong, China.

Nombre: Raysher Foster Morgan
Institución: EARTH University
País: Costa Rica
Estudios:
2013: Ingeniero Agrónomo con grado de Licenciatura en Ciencias Agrícolas.
Email:
rayfosterm@gmail.com

Candidato al título que otorga la Universidad EARTH de Ingeniero Agrónomo con grado de Licenciatura en Ciencias Agrícolas, Raysher se ha dedicado cuidadosamente a conocer y aprender las prácticas más usuales del cultivo, llegando a entender la necesidad de incorporar cada vez más tecnología de precisión en función a la sostenibilidad y producción.

Candidate for the title of agronomy with bachelor's degree in Agriculture Science that EARTH University confers. Raysher dedicated to discover and learn more about the usual practices in Banana, He has come to understand the need to incorporate increasingly precision technology that works in function with sustainability and production.