INTERNATIONAL WORKSHOP

SURVEILLANCE AND CONTROL OF CASSAVA DISEASES IN AFRICA

PÔLE DE PROTECTION DES PLANTES (3P)
SAINT-PIERRE, LA RÉUNION ISLAND

JUNE 10-13, 2014

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PLANT PROTECTION PLATFORM (3P CENTER)
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Under the leadership of the Global Cassava Partnership for the 21st Century - GCP21, CIRAD and IRD, members of Fondation Agropolis, and members of the CRP-RTB, organize an international workshop on cassava at the Plant Protection Platform (3P Center) in Saint-Pierre (La Réunion, France) from June 10 to 13, 2014.

This workshop will gather more than 40 experts from 13 African countries, as well as representatives from the most important centers, networks and foundations involved in food security in Africa. The main objectives are to constitute a PanAfrican Surveillance Cassava Network for viral and bacterial diseases, and to integrate the active participation of the 3P Center as a technological platform dedicated to control these diseases.

Cassava, a crop most important for global food security

Cassava is the fourth most important source of calories in the developing world and feed an estimated **700 millions people** daily. It is naturally resistant to drought, and it withstands high CO2 concentrations and high temperatures, making cassava THE crop adapted to face global climatic change.

A workshop part of a Global Alliance to fight cassava diseases

In order to respond to the growing threat of viral and bacterial cassava diseases, GCP21 organized in Bellagio, Italy, in May 2013, an international conference on this topic and a RoadMap, known as the **Bellagio RoadMap**[1] was recently published. This document is aligning the milestones of a global plan to better control cassava viral diseases and details immediate, medium and long term actions. The International Workshop in La Réunion, will work on the first milestones of this roadmap, focusing on surveillance, diagnostic and control of these diseases in Africa.

Expertise and contribution of the French Team to control cassava diseases in Africa.

A group of **French scientists, belonging to CIRAD and IR**D, expert in bacteria, viruses and their whitefly vectors, and members of Fondation Agropolis, has decided to form a French Team to respond to the Global Alliance formed gy GCP21 in Bellagio.

The CIRAD team is located at the **Plant Protection Platform (3P Center)** in Saint-Pierre, La Réunion, France. This center has all the

1. A global alliance declaring war on cassava viruses in Africa, Food Security, 2014

facilities, equipment, biosafety environment and scientific expertise to perform detailed comparative studies of cassava pests and diseases, has experience in cleaning and propagating plant material, and is managing several international collections. Because of the isolation of the island of La Réunion, in the Indian Ocean, but close enough to the african continent, is offering to the global alliance, a unique opportunity to develop an **international cassava transit site** to propagate and exchange certified pathogen-free cassava cultivars between continents.

The IRD team is base in Montpellier, France, as well as in Burkina Faso, where it is developing a **regional laboratory (LMI)** for the diagnostic of crop diseases.

Deeply involved in training of young african scientists, the French scientists restate their willingness to participate and contribute to the **building of the next generation of cassava scientists** on cassava diseases. CIRAD and IRD take this opportunity to confirm their dedication and participation to the CRPs of the CGIAR.

The organizers of the international workshop

- The **Global Cassava Partnership for the 21st century** (GCP21) : non-for-profit intependent organization collaborating with several CRPs, and particularly the one dedicated to Roots, Tubers and Bananas (RTB), as well as with all the national and international research and development organizations working on cassava in the world.
- The **Agricultural Research Centre for International Development (CIRAD)** and the **Research Development Institute (IRD)**, members of the **Agropolis Foundation** (Montpellier).

The major objectives of the international workshop

- Make known to **the Global Alliance**, the scientific and technical expertise of the CIRAD and IRD team in cassava pests and diseases to control them more efficiently.
- Make known to the cassava community the potential of **the Plant Protection Platform (3P Center)** in La Réunion, offering a real opportunity to use an existing, well equipped and performing platform, to the service and benefit of the international community to fight cassava diseases.

The specific objectives of the international workshop

- Establish a **panAfrican Surveillance Cassava Network** to limit and control the spread of cassava pests and diseases.
- Coordinate **diversity studies** on **bacteria, viruses and their insect vectors** in Africa.
- Establish at the Plant Protection Platform (3P Center) an **international cassava transit site** to exchange certified pathogen-free cassava material between continents.
- Coordinate and increase the training of young cassava scientists.

ATELIER INTERNATIONAL

SURVEILLANCE ET CONTRÔLE DES MALADIES DU MANIOC EN AFRIQUE

PÔLE DE PROTECTION DES PLANTES (3P) ST PIERRE - LA RÉUNION

DU 10 AU 13 JUIN 2014

Sous l'égide du Partenariat Global Manioc pour le 21ième siècle (Global Cassava Partnership for the 21st Century - GCP21), le CIRAD et l'IRD, membres de la Fondation Agropolis et du CRP-RTB, organisent un atelier international sur le manioc au Pôle de Protection des Plantes (3P) à St-Pierre (La Réunion, France) du 10 au 13 juin 2014.

Cet atelier, réunira des experts de 13 pays africains et des principales institutions, réseaux et fondations internationales impliqués dans la sécurité alimentaire. Cet atelier a pour objectif d'établir un réseau de surveillance panafricain des maladies virales et bactériennes sur le manioc, et d'intégrer le Pôle de Protection des Plantes de La Réunion **comme plateforme technologique au service de la lutte contre ces maladies.**

Le manioc, une culture majeure pour la sécurité alimentaire mondiale

Le manioc représente l**a quatrième source de calories dans les pays tropicaux** où plus de **700 millions de personnes en dépendent** pour leur sécurité alimentaire. Il est naturellement résistant à la sécheresse, répond bien à l'augmentation des teneurs en gaz carbonique atmosphérique, ainsi qu'aux températures élevées, ce qui en fait **une des cultures les plus adaptées au changement climatique** à venir.

Un atelier international qui s'insère dans la mise en œuvre d'un plan d'action mondial

Pour répondre à la menace sans cesse croissante des maladies virales et bactériennes du manioc, le Global Cassava Partnership pour le 21ième siècle (GCP21) a organisé une réunion d'experts à Bellagio, en Italie, en mai 2013. Cette rencontre a abouti à la publication de **la feuille de route de la Conférence de Bellagio**[1]. Ce document pose les bases d'un plan de lutte stratégique mondial contre les maladies du manioc et détaille un certain nombre de mesures à court, moyen et long terme. L'atelier a pour but de concrétiser ces mesures par le lancement des premières étapes de mise en œuvre du plan en ce qui concerne la surveillance et le diagnostic des maladies du manioc.

Expertise et engagements des équipes françaises dans la lutte contre les maladies du manioc

Un groupe de **chercheurs du CIRAD et de l'IRD** membres de la Fondation Agropolis, spécialistes mondiaux des bactéries, des virus du manioc et de leurs insectes vecteurs, a décidé de former une équipe, répondant à l'appel international du GCP21.

1. A global alliance declaring war on cassava viruses in Africa, Food Security, 2014

L'équipe CIRAD est basée au **Pôle de Protection des Plantes (3P)** de Saint-Pierre de la Réunion. Ce laboratoire a **les équipements et l'expertise** pour réaliser en toute sécurité des études comparatives approfondies, l'assainissement et la multiplication de matériel végétal ainsi que la mise en place de collections. La Réunion, en raison de sa situation sanitaire et son insularité, mais également de sa proximité de grands pays producteurs de manioc offre un contexte favorable à l'alliance mondiale pour la création au 3P d'un **site international de transit** pour l'assainissement et la diffusion de variétés de manioc garanties sans maladies.

L'équipe IRD est basée à Montpellier, France, et au Burkina Faso, en Afrique de l'Ouest, où elle a établi un Laboratoire Mixte International (LMI) pour le diagnostic des maladies des plantes.

Largement impliqués dans la formation de jeunes chercheurs des pays du Sud, les scientifiques français réitèrent aujourd'hui leur volonté de former un plus grand nombre de chercheurs de ces pays sur la connaissance des maladies du manioc. Le CIRAD et l'IRD ont par ailleurs récemment confirmé leur engagement dans les programmes de recherche (CRPs) du CGIAR.

Les organisateurs de l'Atelier International

- **Le Global Cassava Partnership** pour le 21ième siècle (GCP21) : organisation à but non lucratif indépendante qui collabore avec plusieurs CRPs dont celui pour l'amélioration des plantes à racines, tubercules et des bananes (RTB) ainsi qu'avec de nombreuses organisations de recherche et de développement sur le manioc dans le monde.
- **Le Centre de coopération Internationale en Recherche Agronomique pour le Développement** (CIRAD) et l'**Institut de Recherche pour le Développement** (IRD) regroupés au sein de la **Fondation Agropolis** (Montpellier).

Les objectifs généraux de l'atelier international

- **Faire connaître** à l'alliance mondiale pour lutter contre les maladies du manioc **l'expertise scientifique et les capacités techniques des équipes du CIRAD et de l'IRD**.
- Faire découvrir **le potentiel et les atouts du Pôle de Protection des Plantes (3P)** qui offre une réelle opportunité comme plateforme technologique internationale au service de la lutte contre les maladies du manioc.

Les objectifs spécifiques de l'atelier international

- établir **un réseau de surveillanc**e panafricain des ravageurs et maladies du manioc entre l'ensemble des acteurs impliqués.
- Coordonner **des études de diversité des bactéries, des virus et de leurs insectes vecteurs** en Afrique.
- Faire du Pôle de Protection des Plantes (3P) **un site international** de transit pour l'assainissement et la diffusion de variétés de manioc.
- Assurer **la formation** de jeunes chercheurs africains.

INTERNATIONAL WORKSHOP
SURVEILLANCE AND CONTROL OF CASSAVA DISEASES IN AFRICA

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	TUESDAY JUNE 10	WEDNESDAY JUNE 11
8h30	**Official opening session** Welcoming	Visit field stations and genetic resources
9h00	**Bernard Reynaud** Presentation of the 3P Center | **P.10**	
9h15	**Valérie Verdier** Presentation of IRD Réunion	
9h30	**Claude Fauquet** GCP21 and objectives of the meeting | **P.11**	
9h50	**Stephan Winter** Bellagio RoadMap | **P.12**	
10h10	**Rwomushana Ivan** Expertise and needs at ASARECA | **P.12**	
10h30	Coffee	Coffee
11h00	**Sangare Abourahmane** Expertise and Need at CORAF | **P.13**	Visit field stations and genetic resources
11h20	**Emmanuel Okogbenin** Cassava needs for Africa | **P.14**	
11h40	**James Legg** Spread of viruses and whiteflies and needs in diagnostic and surveillance | **P.15**	
12h00	**Jean-Michel Lett** 3P expertise in virology | **P.16**	
12h20	**Hélène Delatte** Expertise on whitefly studies | **P.17**	
12h40		
01h00	Lunch	Lunch
02h00	Visit 3P laboratories	Visit 3P laboratories
02h20		
02h40		
03h00	**Maruthi Gowda** Point of view of NRI | **P.18**	**Hortense Diallo** Network in West-Central Africa | **P.22**
03h20	**Valerie Verdier** Cassava Bacterial Diseases: needs and prospects | **P.18**	**Fidéle Tiendrébéogo** LMI Patho-Bios - Diagnostic of pathogens | **P.23**
03h40	**Ralf Koebnik** Bacterial Blight : from Population Structures to Tailored Resistance Genes | **P.19**	**Isabelle Robène** Diagnostic at 3P | **P.24**
04h00	**Wilmer Cuellar** Needs for diagnostic and quarantine measures | **P.19**	**Michel Grisoni** Germplasm broad range virus indexing through NGS: SaFePGR case study | **P.24**
04h30	Coffee	Coffee
05h00	**Peter Kulakow** Needs of an International transit site	**Henri Brouchoud** 3P expertise in databases | **P.25**
05h20	**Marie-France Duval** UE-PRASAC project for sustainable cassava production in Central Africa | **P.20**	**Stéphane Poussier** Training in La Réunion | **P.26**
05h40	**Michel Roux-Cuvelier** Expertise in TC and virus cleaning | **P.20**	**Appolinaire Djikeng** Training at BECA | **P.27**
06h00	**Lava Kumar** Surveillance and example of BBTV | **P.21**	
06h30	Drinks	Drinks
07h00	Diner	Diner

	THURSDAY JUNE 12	FRIDAY JUNE 13
8h30	Group discussions	
9h00		
9h15	**Chairs Legg / Winter** Virus, bacterio and whitefly diagnostic	
9h30	**Chairs Diallo / Kumar** PanAfrican Surveillance Network	
9h50	**Chairs Kulakow / Roux-Cuvelier** International Quarantine / Transit site	
10h10	**Chairs Poussier / Djikeng** Training & Capacity Building	
10h30	Coffee	Volcano La Fournaise
11h00		
11h20		
11h40	Report Group discussions	
12h00		
12h20		
12h40	Press conference	
01h00	Lunch	Restaurant
02h00	Group discussions	
02h20	**Chairs Legg / Winter** Establishing a diagnostic network	
02h40	**Chairs Diallo / Kumar** Establishing a pan-african surveillance network	
03h00	**Chairs Kulakow / Roux-Cuvelier** Establishing international quarantine measures / transit site La Reunion	Conservatoire Botanique National de Mascarin
03h20	**Chairs Poussier / Djikeng** Establishing a training program	
03h40		
04h00		
04h30	Coffee	
05h00	Report Proposals	Hotel
05h20		
05h40		Leaving airport
06h00	Closing session	
06h30	Drinks	
07h00	Diner	

ABSTRACTS PRESENTATIONS

THE 3P CENTER, AN INTERNATIONAL TECHNOLOGICAL RESEARCH PLATFORM DEDICATED TO PLANT PROTECTION

Bernard REYNAUD
Manager Plant Protection Platform (3P) Center
& Director "Plant Communities and Biological Invaders in Tropical Environments" (PVBMT)
CIRAD, Reunion Island

CIRAD's 3P Center is an original and efficient research platform dedicated to the protection of agro-ecosystems and tropical natural ecosystems. The 3P center is located on the tropical island of La Réunion, a French overseas department in the Indian Ocean. The 3P Center, launched in 2002, offers a unique tropical dimension to regional (Indian Ocean), national, and international research communities. It provides high-quality, secure access to tropical experimental conditions and new opportunities for visiting international researchers. The 3P Center hosts permanent users (more than 100 scientists and technicians) such as CIRAD, University of La Réunion, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES), the plant clinic of the Organization for Plant Protection against Pests and Diseases (FDGDON), and two start-up companies in the fields of information and communications technology (eKoal) and in-vitro culture (VitroRun).

The 3P Center is divided into 11 laboratories and comprises innovative and original components: infrastructure for R&D activities such as phytopathology, entomology, molecular biology, genetics, *in vitro* culture and biotechnology; services in pests and plant diseases diagnostic/detection, genotyping, seed quality control, and microscopy; technology and knowledge transfer in plant protection systems, detection tests, plant sanitation, and plant micro-propagation; and training and teaching. The Center contains 1,500 m^2 of laboratories (biosafety containment levels 2 and 3) with up-to-date technologies (2 M€ worth of equipment). The laboratories are designed to receive a broad range of plants, pests, and pathogens, including quarantine virus, bacteria, and arthropods. The 3P Center also has high performance workstations, a specialized library resource center, private and open spaces with internal network and web access, and meeting rooms with videoconferencing systems.

The 3P center contains 15 ha of experimental tropical fields that include 1,950 m^2 of insect-proof shade houses, 2,300 m^2 of insect-proof greenhouses (two BL2 glasshouses), 2,300 m^2 of insect-proof tunnels, and an experimental station in the tropical forest inside La Réunion National Park.

The 3P Center holds three collections in the BRC Vatel: vanilla, tropical garlic, and under-utilized root, tuber and vegetable species.

Since its opening, the 3P Center has produced more than 600 refereed publications, patents, softwares and plant varieties; trained 400 students (including 300 Masters and 60 PhD). The 3P Center and the University of La Réunion are committed to continuing education at local and regional levels. Under the regional program of Plant Protection, more than 150 professionals (researchers, engineers, and technicians) from the Indian Ocean region were trained on plant disease diagnosis, identification of insects, use of databases, and statistics.

GCP21 AND THE GLOBAL ALLIANCE DECLARING WAR ON CASSAVA VIRUSES IN AFRICA

Claude M. FAUQUET
Director GCP21, CIAT, Colombia

Cassava is the fourth most important source of calories in the developing countries and the most important food crop in sub-Saharan Africa. Africa, is the largest producer of cassava in the world (55%), but it has the lowest average yield in the world with 10t/Ha. A productivity of 10t/Ha is below the level of poverty and does not allow farmers to support input to improve yield. In Africa, for more than a century, viral diseases have had a very high impact on cassava and new diseases are emerging. The last pandemic of cassava mosaic disease (CMD), started in the early 90s in Uganda and crossed the continent in 15 years. A new pandemic, the cassava brown streak disease (CBSD), started on the East African coast in 2003 and invaded all the highlands in the East African countries to become the most important constraint to the crop and threatening to spread across the continent. These diseases are both transmitted by whiteflies, and a new super abundant population is present on cassava in East Africa and some countries in West Africa. In addition, cassava bacterial disease has been a recurrent and endemic problem in Africa since the 70s.

GCP21 - The Global Cassava Partnership for the 21st Century - a global organization working on the improvement of yield and products of cassava, is promoting the convening of workshop in La Reunion on establishing a panAfrican Cassava Surveillance Network and an International Cassava Transit Site.

In May 2013, GCP21 conducted a meeting to better address the viral problems of cassava and a RoadMap was published with the participants. The first item of the roadmap is to create a panAfrican network of surveillance and diagnostic of these diseases to survey and limit their spread of CBSD. In addition, there is a risk that CMD and CBSD, through their whitefly vector, could spread in the world, which would be a disaster as all cassava cultivars are susceptible to these diseases, therefore international transit sites for cassava with proper control measures are required. The French team (CIRAD and IRD), working on all these diseases, has the scientific and technical capacity to contribute to these actions in partnership with NARs and CG centers and could host an international cassava transit site in La Reunion. The meeting in St Pierre de La Reunion will focus on these issues.

THE BELLAGIO ROAD MAP

Stephan WINTER
Head, DSMZ Plant Virus Department, Germany

The Global Alliance to combat viruses infecting cassava and to mitigate the impact from the diseases has formulated a number of coordinated actions;

1) to prevent spread and subsequently establishment of Cassava brown streak viruses into cassava growing regions of Sub Sahara Africa;

2) to reduce the incidence of viruses causing CMD and to prevent the global dissemination of these and other cassava diseases. A major task is;

3) to alleviate impact of the diseases through prevention and control of viruses and their whitefly vectors, improved seeds systems and enhanced breeding efforts. All activities will have to be accompanied with;

4) training and capacity building programmes on all actor's levels and an enhanced communication and exchange with stakeholders to raise awareness of farmers and the private sector and to receive appropriate support from policy makers.

A number of short, mid and long term actions are defined and prioritized to; contain CBSD and prevent its further spread throughout cassava growing regions of Africa; prevent global spread of viruses and their whitefly vectors and; mitigate impact of the diseases. The elements of the Road Map will be presented highlighting the actions to be taken and the complexity of the tasks.

EXPERTISE AND NEEDS AT ASARECA

Ivan RWOMUSHANA
Manager, Staple Crops Programme,
ASARECA, Uganda

Cassava, a 21st century crop often regarded the "food of the poor", has become a multipurpose crop that responds to the priorities of Eastern and Central Africa (ECA), due to recent trends in the global economy and climate change. Grown almost exclusively by low-income, smallholder farmers, it is one of the few staples that is produced efficiently on a small scale, without need for mechanization or purchased inputs, and in marginal areas with poor soils and unpredictable rainfall.

ASARECA recognizes strategic importance of this crop and thus between 1994 and 2006, cassava R&D in ECA was implemented through the Eastern and Central Africa Root Crops Research Network (EARRNET). EARRNET sought to transform cassava into a broad-based commercial commodity for income to contribute to socio-economic growth and development, through development, transfer and promotion of market-oriented technologies in collaboration with major sub-sector stakeholders. From 2008, the activities of EARRNET were integrated into the Staple Crops Programme, which until 2011 was involved in cassava R&D value chain activities mainly focused on breeding for CMD and CBSD resistance, capacity building and information and awareness of cassava diseases. Implementing this mission required establishing strategic partnerships with key stakeholders in the cassava subsector. From 2011, the cassava activities in Uganda, Kenya, Tanzania and Ethiopia were incorporated into the Cassava Regional Centre of Excellence (CRCoE), one of the 4 Centre's of the Eastern Africa Agricultural Productivity

Programme (EAAPP). ASARECA has continued to play a convening role for the CRCoE, and technical back-stopping particularly in identifying regional priorities, development of regional projects, technical reviews, M&E, communication and ICT, gender mainstreaming and policy harmonization. ASARECA also continues to mobilize resources for cassava work in other member countries to access varieties and technologies from the CRCoE.

ASARECA will continue its coordination role for collective action and collaboration of cassava value chain actors to solve common regional problems. This would include R&D, support to incubation centres, building public-private partnerships, facilitating the development and brokering for supportive policies on cassava and seek to become the Knowledge and Information Hub for cassava in ECA.

BUILDING SYNERGIES TO CONTROL CASSAVA DISEASES IN WEST AND CENTRAL AFRICA

Abdourahamane SANGARÉ
Program Manager,
CORAF/WECARD, Ivory Coast

Cassava is the fourth largest source of carbohydrates for human food in the world and Africa is its largest center of production. More than half of the 242 million tons of the world production of cassava is produced in Africa, where the production is entirely consumed locally. Its starchy roots are rich in calcium (50 mg/100 g), phosphorus (40 mg/100 g) and vitamin C (25 mg/100 g). The cassava leaves which are also consumed are a good source of protein and minerals. It is a very basic food crop capable of producing its tuberous roots in almost all the cultivable soils of the continent and it needs little attention as compared to other staple crops such as yam, plantain and cereals. Cassava is therefore a very strategic food crop for food security on the continent.

Through its Commissioned Projects Mechanism, CORAF/WECARD has implemented, from 2007 to 2012, two major initiatives on Cassava: the DFID funded DONATA initiative and the USAID funded project on the Control of the Cassava viral diseases. The very successful outcomes of these projects have triggered the development of a new and broader initiative for the diffusion of integrated management approaches to control Cassava diseases (DALIMA initiative) in CORAF/WECARD area. The main objectives of that initiative are to:

1) Identify and share the relevant cassava germplasm available in countries and international centers,

2) Identify and diffuse appropriate disease management methods through an integrated approach,

3) develop capacities of countries to sanitize and multiply relevant germplasm for diffusion to farmers though innovation platforms,

4) develop capacities of Regional Centers of Specialization to detect cassava diseases and develop action plans for intervention,

5) Put in place an early warning system.

This initiative will build on existing projects and will be initially supported by the West African Agricultural Productivity Program (WAAPP). It has the ambition to create at the regional level, a technical and decision making platform in the West and Central African Region, for an effective control of the cassava diseases. The possible partnerships with the international initiatives such as GCP21 and the CRPs of the CG Centers as well as with region focused projects will be discussed; and cooperation mechanisms involving the WAAPP Center of Specialization for Root and Tubers will be proposed.

CASSAVA NEEDS FOR AFRICA

Emmanuel OKOGBENIN
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Cassava is a major source of food in the tropics, and is strategic to food security in Africa. Africa has the vision to use cassava to spur economic growth and rural development.

Two viral diseases, the cassava mosaic disease (CMD) and the cassava brown streak disease CBSD), remain as looming threats to this vision causing severe yield losses in high susceptible varieties.

Initiatives in the last few decades have uncovered dominant gene and quantitative sources of CMD resistance while limited resistance sources exist for CBSD. The dominant gene (CMD2) for CMD is widely and effectively used in conventional breeding, but the necessity to build durable and stable CMD resistance requires efficient strategies to combine it with quantitative resistance.

Molecular breeding strategies offer the best option to track multiple resistance loci in breeding. The development of technical capacity and requisite facilities in NARS breeding programs, are critical. Genotyping and diagnostic labs are needed to analyze and characterize parent materials used as sources of resistance. Majority of improved varieties deployed in Africa, are based on *CMD2* resistance which, with the high risk of evolutionary pressures on viruses, could lead to possible resistance break down.

Identifying and combining different sources of resistance therefore remains a high priority for Africa. A good proportion of farmers still grow susceptible landraces for unique desired traits. Access to relevant technologies to facilitate trait introgression of CMD resistance into such farmer-preferred genetic background are highly desired to reduce the continued cultivation of susceptible cultivars. Transgenic approach is rapidly facilitating this; however, Africa needs to create the regulatory environment to promote access and investment in such technologies. A re-orientation of extension services to promote adoption of improved resistant varieties and good cultural practices to reduce whitefly population, as well as planting of virus-free material, are needed to mitigate disease impact. Improved seed and multiplication systems to rapidly generate and enhance farmer-access to virus-free stems are needed. NARS quest for improved germplasm for cassava genetic improvement demands for an internationally coordinated germplasm exchange to control disease risk. International surveillance platforms to monitor disease and vector are crucial in devising containment strategies to limit damage and activate response plans.

Combatting cassava viruses in Africa will be best implemented under integrated pest and disease management system that involves combining whitefly and viral disease resistance in improved varieties.

SPREAD OF VIRUSES AND WHITEFLIES AND NEEDS IN DIAGNOSTICS AND SURVEILLANCE

James P. LEGG
Scientist,
IITA, Tanzania

Diseases caused by cassava viruses have been recognized from Africa for more than a century, but the recent spread of the pandemics of severe CMD and CBSD has raised their importance to a much higher level. Losses associated with these diseases now exceed US$ 1 million every year.

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The contrasting biological characteristics of the viruses causing these two diseases mean that the cassava mosaic disease (CMD) and cassava brown streak disease (CBSD) pandemics have spread differently, but the common factor driving both is the occurrence of super-abundant populations of the whitefly vector, *Bemisia tabaci*. Both biological and genetic evidence suggest that these populations of insects have changed in a way that has enhanced their adaptation to cassava.

There has been great progress in the development of diagnostics for both viruses and whitefly vectors over the last two decades, with the most rapid progress seen in the development of diagnostic tests for cassava brown streak viruses (CBSVs). For whiteflies, cassava mosaic geminiviruses (CMGs) and CBSVs, it is essential to have robust, reasonably priced and sensitive diagnostic methods in order to facilitate the monitoring of virus/vector presence and spread. Surveillance activities are an essential element of any cassava virus mitigation programme. For CBSD in particular, the cryptic, localized and seasonally ephemeral nature of symptom expression is such that accurate diagnostic testing is an important requirement for schemes that aim to produce planting material with certified levels of quality.

The history of surveillance of cassava virus diseases and their vectors in Africa is relatively short, but the scale and geographic coverage of this work has increased greatly in recent years. Most of this work has been in East Africa, and implemented by Anglophone research networks. As the scale of the pandemics continues to increase, the need for broader continental coverage and integration between both Anglophone and Francophone networks is stronger than ever. The Reunion meeting provides an excellent opportunity to initiate this process, with the long-term goal of enhancing sustainable productivity of cassava in Africa.

MOLECULAR EPIDEMIOLOGY, GENETIC DIVERSITY AND DISSEMINATION ROUTES OF CMGs IN SUB-SAHARAN AFRICA AND THE SOUTH-WEST INDIAN OCEAN (SWIO) ISLANDS

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Cassava cultivation is associated with a wide range of diseases that seriously undermine the food and economic security in African countries. The most notable of these is CMD, caused by a complex of cassava mosaic geminiviruses (CMGs; *Geminiviridae*, *Begomovirus*).

To better understand the epidemiology of CMD as a major constraint of cassava production, we investigated a large-scale plant epidemiological survey in Central African Republic (CAR) and Madagascar, as part of two PhDs with a CAR student, Innocent Zinga (2010-2012), and a Malagasy student, Mireille Harimalala (2010-2012).

CMD was shown to be the most serious constraint to cassava in both countries (Harimalala et al., 2014; Zinga et al., 2013). CMD is distributed throughout the two countries, with an average incidence of 85% in CAR. Importantly, 94% and 95% of diseased plants collected in CAR and Madagascar, respectively, had cutting-derived CMD infection, suggesting that farmers mostly use virus-infected cuttings for planting.

Molecular diagnosis revealed that the causal agents of CMD in CAR, Chad (Zinga et al., 2012), and Burkina Faso (Tiendrébéogo et al., 2009) are ACMV and/or EACMV-UG. We also demonstrated that 58% of CMD samples of CAR present mixed infections (ACMV and EACMV-UG) and that the severity of symptoms was significantly higher in these samples (Zinga et al., 2013). Molecular diagnosis of CMGs in Madagascar revealed an unprecedented diversity of six species: ACM, EACMC, EACMK, EACMV, SACMV, and CMMGV (Harimalala et al., 2014; Harimalala et al., 2012). Distinct geographical distributions were observed for the six species in Madagascar.

While ACMV was more prevalent in the central highlands, EACMV and EACMKV were prevalent in lowlands and coastal regions. Molecular diagnosis revealed that mixed infection (up to four co-infected viruses) occurred in 21% of the samples and was associated with higher symptom severity scores.

All our results suggest that mixed infection and synergism between CMGs could be an important feature in the low yields of cassava plants in these countries, similar to the severe CMD epidemics reported in East Africa. Given the sampling locations, sampling dates, and full genome sequences of hundreds of CMG isolates sampled during 1996–2009, we statistically retraced the historical migration routes of these viruses across sub-Saharan Africa and the SWIO islands (De Bruyn et al., 2012).

Phylogeographic analyses suggest that presence of CMGs on these islands is likely the result of their being introduced at least four times independently from mainland Africa between 1988 and 2009.

Our results suggest that anthropic factors may play a major role in the spread of CMGs, as the principal axes of viral migration correspond with major routes of human movement and commercial trade.

A POPULATION GENETIC APPROACH ON WHITEFLIES VECTORS OF CMGs AND CBSVs

Hélène DELATTE
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Cirad, Reunion Island

CMGs that cause CMD are transmitted by the whitefly *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae). *B. tabaci* is a complex of cryptic species comprising genetically variable but morphologically indistinguishable populations. These cryptic populations vary in host range, fecundity, insecticide resistance, and virus transmission competency (among others). Within this species complex, several species are associated with cassava. Some might be better vectors or the most prevalent vectors of these viruses. Virus transmission was shown to be relatively efficient, indicating that even a small number of whiteflies is enough to transmit the virus and cause disease outbreaks.

In Africa, *B. tabaci*-colonizing cassava have been shown to be different from non-cassava-colonizing species. Those cassava-associated genotypes were raised at species rank and recently renamed as sub-Saharan Africa high-level genetic group (non-silverleafing). During the past decades, outbreaks of *B. tabaci* in many parts of sub-Saharan Africa have become more and more frequent. This whitefly is not only the vector of CMGs. It has also been conclusively proven as the vector of CBSVs. At present, *B. tabaci* is driving the dual pandemic of CMD and CBSD in several East and Central African countries and causing tremendous yield loss every year. Whitefly species diversity on cassava thus still needs more attention as few populations were studied from few African countries.

To fill this knowledge gap, two PhD students (Lensa Sefera Tajebe and Brice Kette Tocko-Marabena) have made recent studies in Tanzania and countries around CAR. Those studies focus on determining whitefly species on cassava plants, together with their associated endosymbionts, and more specific studies on some of those species at a population level. Our knowledge of biology, population genetic, and endosymbionts studies on *B. tabaci* in the Indian Ocean area will contribute to an understanding of the overall scheme of these whitefly upsurges observed together with CMD/CBSD pandemics.

POINT OF VIEW OF NRI

Maruthi M. N. GOWDA
Scientist,
NRI, United Kingdom

Cassava brown streak disease (CBSD) has been a major constraint for cassava production in eastern and central parts of Africa during the last decade. The disease causes necrotic rotting of infected tubers and up to 100% yield loss in susceptible varieties thus affecting the food security of millions of poor in the region. For providing effective control, NRI has been involved in research on many aspects of the disease from field epidemiology to the next generation sequencing. Research on disease epidemiology provided the first evidence of the natural spread of the virus by an insect vector. The whitefly, *Bemisia tabaci*, was subsequently confirmed to be the vector of cassava brown streak viruses which transmits the viruses in a semi-persistent manner. For detecting viruses, highly efficient and cost-effective RT-PCR and real-time PCR diagnostic methods were developed which have been useful for tracking the spread of viruses in the region. In order to provide effective control measures, two complementary approaches are developed; cleaning elite cassava from virus infections by tissue culture and identifying cassava varieties naturally resistant to the disease. Combination of thermo- and chemotherapies and tissue culture methodologies were developed which has proved highly successful for cleaning tolerant cassava lines from virus infections while the cleaned varieties are being re-introduced into Africa. Methodologies were developed for identifying resistance sources by virus inoculation by grafting and subsequently by RNA-Seq to identify genes contributing to virus resistance. RNA-Seq has identified over 600 differentially expressed genes which are currently validated for developing molecular markers. Results of the above many studies and their contribution to controlling CBSD will be discussed.

SURVEILLANCE OF BACTERIAL DISEASES IN AFRICA

Valérie VERDIER
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Research on bacterial diseases of cassava is an important task in fighting against yield losses and will support our goals to reduce poverty and hunger. Given the severity and extent of bacterial epidemics in recent years, achieving stable resistance against diseases is an important goal for breeding programs. Cassava bacterial blight (CBB) caused by *Xanthomonas manihotis* pv. *manihotis* is a disease of quarantine significance that persists in planting material causing devastating crop losses in Africa. With the intensification of cassava crop production this disease can become more destructive. Its negative impact on yield calls for the development of a concerted approach in Africa. Our group is identifying strategies to control CBB. Another goal is to develop diagnostic and molecular tools for CBB that will be useful for surveillance activities of cassava fields in Africa.

BACTERIAL BLIGHT: FROM POPULATION STRUCTURES TO TAILORED RESISTANCE GENES

Ralf KOEBNIK
Director of Research,
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Dr. Ralf Koebnik heads the Bacterial Plant Pathogen Laboratory at the Institut de Recherche pour le Développement in France. His research interests include genomics and transcriptomics of bacterial plant pathogens, bacterial protein secretion, and molecular typing of bacteria. Recent work of the lab has focused on xanthomonads infecting rice, barley, cassava, cotton and banana. Combining molecular plant pathology, population genetics and plant genome engineering, he aims to develop durable resistant crops to the benefit of smallholder farmers.

NEEDS FOR DIAGNOSTIC AND QUARANTINE MEASURES

Wilmer J. CUELLAR
Virologist,
CIAT, Colombia

A combination of new and classic virus diagnostic methods have confirmed the presence of mixed virus infections in cassava grown in Colombia including new virus species not previously reported associated with disease symptoms. Current virus surveys have revealed the widespread presence of these mixed virus infections in Central and South America. At the same time it has been shown that most single virus infections hardly show any symptoms in cassava indicator plants. This stresses the importance of improving methods for seed certification and the updating of local quarantine pathogen lists. For example, for cassava viruses reported in the 1980s such as CsSLV, CsCaMV, CsCSLV and CsALV there are no sequences or antisera available and thus identification by indexing is impractical since it would require time-consuming and expensive virus purification and electron microscopy, and in some cases would not be possible at all. Moreover, some of these viruses could be related to (and possibly even the same as) those novel virus species recently identified. It is therefore suggested that their permanence in quarantine lists should be removed to facilitate the movement of cassava germplasm. On the other hand, for those viruses that can be identified more attention should be given to study their potential presence and distribution in Africa and Asia as it is predicted that they would most likely only contribute negatively to the disease already occurring in these continents. In this context we should invest in basic research to determine the ecology of well characterized cassava viruses and their potential new plant hosts and insect vectors. At the same time we should agree on the best protocol (efficient, sensitive and cost saving) for virus indexing and the early detection of new pathogenic virus species. Altogether the aim is to develop and constantly improve early detection methods and host-virus pathogenicity prediction tools.

CASSAVA GENETIC DIVERSITY IN CENTRAL AFRICA : A SURVEY CONDUCTED WITHIN A UE-PRASAC PROJECT FOR SUSTAINABLE CASSAVA PRODUCTION IN THE CEMAC REGION

Marie-France DUVAL
CIRAD UMR AGAP, France

Originally domesticated in the southern rim of Amazonia, cassava was introduced into Africa by Portuguese in the 16th century at the Congo Estuary and quickly adopted and spread by African populations. Cassava is now a major staple crop for the Central African region. However its productivity is low and farmers face major constraints including recent devastating pandemics of viral diseases.

Faced with this difficult situation, PRASAC and Institutes from the six CEMAC countries developed a regional project funded by EU for sustainable cassava production adapted to local markets (2011-2015). One of the project goals is to improve the knowledge of local genetic resources. For this purpose 753 accessions were collected among five countries: Cameroon, Central African Republic, Congo, Gabon and Tchad. The sampled accessions were analyzed using SSR markers together with 38 American varieties selected for their geographical diversity.

Despite their considerably lower representation the American accessions displayed a higher number of specific alleles. Nevertheless and despite the bottle-neck following their introduction, the African accessions reached high levels of genetic diversity. Although African farmers generally report a strictly vegetative propagation, it is highly probable that sexual reproduction played a major role in the diversification of cassava in Central Africa.

CASSAVA INTERNATIONAL TRANSIT SITE ON LA RÉUNION

Michel ROUX-CUVELIER
Researcher,
CIRAD, France

Located in the Indian Ocean, Réunion Island is relatively isolated. Sanitary conditions are exceptional for growing and studying cassava because no known cassava virus diseases (especially CMD and CBSD) are present and the incidence of other diseases such as CBB caused by *Xanthomonas axonopodis pv. manihotis* remains very low. These favorable factors, together with the presence of the Plant Protection Center's infrastructure and human skills, make La Réunion ideal for developing an international transit site of healthy plant material and so facilitate international exchange of disease-free cassava material in the near future. CIRAD's Bassin Plat and Ligne Paradis experimental stations have more than 10 ha of experimental fields and 4,600 m^2 of insect-proof tunnels or greenhouses. The Ligne Paradis station hosts the Plant Protection Center (Fig. 2A, G), where research in plant pathology and plant genetics is carried out. The 3P Center contains an *in-vitro* culture laboratory and a staff qualified to carry

out plant sanitation programs. Previous similar work was conducted on local varieties of garlic for which two potyviruses, *Onion yellow dwarf virus* (OYDV) and *Leak yellow streak virus* (LYSV), were eliminated by *in-vitro* meristem-tip culture. Two varieties have been cleaned and recorded in the French official catalog of varieties and a production of certified seed has been implemented. Similarly, a local variety of passion fruit contaminated by a potyvirus (*Cowpea aphid-borne mosaic virus*; CABMV) was successfully sanitized using a technique of in-vivo shoot-tip grafting. In recent years, CIRAD has acquired significant experience in the management of plant genetic resources. In 2008, a Biological Resources Centre (BRC) was established within the Plant Protection Center. The BRC is committed to a quality standard according to the French standard AFNOR NF S 96-900. The BRC holds three collections:

1) Vanilla, unique in the world, with about one third of the global diversity

2) Short-day tropical garlic of local and regional interest.

3) "Under-utilized vegetables" of local and regional interest, including a sub-cassava collection consisting of 13 landraces and seven hybrids.

On Mayotte, a French island in the Mozambican channel, CIRAD also manages a collection of 17 cassava landraces, representative of the local diversity.

'ALLIANCE APPROACH' FOR PREVENTION AND MANAGEMENT OF DISEASE EPIDEMICS AND PANDEMICS IN AFRICA

P. Lava KUMAR
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Staples crops are under perpetual threat from emerging and re-emerging diseases in sub-Saharan Africa. A few notable examples are cassava brown streak, banana bacterial wilt, banana bunchy top, maize lethal necrosis and wheat rust. Both natural and manmade drivers are expanding disease outbreaks into epidemics and pandemics in Africa. Despite significant advances during the past two decades in disease diagnosis and control, unequal national capacities and fragmented implementation have limited the effectiveness of these interventions in Africa.

Learning from these experiences, regional alliances adopting a common framework for disease prevention and management have been unveiled as an effective approach to tackle transboundary diseases on the continent. The '*War on Cassava Viruses in Africa*' and '*the Alliance for the Control of Banana Bunchy Top Disease in Africa*' are recent initiatives to tackle important diseases of cassava and banana. Active surveillance for disease outbreaks, early detection, and strategies and resources for emergency response are critical components of these frameworks. Research and development efforts are also being mobilized for better understanding of the disease biology, development of rapid diagnostic tools, finding novel solutions for disease management and even eradication of diseases.

Despite growing optimism, several challenges exist to translate 'alliances' into an effective force in sub-Saharan Africa. This presentation shares the experiences of alliance approach to contain banana bunchy top disease and piloting of a model initiative '*BBTD containment and recovery: building capacity and piloting field recovery approaches through a learning alliance*' to eradicate infected plants and recover banana production across nine pilot sites in Benin, Nigeria, Cameroon, Gabon, Congo Brazzaville, DR Congo, Burundi and Malawi.

NETWORK IN WEST-CENTRAL AFRICA AND CASSAVA PESTS AND DISEASE PROJECTS COORDINATED BY THE UNIVERSITY NANGUI ABROGOUA

Hortense ATTA DIALLO
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The Plant Protection Network PROVEG was set-up by 7 research teams: LVBV-INERA (Burkina Faso), LSA-URAD (Gabon), GEC and SMART (IRD-CIRAD, France), 3P (La Reunion, France), LASBAD (Central Africa) and the coordinating team GRCM (Cote d'Ivoire). PROVEG aims mainly at facilitating research and training collaboration and partnership between team members of the network. The LASBAD team worked on projects that aim to improve the production cassava in Central Africa. It has received the support of the international NGOs (MercyCorps and CRS) and FAO for the dissemination of improved varieties of cassava to the rural population. The team is involved in a regional project entitled: Sustainable Cassava Production and market integration.

The West Africa Agricultural Productivity Program (WAAPP) was initiated by the Economic Community of West African States (ECOWAS) and is funded by the World Bank. In Cote d'Ivoire, the Plant Pathology Unit of the UNA is coordinating the implementation of a WAAPP project. The main project objective is to generate and/or adapt technologies to reduce the incidence of diseases and pests on cassava. The specific objectives are to:

1) make an inventory and to identify pests and diseases of cassava in Côte d'Ivoire;

2) establish maps of the main cassava pests and diseases;

3) know the control methods used against these diseases and pests;

4) provide producers with the necessary tools, data sheets illustrating the symptoms and damage caused by pests and diseases and appropriate control methods. This four-year project involves collaboration with the following partners: UJLG, ANADER, CNRA, IITA and DSMZ.

Another initiative on cassava is the project untitled Production of clean cassava through tissue culture and the establishment of a certification system (PROVACIS). This project was submitted recently in response to a call for proposal made by PReSeD-CI "Projet de Partenariat rénové pour la Recherche au Service du Développement de la Côte d'Ivoire". The objective of the project is to contribute to food security in Côte d'Ivoire by improving cassava production. The associated teams are: the Biosciences Research and Training Unit (RTU)–UFHB, the Agronomy RTU–Univ. of Parakou, CIRAD-La Reunion, and IRD–Montpellier.

Several initiatives in West and Central Africa are implemented with partners from the North. The meeting in La Reunion will be an opportunity to better coordinate our activities and create linkages for the well being of cassava producers.

DIAGNOSTIC OF BEGOMOVIRUSES AND SWEET POTATO VIRUSES IN BURKINA FASO

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Virologist,
INERA, Burkina Faso

In Burkina Faso, diseases represent the main constraint for cassava and sweet potato production. It is known that Cassava is affected by two main viral diseases groups: cassava mosaic disease (CMD) and cassava brown streak disease (CBSD) and also by a bacterial disease called cassava bacterial blight (CBB). CMD is caused by cassava mosaic geminiviruses (CMGs) (Family *Geminiviridae*: genus *Begomovirus*) which are currently the most important constraint to the production of cassava in Africa. CMGs are transmitted by the whitefly vector, *Bemisia tabaci* (Gennadius) and through cuttings from infected materials. Seven species of CMGs with two genomic components (bipartite) have been associated with CMD in Africa. Several strains of the East African cassava mosaic virus (EACMV) species are also described throughout the continent. Among these species, *African cassava mosaic virus* (ACMV) and *East African cassava mosaic virus*-Uganda (EACMV-UG) are described in Burkina Faso with negative impact on cassava production in the country. Recently, one new species of CMGs has been characterized in Burkina Faso, *African cassava mosaic Burkina Faso virus* (ACMBFV).

Sweet potato production in Burkina Faso was limited in 1984 with 15,066 t and has rapidly increased to 61,916 t in 2007 and to 140,061 t in 2011, but the yields remain low, under 10 t/ha. Key constraints have been identified that affect the productivity of sweet potato on small farms in Burkina Faso. These include viral invasion, lack of processing technology, poor availability of quality planting materials and lack of improved cultivars with high and stable yield. A recent survey showed that the following viruses are widespread in Burkina Faso: *Sweet potato feathery mottle virus* (SPFMV) (Genus: *Potyvirus*, Family: *Potyviridae*), *Sweet potato chlorotic stunt virus* (SPCSV) (Genus: *Crinivirus*, Family: *Closteroviridae*) and *Sweet potato leaf curl virus* (SPLCV) (Genus: *Begomovirus*, Family: *Geminiviridae*) and Alphasatellites.

Our activities were focused on analysis and diagnostic development.

DIAGNOSTIC TOOLS AT THE 3P CENTER

Isabelle ROBÈNE
Researcher,
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A team at the 3P Center is developing diagnostic molecular tools for quarantine bacterial and viral plant diseases. The work relies on the abundant and various data obtained from taxonomy, diversity, epidemiology, and genomic studies of the different pathogens, generated by the 3P Center team and collaborators.

Several sensitive and specific PCR-based protocols have been developed to detect bacterial and viral pathogens (e.g detection of *Xanthomonas axonopodis* pv. dieffenbachiae in Anthurium tissues by nested PCR, (Robène-Soustrade et al., 2006. AEM *72*: 1072–1078), detection of *X. axonopodis* pv. allii in onion seeds by duplex-nested PCR (Robène-Soustrade et al., 2010. AEM *76*: 2697–2703), detection and quantification of a wide range of begomoviruses by five duplex real-time quantitative PCRs (Péréfarres et al., 2011. Virol J *8*: 389). These methods are useful diagnostic tools for indexing propagative plant material and for international sanitary surveillance of plant material exchanges. These protocols are intended to be referenced as French official methods and EPPO standards (e.g. *X. axonopodis* pv. dieffenbachiae).

The team has an expertise in comparing and validating different molecular tools (Delcourt et al., 2013. Plant Dis *97*: 373–378) and collaborates with the French agency for food, environmental and occupational health safety (ANSES) to validate the different protocols through both intra laboratories and ring tests involving different European laboratories (Chabirand et al., 2014. Plant Pathol *63*: 20–30). We are also innovating into new DNA-based diagnostic technologies by developing an efficient and portable microarray technology to detect and identify different pathogenic and/or genetic groups of *Ralstonia solanacearum*.

The team's competencies span development, assessment, and validation of diagnostic tools as well as management of collaborative studies. We can rapidly adapt to new challenges such as the evaluation and improvement of the sanitary situation of cassava in Africa. We propose to assess different existing diagnostic tests and to innovate into new DNA-based diagnostic technologies if necessary, in order to optimize the diagnostic of the main viral and bacterial pathogens of cassava in Africa.

BROAD RANGE VIRUS INDEXING THROUGH NGS: THE SAFE-PGR CASE STUDY.

Michel GRISONI
Researcher,
CIRAD, France

Biological Resources Centers (BRCs) conserve and distribute plant germplasm for research and development purposes. As such, they play a strategic role by providing breeding programs with genitors that are critical for crop adaptation to ongoing environmental and societal changes. BRCs must guarantee the sanitary status of the resources they distribute, in order to prevent the spread of diseases, particularly for vegetative propagated that do not benefit from the virus sanitation occurring through a seed cycle.

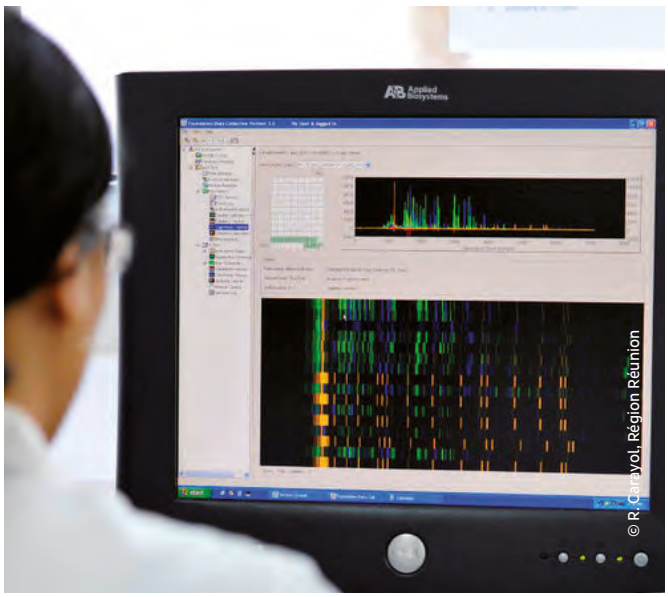
The Safe-PGR project (*Towards Safer Plant Genetic Resources through improved viral diagnostics*) was initiated in 2012 to improve the knowledge of the viruses infecting the crops addressed by four partner's BRCs in Guadeloupe, Madeira, Azores and Reunion, and develop classical or new diagnostic techniques for the species they deal with: banana, garlic, sugarcane, sweet potato, vanilla and yam. The project is funded by the French National Agency for Research and the governing bodies of Azores, Madeira, Guadeloupe and Reunion. The research consortium involves teams from INRA (BFP, ASTRO), CIRAD (BGPI, AGAP, PVBMT), CBA Azores and ISOPLEXIS Madeira.

Methods: The project aims at exploring the molecular diversity of the viral families affecting the targeted crops, optimize classical diagnostic methods taking into consideration data generated through this analysis of viral diversity and develop new multi-pathogen diagnostic methods based on metagenomics and deep-sequencing technologies (Roche 454). Eight nucleic acids extraction methods for metagenomics studies have been tested and compared. Two complementary methods based on the extraction of double-strand RNA and viral particles have been selected. Bioinformatics tools have been successfully developed for analyzing the metagenomics data. These methods are currently used for the screening of 1500 plants from the CRB germplasm collections.

Virus discovery : The preliminary bioinformatics analyses of plant EST databases and of the first deep sequencing results generated, allowed the tentative identification of a total of 25 new viruses in Garlic, Sugarcane, Yam and Vanilla for which new and efficient detection assays have been developed and implemented. Further characterization of a new *Allexivirus* of garlic and new *Potexvirus* of vanilla will be presented.

IT CAPACITIES IN LA RÉUNION ISLAND

Henri BROUCHOUD
IT Manager,
Cirad, France



La Réunion island The Plant Protection Platform Center (3P Center) is CIRAD's largest laboratory and hosts and manages most of the technical IT resources for the entire island.

The IT infrastructure includes all that is necessary for high level science activities : virtualized datacenter, high bandwidth networks, high performance workstations...

Since 2003 the 3P Center has been involved in several regional programs and projects in which it has taken the lead in IT activities, especially the creation and development of a Web portal for biodiversity and sustainable agricultural production. The 3P Center has also helped to develop a database of regional pests and diseases that contains a visual inventory of plant pests and diseases in the Indian Ocean area.

Another project involves innovative applications for smartphones that can automatically recognize plants from pictures, or observation statements and visual diagnosis of plant diseases on the spot.

TRAINING AND HIGHER EDUCATION IN LA RÉUNION

Stéphane POUSSIER
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The 3P Center and the University of La Réunion are closely involved in the supervision of PhD students. Many of them come from priority countries for French cooperation, CIRAD, and the University of La Réunion (e.g., Madagascar, Comoros, Mauritius, CAR, Burkina Faso, Ivory Coast, Vietnam, India). The 3P Center is helping to build capacity of southern universities where most of the joint PhDs provide the necessary support for lecturers that will allow them to supervise research. The 3P Center and the University of La Réunion spearheads the development of the network of excellence for research and higher education in plant health in Africa (http://proveg.org/).

The 3P center is co-holder of the Master's "Biodiversity and Tropical Ecosystems (BEST)" at the University of La Réunion. This master's program allows students to specialize in the field of tropical ecology and agronomy with skills in biology and epidemiology of plant pathogens (viruses, bacteria, fungi) and insects, plant breeding, quantitative genetics, and multi-species interactions and their applications to integrated pest management and agro-ecology. It is a very attractive program (~50 students / year) locally and beyond La Réunion. The 3P Center provides more than half of the courses and hosts approximately 40% of the student internships every year. After 2017, master's students will be directly hosted at the 3P Center.

At the regional level, we provide lessons at the University of Cape Town in South Africa. In Europe, we contribute to master's courses at French and Belgian (Liège, Louvain) universities. We are also involved in the European Master course "Plant health in sustainable cropping systems" (Erasmus+ call for proposals 2014). Typically every year we receive numerous internship students from universities and schools for engineers from France, Belgium and our regional and African partners.

Under the regional program of Plant Protection (http://www.agriculture-biodiversite-oi.org/), more than 150 professionals (researchers, engineers and technicians) from the Indian Ocean region were trained on plant disease diagnosis, identification of insects, use of databases, and statistics. Developed under the project "BioPhyto," a first training in agro-ecological crop protection for professionals was coordinated in 2013. Currently, a virtual module "Invasive insects and agro-ecological management: the case of vegetables flies in La Réunion", is being developed based on a strong collaboration between the National Museum of Natural History (MNHN, Paris), the University of La Réunion, and the 3P Center. This virtual module will be hosted on the platform (http://plateforme-depf.mnhn.fr).

THE BECA-ILRI HUB: ENHANCING AGRICULTURAL RESEARCH AND TECHNOLOGY CAPACITY IN AFRICA

Appolinaire Djikeng
Director, Biosciences eastern and central Africa-International Livestock Research (BecA-ILRI) Hub, Kenya

One of the major challenges posed to addressing Africa's key agricultural productivity (i.e. emerging devastating crop diseases), food security and income generation issues is the low number s of skilled researchers available on the continent.

There are various reasons for this including lack of adequate training and capacity building opportunities and the lack of facilities in which high-end research can be conducted.

The BecA-ILRI Hub is a unique program born out of a partnership between AU/NEPAD and ILRI to begin to address this gap. By offering access to a first class, shared research platform in Africa the BecA-ILRI Hub is empowering African researchers and institutions to harness biosciences innovations for regional impact. The BecA-ILRI Hub is a centre of excellence in agricultural biosciences, which enables research, capacity building and product incubation, conducted by scientists in Africa and for Africa.

Through the BecA-ILRI Hub, a range of biosciences competencies are available for agricultural research including Genomics/Metagenomics; Bioinformatics; Genetic engineering; Diagnostics; Molecular breeding; Vaccine technology/Immunology; and Mycotoxins diagnostics. The Hub also offers access to an international network of scientists through its various partnerships and has training and capacity building programs designed to enhance the agricultural research capacity in Africa. Since its operations from 2007, the BecA-ILRI Hub has demonstrated successes of the innovation approach to capacity building and research designed to align with key agricultural productivity priorities.

The presentation will give an overview of the BecA-ILRI Hub; the facilities, expertise and competencies available for research; and the training programs that have been developed to strengthen the capacity of research in agriculture in particular, research on managing emerging crop diseases.

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