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CGIAR

Workshop report:
IITOOIS for improved cropping systems intensification in mixed RTB systems with plantain in West and Central Africa

10-14 November 2013

Abidjan, Côte d'Ivoire

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RTB Workshop Report

Published by the CGIAR Research Program on Roots, Tubers and Bananas (RTB)

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About the CGIAR Research Program on Roots, Tubers and Bananas (RTB)

Within the new structure of CGIAR, new defined Research Programs should bring together the research synergies, strengths, and resources from multiple centers to increase efficiencies and enhance impacts in achieving global development goals. The Research Program on **Roots, Tubers and Bananas** (RTB) is one of these initiatives; it is led by the International Potato Center (CIP) together with the research centers Bioversity International, the International Center for Tropical Agriculture (CIAT), and the International Institute for Tropical Agriculture (IITA) and Centre de coopération internationale en recherche agronomique pour le développement (CIRAD).

About the workshop

This workshop is funded as part of the RTB complementary grant "Tools for improved cropping systems intensification in mixed RTB systems with plantain in West and Central Africa". The workshop aimed to develop tools for improved research in cropping system intensification in mixed crop systems, including the estimation of yields, yield gaps and intensification potential and for improved research to clarify alternative intensification approaches. How far such approaches are realistic and how much scientific basis for such approaches exists was elucidated in this expert workshop which used mixed crop systems with plantain in West and Central Africa as a case study. The workshop considered what RTB contributes to addressing the problem (Intellectual assets, experience working on this or related problems).

Acknowledgements

This workshop was financed by RTB as part of the complementary planning grant awarded to CIRAD with significant contributions by Bioversity International and IITA. Organizers of the workshop gratefully acknowledge the support of Dr Amoncho Adiko (Director of Research Programs and Development Support of CNRA – National Center of Agronomic Research, and National Coordinator of CNS-Plantain – PPAAO/WAAPP project) and all the staff of CNRA Office in Abidjan, Côte d'Ivoire for supporting the organization, administration and logistical arrangements of the workshop. We acknowledge all the participants for their enthusiastic participation and excellent contributions.

Authors of the report

This report compiles background, presentations and discussion summaries of the workshop participants from the following organizations: Bioversity International, CARBAP, CIRAD, CNRA, CORAF, CSIR-CRI Ghana, IITA, IRAF, IRAG, IRD Congo, NIHORT, Université de Bâle, Université Félix Houphouët Boigny, University of Ghana, University of Agriculture Nigeria, Université de Kinshasa, Université de Kisangani.

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List of acronyms

CARBAP	Centre Africain de Recherches sur Bananiers et Plantains
CGIAR	CGIAR is a global partnership that unites organizations engaged in research for a food secure future
CIAT	International Center for Tropical Agriculture
CIP	International Potato Center
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement - France
CNRA	Centre National de Recherche Agronomique – Côte d'Ivoire
CORAF	Conseil ouest et centre africain pour la recherche et le développement agricoles (in English WECARD)
CRP	CGIAR Research Program
DGRST	Direction Générale de la Recherche Scientifique et Technique
DRC	Democratic Republic of Congo
EAHB	East African Highland Banana
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
IITA	International Institute of Tropical Agriculture
INERA	Institut National pour l'Etude et la Recherche Agronomiques
INRA	Institut National de la Recherche Agronomique
INRAB	Institut National des Recherches Agricoles du Bénin
IRAD	Institute of Agricultural Research for Development - Cameroon
IRAF	Institut de Recherche Agronomique et Forestière – Gabon
IRAG	Institut de Recherche Agronomique de Guinée
IRD-Congo	Institut de Recherche Pour le Développement
NARES	National Agriculture Research and Extension Services

NIHORT	National Horticulture Research Institute
PROMUSA	Mobilizing Banana Science for Sustainable Livelihood
R4D	Research for Development
RTB	CGIAR Research Program on Roots, Tubers and Bananas
TC	Tissue culture (*in vitro*)
UCL	Université Catholique de Louvain
UNIKIN	Université de Kinshasa, DRC
UNIKIS	Université de Kisangani, DRC
WECARD	West and Central African Council for Agricultural Research and Development (in French: CORAF)

List of organizations represented

- Bioversity International (Uganda, Ethiopia and France)
- Centre Africain de Recherche Agronomique sur Bananiers et Plantain, CARBAP-Cameroon
- Centre de Coopération Internationale en Recherche Agronomique pour le Développement, CIRAD-France
- Centre de National de Recherche Agronomique, CNRA-Côte d'Ivoire
- College of Plant Sciences, COPLANT, University of Agriculture-Nigeria
- Council for Scientific and Industrial Research, Crop Research Institute, CSIR-CRI-Ghana
- Department of Environmental Sciences (Biogeography), University of Basel-Switzerland
- Direction Générale pour la Recherche Scientifique et Technologique, DGRST-Congo Brazzaville
- Institut de Recherche Agronomique de Guinée - Conakry
- Institut de Recherches Agronomiques et Forestières, IRAF-Gabon
- International Institute of Tropical Agriculture, IITA-Kenya, Nigeria & Tanzania
- National Horticultural Research Institute NIHORT, Ibadan, Nigeria
- Projet IRD Julien Hanus, Pointe-Noire-Gabon
- Université Félix Houphouët Boigny, Cocody-Côte d'Ivoire
- University of Ghana, Legon-Ghana
- University of Kinshasa, UNIKIN-DR Congo
- University of Kisangani-DR Congo
- West and Central African Council for Agricultural Research and Development, CORAF/WECARD

Tools for improved cropping systems **intensification** in mixed RTB systems with plantain in West and Central Africa

1. Introduction

1.1. Background and workshop objectives

Mixed RTB cropping systems are widespread in West and Central (W&C) Africa. Estimates of low yields are often made for component crops in these systems, although total system productivity is generally not estimated. A three-day workshop was organized to bring together a selected group of plantain and cassava agronomists, economists and sociologists from W&C Africa and diverse IARCs with experience and interest in cropping systems' intensification applied to mixed cropping systems. Mixed cropping systems with plantain were proposed as a case study, although tools and approaches could serve for other RTB cropping systems. The participants identified target cropping systems and proposed activities for methods and tools development in several areas: estimates of individual crop yields and total system yields, the identification of yield gaps and causal factors, estimation of the potential for system intensification and development of intensification alternatives. Experts critically reviewed selected research approaches and results and proposed new approaches addressing shortfalls of previous system intensification attempts. The workshop will make key contributions to the formulation of an RTB-Flagship and will result in a full proposal to generate improved tools and specific technologies for gender-friendly, pro-poor cropping system intensification. The full proposal will be designed to foster collaboration with the Humidtropics CRP.

1.1.1. Problem statement (Dimensions of problem)

Mixed cropping systems are widespread in W&C Africa. RTB crops are common in these systems. Estimates of low yields are often made for component crops in these systems. Plantain yields, for example, are often only 4-5 tons/hectare, according to country statistics, far below plantain yields in monocultures with use of external inputs. Total system productivity is generally not estimated and off-farm input use, per crop, is often low. Yield gaps have recently been employed to measure the potential contribution of research on different technologies to farm household livelihoods. This approach provides valuable perspectives on the relative importance of diverse limiting factors of the yields of individual crops. However, addressing the potential for improvement of total yield of the system, of improving returns on production inputs in the system and of comparing relative returns to alternative uses of production resources may benefit from an expanded tool kit.

The estimation of yields and yield gaps in mixed crop systems presents numerous challenges: total field productivity versus component crop yield; differing cycle lengths for different crops; potential complementarity among crops which increase overall production resource efficiency; and crops in the mixed system linked differently to men and women with different interests and access to resources. In addition, yield gaps for individual crops may not capture a full understanding of system resource or the interaction potential of crop combinations, some of which are at the core of agroecological intensification. The identification of the potential for system intensification may need an improved set of tools beyond individual crop yield gap limits which also need to be taken into account.

With more comprehensive information on mixed systems, including individual crop yields and total field yield and an assessment of limiting factors in yield gaps and of the potential for overall system intensification, the challenge of how to research options and choices for system intensification remains. Even if systems were simplified to allow targeting only one or a small number of crops, increased input use (labor, fertilizer, plant protection, weed control) may be also be needed to increase productivity. Past research concentrated on single crops and single or a few combined interventions and thus did not address the complexity of existing systems. Part of the low productivity of individual crops may be linked to the complexity of the systems, comprising large numbers of crops (targeting food security for different seasons, risk reduction, commercial and food needs, leveraging scarce labor or land) and limiting intensification which usually requires specific inputs for a specific crop. New approaches may be needed that better address the farm household crop yield targets and clarify the returns to alternatives in terms of resource use, crop mixtures and the sequence of management changes. Approaches which take into account livelihood systems, including the role of gender, household dynamics and household differences in resource access and use, along with other socioeconomic factors, will contribute to a more realistic assessment of the potential to increase crop and system yields.

The workshop provided a forum to discuss tool development for improved research in cropping system intensification in mixed crop systems, including the estimation of yields, yield gaps and intensification potential and for improved research to clarify alternative intensification approaches. How far such approaches are realistic and how much scientific basis for such approaches exists was elucidated in the expert workshop which used mixed cropping systems with plantain in West and Central Africa as a case study.

1.1.2. What does RTB contribute to addressing the problem? (Intellectual assets, experience working on this or related problems)

Theme 5 of RTB provides an integrating framework for bringing together appropriate germplasm, pest and disease management and seed systems with better management of abiotic factors, including light, water and nutrients. Building on these multiple themes of relevance for mixed system improvement, RTB is well placed to develop suitable tools which contribute more comprehensive research in development frameworks. The sharpened gender perspective of RTB and the link to markets and processing can add much needed dimensions to more successful technology development. The recent incorporation of CIRAD to RTB as a full partner with their plantain research group and their increasing focus on ecological intensification contributes an important new dimension to RTB.

The proposed workshop builds on literature reviews funded through RTB complementary funding on yield gaps conducted in 2012 and early 2013. The proposed workshop addressing yield gap synthesis is still pending and will be addressed as a component of the new proposal.

1.2. EVIDENCE OF DEMAND

In Cameroon for instance, among the largest plantain producers, the government has determined that the regional market for plantain is about twice as large as the current production. Plantain has a positive income elasticity thus people will spend more money on plantain as incomes increase. Both legal and physical trade barriers with neighboring countries are being removed to promote regional trade in plantain and other staples (largely roots and tubers). In Nigeria the government facilitates the so called Agricultural Transformation Agenda comprising cassava, yam and plantain.

International trade in starchy staple products is increasing and cereal shortages could be bridged with RTB crops. However, current research tools and results have not generated successful models for cropping system intensification. Such tools and resulting research and development outcomes are a vital contribution to market-driven rural income improvement from RTB crops.

1.3. WORKSHOP FORMAT

The workshop was organized in three sections. In the first section, participating countries provided an overview of plantain production systems in their countries, limiting factors and ongoing research. In the second section, invited scientists presented overviews of different methods to characterize mixed food cropping systems and to identify limiting factors. This section culminated in three working groups which provided input into the concept note. In the third section invited scientists presented the latest advances on research approaches to cropping systems intensification. Working groups identified research questions on the important cropping systems of their region. For each section a presentation prepared by the gender focal points from IITA and Bioversity was given to demonstrate the importance of gender and social relations and research methods. The content of each workshop section is provided in the following pages. Links to presentations are given in Annex 8.1.

1.4. INAUGURAL SESSION

The inaugural session was chaired by Dr Amoncho Adiko, Director of research programs and development support of CNRA – National Center of Agronomic Research – Côte d'Ivoire, and National Coordinator of the CNS-Plantain – PPAAO/WAAPP project. He also introduced the relevance of plantain research in RTB for West and Central Africa. Thierry Lescot, an agronomist of the CIRAD banana and plantain program, and Dr Charles Staver, leading the Sustainable *Musa* Production and Utilization Program of Bioversity, welcomed the participants and introduced the RTB program and its efforts to improve plantain cropping systems intensification in the region. Thierry Lescot presented the agenda, purpose and objectives of the workshop. This session concluded with the self-introduction of participants. A complete list of participants is available in Annex 8.2 and the program is given in Annex 8.4.

2. Situation of plantain production in West and Central Africa

2.1. STATUS OF PLANTAIN PRODUCTION, MAIN CROPPING SYSTEMS AND YIELDS, MAIN AGRONOMIC AND SOCIO-ECONOMIC CONSTRAINTS AND RESEARCH STATUS IN COUNTRIES OF THE REGION

Dr. Sunday Oluseyi Akinyemi, of NIHORT, presented the plantain situation in Nigeria (see Annex 8.1.1).

Dr. Beloved Mensah Dzomeku of CSIR–Kumasi, presented the plantain situation in Ghana (see Annex 8.1.2).

Dr. Deless Thiemele, of CNRA, presented the plantain situation in Côte d'Ivoire (see Annex 8.1.3).

Simon Keleke, of General Delegation to the Scientific and Technological Research (DGRST), presented the plantain situation in Republic of Congo (see Annex 8.1.4).

Mathieu Lamah, of IRAG, presented the plantain situation in Guinea (Conakry) (see Annex 8.1.5).

Dr. Moïse Kwa, of CARBAP, presented the plantain situation in Cameroon (see Annex 8.1.6).

Due to the late arrival for the workshop for the representative of Gabon and Democratic Republic of Congo, the presentation of the situation for these two countries was made in group work: Mesmin Ndong Niyoo, of IRAF, for Gabon, and Germaine Vangu Paka, of University of Kinshasa, for Democratic Republic of Congo.

Following overview countries presentations, participants were split into three groups based on regional group of countries and languages (French and English).

- Group 1 (French, zone of 2.6 million plantain production tons) : RDC, Congo, Gabon and Cameroon
- Group 2 (French, zone of 2 million plantain production tons): Côte d'Ivoire and Guinea
- Group 3 (English, zone of 3.9 million plantain production tons): Ghana and Nigeria

Each group discussed plantain production, main cropping systems and yields, main agronomic and socio-economic constraints and research situation in countries and selection of 2 to 3 reference zones for project activity development.

Simplified country profiles regarding plantain status were developed, during the first working group session, based on information shared by the participants (summarized in **Table 1**).

2.2. YIELD GAP REVIEW OF PLANTAIN PRODUCTION SYSTEMS IN WEST AND CENTRAL AFRICA

Dr Lindsey Norgrove, from the University of Basel (Switzerland), Department of Environmental Sciences (Biogeography), and consultant for IITA, presented (Skype presentation from Basel) her work on yield gap review of plantain production systems in West and Central Africa, work review made in March 2013 by contract of IITA in the context of RTB and Humidtropics programs. The link to the presentation is available in Annex 8.1.7.

Dr Norgrove described the concept of yield gaps, based on actual yield, attainable yield and potential yield. Her review of experimental data confirmed the conclusion from plantain producing countries that yield data are not abundant. Virtually no data are available from farmers' fields. Trial data are from first harvest with almost no data on ratoon harvests. She identified certain practices which contributed to increased yield, including boiling water sucker treatment, potassium fertilization and mulching. Experimental yields are only 3.2 – 7.8 tons/ha in researcher managed trials. Many plantain growing countries in WC Africa have national yields in that range.

Table 1. Country situation for plantain production, cropping systems, limiting factors and selection of reference zones.

Country	Plantain production (data CIRAD 2011)	Plantain production (data actualized-> actual workshop country presentation	Limiting factors mentioned in the presentations	Listing cropping systems by importance order (indicating zone)	Choice/selection of 2 to 3 reference zones for project activity development
DRC	1 345 000Mt (CIRAD 2011)	1 552 060Mt (FAO 2011)	1-weevils 2-nematodes 3- planting material 4-BBTD 5-bacterial wilts	1-association with food crops (forest zone) 2-association with perennial crops (coffee, cacao, in forest zone) 3-home gardens (forest zone)	1-Centre-South-Littoral zone -Cameroon/Nord Gabon 2-South Gabon /South Congo 3-South-West DRC 4-Highland West Cameroon
Congo	81 000Mt	75 487Mt (FAO 1996)	1-weevils 2-planting material (cost) 3-lack of roads 4-BBTD	1- association with food crops (forest zone and savannah) 2- home gardens (forest zone and savannah) 3- Plantain monocrop (any cultivar available, without slash & burn, without inputs, forest zone)	
Gabon	110 000Mt	452 000Mt (FAO 2011)	1-planting material 2-cultivation techniques 3-weevils 4-nematodes 5-Yellow Sigatoka/BLS	1- association with food crops (forest zone) 2-association with perennial crops (cacao, coffee, rubber, forest zone) 3-home gardens (forest zone)	
Cameroon	1 300 000Mt	3 400 000Mt (FAO 2011)	1-weevils 2-soils (decreasing fertility) 3-planting material (quality)	1- association with food + perennial crops (forest zone and highlands) 2-association with perennial crops (cacao, coffee, rubber, in forest zone and highlands) 3-association with food crops (forest zone, intermediate zone and highlands) 4-plantain monocrop (forest and highland zones)	
Côte d'Ivoire	1 500 000Mt	1 500 000Mt	1-planting material (quality and quantity) 2-diseases (Yellow Sigatoka/BLS) 3-pests (nematodes, weevils) 4-no fertilizer inputs used	1-association plantain + cacao 2-association plantain + rubber 3-association plantain + food crops (peppers, okra, yam, etc.-) + fallow (5 years) 4-monocrop 5-backyard banana	1-Southern forest zone (CIV) 2-Western forest zone (CIV)

Country	Plantain production (data CIRAD 2011)	Plantain production (data actualized-> actual workshop country presentation	Limiting factors mentioned in the presentations	Listing cropping systems by importance order (indicating zone)	Choice/selection of 2 to 3 reference zones for project activity development
Guinea	445 000Mt	400 000Mt	1-planting material (quality and quantity) resulting in a low planting density 2-diseases (Yellow Sigatoka/BLS) 3-pests (nematodes, weevils) 4-irrigation	1-banana + plantain + rice + fallow (3 to 7 years) 2-plantain + cassava + market gardening (lettuce, tomatoes, etc.-) + fallow 3-plantain + perennial crops (coffee, rubber, cocoa, cola and natural palm) 4-backyard banana	3-Guinea 'forestière'
Ghana	1 680 000Mt	3 538 000Mt	1-seasonalitity 2-pests (nematodes) 3-group marketing 4-poor soil fertility	1-plantain with perennial crops 2-plantain/food crops 3-plantain/other tree crops 4-backyards	1-Joaso-Konongo (Ghana) 2-Agbor (Delta State) Nigeria
Nigeria	2 25 000Mt	3 876 600Mt	1-planting material 2-soil fertility 3-farmer knowledge 4-inadequate water 5-pest and diseases (weevil)	1-plantain with perennial crops-cocoa 2-plantain with food crops 3-perennial plantain with annual food crops 4-backyards	3-Ondo (Ondo State) Nigeria

2.3. ESTIMATING YIELDS AND YIELD GAPS: EXPERIENCES FROM EAST AFRICA

Dr Godfrey Taulya, from IITA (Kampala, Uganda), presented (Skype presentation from Kampala) the experiences on the estimation of yields and yield gaps in East Africa, specifically on the East African Highland banana group (AAA). Link to presentation is available in Annex 8.1.8.

Dr Taulya described the method and some results of studies conducted by the IITA team in East Africa to identify yield gaps and limiting factors. The method is based on one time, repeated visit and farmer collected data. A key element in their approach is an allometric equation which allows an estimate of bunch weight based on plant characteristics. This is a particular challenge when different cultivars are planted in the study zone. He illustrated the results with boundary analysis, linking yield/hectare to specific factors, and bar charts with % plots suffering specific yield limitations ranging from climate to pests and diseases to soil and plant nutrition.

2.4. EVALUATION OF AGRONOMIC PERFORMANCES OF MULTI-SPECIES CROPPING SYSTEMS BASED ON PLANTAINS

Dr Sylvain Dépigny, from CIRAD (CARBAP-Nyombé, Cameroon), presented (Skype presentation from Douala) a study on the evaluation of agronomic performances of multi-species cropping systems based on plantains in one important zone of plantain production in Cameroon. Link to presentation is available in Annex 8.1.9.

Dr Dépigny presented methodological challenges and results of studies conducted in farmers' fields to quantify total yield and plantain yield. His presentation highlighted the challenge of working in mixed food crop systems which are much less diversified in East African Highland systems than in food crop systems with plantains in West and Central Africa. In preliminary results, bunch weights varied from 4 to 28 kg with an average of 16 kg/bunch. He also described methods to characterize nearest neighbors of other species and to estimate of potential yield in monoculture by cultivar.

2.5. SPECIFIC SITUATION OF THE PLANTAIN DIVERSITY IN DEMOCRATIC REPUBLIC OF CONGO

Dr Guy Blomme, of Bioversity International (Kampala, Uganda), presented a study made in collaboration with the University of Kisangani (UNIKIS), the Catholic University of Graben (UCG – Butembo – DRC) and *Katholieke Universiteit Leuven* (KULeuven – Belgium), on plantain collection and morphological characterization in the Democratic Republic of Congo. A link to the presentation is available in Annex 8.1.10.

Dr Blomme described studies on banana and plantain diversity in farmers' fields throughout the middle and upper Congo Basin. The data collected by nine MSc students and being analyzed by a PhD student shows very high plantain diversity in certain forest margins zones of Congo, although up to five cultivars in each region can be identified with greater importance for markets and in farmer fields.

2.6. GENDER ROLES IN CROPPING SYSTEMS WITH PLANTAIN IN WEST AND

CENTRAL AFRICA

Anne Rietveld, of Bioversity International (Kampala, Uganda), presented an overview about understanding gender roles in cropping systems with plantain in West and Central Africa. A link to the presentation is available in Annex 8.1.11.

Anne introduced the concept of gender and social relations, then provided a few examples from studies on plantain production systems in West Africa. She noted that few studies have been published and many studies suffer the classic weaknesses of aggregating all households members as farmers, interviewing only the head of household and considering that women headed households can represent all women. She also presented some guidelines for studies to be undertaken in a new proposal on cropping systems. These included: interviews with diverse members of household, gender-disaggregated analysis for household activities, not only agriculture and production activities, studies on use of resources, decision-making powers and access to benefits.

2.7. CLIMATE SITUATION IN THE DIFFERENT PLANTAIN PRODUCTION BASINS OF THE REGION

Dr Charles Staver, of Bioversity International (Montpellier, France), presented an overview of climate (annual and monthly precipitations and temperatures) in 4 sites in Guinea, 4 sites in Côte d'Ivoire, 4 sites in Ghana, 4 sites in Nigeria, 3 sites in Cameroon, 2 sites in Equatorial Guinea, 2 sites in Gabon, 4 sites in Congo and 7 sites in the Democratic Republic of Congo. Link to presentation is available in Annex 8.1.12.

In response to Dr Staver's initial question to the plenary, about important factors for differentiating zones in terms of plantain performance, participants responded as follows: rainfall amount and distribution, temperature and soils. Participants grouped graphs of monthly rainfall, temperature and potential evapotranspiration into three main groups: lowland monomodal rainfall; lowland bimodal, and lowland year round wet. A few stations were also presented with lower temperatures due to their increased altitude. The presentation closed with a set of slides on climatic zones for West and Central Africa using global weather data bases. Zones are proposed based on total annual rainfall, the length of the dry season and annual average temperature. Use of such zoning can help to plan regional research strategies. These maps are shown in the maps in Section 4 with potential pilot sites.

3. Discussions on cropping systems' intensification, research and development options

3.1. WHAT TO EXPECT FROM MODELING TO ASSIST IN THE DESIGN OF PLANTAIN-BASED SYSTEMS?

Dr Philippe Tixier, from CIRAD (CATIE-Turrialba, Costa Rica), presented (Skype presentation from Turrialba), a specialist on banana cropping systems modeling, elements in modeling which assist the design of plantain based systems. A link to the presentation is available in Annex 8.1.13.

Dr Tixier proposed that models should be designed to explore specific questions. He illustrated the use of models for looking at different strategies for soil fertility management, and for considering how varietal differences can be explored for different production systems and how mixed systems perform. The different questions involve different types of models. He

concluded that at the moment models are not very well adapted to address pest and disease questions. He also concluded that models should use existing data as much as possible and be validated frequently and regularly with field data.

3.2. ECOLOGICAL INTENSIFICATION OF BANANA CROPPING SYSTEMS

Dr Marc Dorel, from CIRAD (Research station of Neufchâteau, Guadeloupe - FWI), presented the experience of research studies on ecological intensification with special emphasis of accompanying plants and agro-ecological services in intensive banana cropping systems. A link to the presentation is available in Annex 8.1.14.

Dr. Dorel reviewed the concept of ecological intensification and explained that service plants provide services such as Nitrogen fixation, improvement of soil organic matter and greater diversity in soil faunal communities. However, such plants may also compete with banana for water and slow growth. The plants must also be adapted to changing conditions in terms of available light from initial banana establishment to full canopy development. He illustrated the proposal for service plants in intensive export banana production in the Caribbean. A fallow period with both grass and legume would contribute to suppression of nematodes. A cover crop would then be established which tolerates shade but is not extremely competitive with banana. Such conditions would contribute to suppression of such pests as nematodes and stem weevils.

3.3. PARTICIPATORY RESEARCH EXPERIENCE ON AGRO-ECOLOGICAL INTENSIFICATION OF BANANA PRODUCTION

Dr Charles Staver presented an overview of experience on participatory research experience on agro-ecological intensification of banana production in Latin America, with special emphasis on systems intercropping bananas with coffee and trees, prototyping agro-ecological intensification systems by farmers and scientists. A link to the presentation is available in Annex 8.1.15.

Dr Staver reviewed the results of a project for the development of agroecological approaches to improving farmer management of bananas in multi-strata perennial crop systems. The approach included a formal survey, participatory farmer learning and experimentation to test prototypes for how the multi-strata perennial crop with banana system could be intensified around concepts of agroecosystem processes and formal studies which provide useful decision criteria. He illustrated how light distribution could be improved based on studies of banana cultivar response to four light levels and the need of the coffee plant for good yields. Farmers and scientists then used this basic information to propose the planting distance and management of banana mats for optimum bunch size which did not disrupt coffee yields.

3.4. CROPPING SYSTEM INTENSIFICATION FROM A GENDER PERSPECTIVE

Anne Rietveld presented her point of view on tools and methods on participatory approaches about cropping system intensification from a gender perspective. A link to the presentation is available in Annex 8.1.16.

Anne addressed the question of how to address the differential effects of alternative technologies of women's access to benefits, use of resources which they control and their role in technology choice. She referred to a baseline study being carried out that would characterize gender norms and agency under different conditions and analyze the implications in each case for agricultural development. She illustrated with tools that contrasted women's versus men's roles in different crops and how men's and women's interests might conflict or overlap.

4. Project structure proposal on RTB cropping systems intensification

Thierry Lescot (CIRAD) proposed a project structure on cropping systems intensification in five work packages (WP) for discussion:

- WP1: tools/methods for objective data: productions/zones (CS), number of household, productivity (plantain + others), yield gap (potential/current), constraints (limiting factors: biotic, abiotic, socio-economics, etc.)
- WP2: global and specific surveys (including field/lab trials to objectively demonstrate some constraints)
- WP3: tools/methods for Cropping Systems intensification
- WP4: participative intensification experiments/tests (models, factorials, etc.)
- WP5: Communication, capacity building, governance, management, dissemination, knowledge and data sharing, monitoring and evaluation.

1. • Dissemination
2. • Communication
3. • Knowledge sharing, data sharing
4. • Governance and management
5. • Capacity building
6. • Monitoring and evaluation.

4.1. DISCUSSION IN WORKING GROUPS

Participants were split into the same three groups (regional group by countries by French – English languages) and asked to follow a discussion format.

- Group 1: DRC, Congo, Gabon and Cameroon
- Group 2: Côte d'Ivoire and Guinea
- Group 3: Ghana and Nigeria

4.2. GUIDELINES FOR DISCUSSION IN WORKING GROUP

1. Details to develop in WP1: tools/methods for objective data: productions/zones (CS), number of household, productivity (plantain + others), yield gap (potential/current), constraints (limiting factors: biotic, abiotic, socio-economics, etc.)
2. Details to develop in WP2: global and specific surveys (including field/lab trials to objectively demonstrate some constraints)
3. Details to develop in WP 3/WP 4.

Indicate the three most prevalent cropping systems with plantain for proposed work sites:

1 ___ 2. ___ 3. ___

For every priority cropping system, propose a question relevant to cropping systems intensification to be addressed using each of the research categories below:

- Replicated field trials

- Participatory experimentation/prototype development
- social studies
- Modeling approaches (crop growth, component interaction, pre-prototype designing)
- Economic studies.

4.3. GROUP 1

Systems summary

RDC	Congo	Gabon	Cameroun	Synthesis
1-association with food crops (forest zone)	1-association with food crops (forest zone and savannah)	1-association with food crops (forest zone)	1-association with food and perennial crops (forest zone and highlands)	Association with food crops
2-association with perennial crops (cacao, cof Synthesis on existing constraints fee, in forest zone)	2-home gardens forest zone and savannah)	2-association with perennial crops (cacao, coffee, rubber, forest zone)	2-association with perennial crops (cacao, coffee, rubber, oil palm in forest zone and highlands)	Association with perennial crops
3-home gardens (forest zone)	3-plantain (any cultivar available, without slash & burn, without inputs, forest zone)	3-home gardens (forest zone)	3-association with food crops (forest zone, transition zone and highlands)	
			4-plantain monocrop (forest zone and highlands)	Plantain monocrop (forest zone and highlands)

Synthesis on existing constraints

RDC	Congo	Gabon	Cameroun	Synthesis
1-weevils	1-weevils	1-planting material	1-weevils	1-weevils
2-nematodes	2-planting material (cost)	2-cultivation techniques	2-soil (decrease of fertility)	2-nematodes
3-planting material	3-lack of roads	3-weevils	3-planting material (quality)	3-planting material (quality)
4- BBTD	4-BBTD	4-nematodes		4-BBTD
5-bacterial wilts		5-Yellow Sigatoka/BLS		

Retained priority systems	Involved countries
Association with food crops	DRC, CONGO, GABON, CAMEROON
Association with perennial crops	DRC, CONGO, GABON, CAMEROON
Home gardens	DRC, CONGO, GABON
Plantain monocrop (forest and highlands zones)	CAMEROON

Systems and approaches

Cropping system 1	Research approach	Questions to solve	Nature of the research
Association with food crops Cassava, taro, corn, peanut, eggplant, peppers, squash (egoussi), tomato, cocoyam, various vegetables, pigeon peas, sweet potato, yam, bean, cowpea, upland rice	Replicated field trials	1-What are the possible combinations to obtain a maximum yield for plantain? 2- How to get good yields for all crops in the association? 3-What are the functional traits of associated plants? 4-What combination allows extending the life of a productive plantation? 5-What is the best combination that reduces pest pressure? 6-What optimal combinations of crops can help ensure food security for people and animals? 7-What combinations can improve the nutrients composition in the diet of the population?	-Agronomy -Post-harvest technologies
	Participatory experimentation/ prototype development	1-How to involve the farmers in the experiment? 2-What are the farmers' priorities? 3-How to improve the system on the basis of farmers' priorities 4-How to ensure the adoption of new technologies by farmers	-Agronomy -Sociology and anthropology
	Gender studies	1-What is the division of labor in the implementation of the different cropping systems? 2-What is the decision making process in the implementation of activities? 3-What is the farmers' perception of the performance of different cropping systems. 4-What are the effects of changes in cropping systems on the relationships Male /	- Sociology and anthropology

Cropping system 1	Research approach	Questions to solve	Nature of the research
	Gender studies (cont'd)	Female? 5-What is the level of access to resources (land, knowledge, etc.), extension services, market by farmers? 6-Are there structural constraints or taboos that farmers face? 7-What are the opportunities given to men / women (gender in the broad sense) in decision making during participatory meetings? 8-What is the representation of women at the district level? 9-How to ensure the representativeness of the groups involved in the project	
	Modeling approaches	1-What is the optimal combination of crops to get the best yields in a given production context (soil, light, climate, etc.). 2-Is it possible to validate the model scenario with users?	-Biometric and statistics studies -Study of the modeling of production systems
	Economic studies	1-Which cropping system allows the producer to have the best revenues in his farm? 2-What are the opportunities and markets available? 3-How to improve the value chain? 4-Are there labor forces available for work in the area?	-Economics studies -Socioeconomics studies

Cropping system 2	Scientific approach	Questions to solve	Nature of the research
Association with perennial crops Cocoa, coffee, oil palm, fruit trees, rubber, limba	Replicated field trials	1-What are the possible combinations to obtain a maximum yield for plantain? 2- How to get good yields for all crops in the association? 3-What is the functional trait of associated plants? 4-What combination allows extending the life of a productive plantation? 5-What is the best combination that reduces pest pressure? 6-What optimal combinations of crops can help ensure food security for people and animals? 7-What combinations can improve the nutrients composition in the diet of the population?	-Agronomy -Post-harvest technologies

Cropping system 2	Scientific approach	Questions to solve	Nature of the research
	Participatory experimentation/ prototype development	1-How to involve the farmers in the experiment? 2-What are the farmers' priorities? 3-How to improve the system on the basis of farmers' priorities 4-How to ensure the adoption of new technologies by farmers	-Agronomy -Sociology and anthropology -
	Gender studies	1-What is the division of labor in the implementation of the different cropping systems? 2-What is the decision making process in the implementation of activities? 3-What is the farmers' perception of the performance of different cropping systems. 4-What are the effects of changes in cropping systems on the relationships Male / Female? 5-What is the level of access to resources (land, knowledge, etc.), extension services, market by farmers? 6-Are there structural constraints or taboos that farmers face?	-Sociology and anthropology
	Gender studies (cont'd)	7-What are the opportunities given to men / women (gender in the broad sense) in decision making during participatory meetings? 8-What is the representation of women at the district level? 9-How to ensure the representativeness of the groups involved in the project	
	Modeling approaches	1-What is the optimal combination of crops to get the best yields in a given production context (soil, light, climate, etc.). 2-Is it possible to validate the model scenario with users?	- Biometric and statistics studies -Study of the modeling of production systems
	Economic studies	1-Which cropping system allows the producer to have the best revenues in his farm? 2-What are the opportunities and markets available? 3-How to improve the value chain? 4-Are there labor forces available for work in the area?	-Economics studies -Socioeconomics studies

4.4. GROUP 2

Systems summary

Country	Zone	Cropping system
Côte d'Ivoire	South	Plantain + perennial crops (rubber – cacao) Plantain + food crops (cassava, tomato, peppers, etc.) Monocrop
	West	Plantain + perennial crops (cacao) Plantain + food crops (tomato, peppers, eggplant, okra, etc.) Banana home gardens
Guinea	Forestière	Banana + Plantain + food crops (rice, beans, cassava, etc.) Banana + Plantain + perennial crops (coffee, cacao, oil palm, etc.) Banana home gardens

Cropping system	Scientific approach	Questions to solve	Nature of the research
Plantain + perennial crops (cacao, rubber, coffee, oil palm, cola)	Replicated field trials	How to confirm the reliability of the results of the proposed methods?	-Statistical data from the different zones
	Participatory experimentation/ prototype development	How to solve the problem of the quality and quantity of planting material? Spatio-temporal arrangement of crops? Weed control? Disease (yellow Sigatoka) and pests (nematodes, weevils) control? How to solve the problem of soil fertility?	-Research on the optimum density of banana -Research on the spacing between the cultures -Research on cover crops or food crops -Trapping weevils -Biological control - Utlity of biofertilizers -Research on the best climate conditions
	Gender studies	What roles for women in the production and marketing system	Survey and sensitization
	Modeling approaches	What are the appropriate models for evaluating the improved system?	Research formula for the best yield

Cropping system	Scientific approach	Questions to solve	Nature of the research
	Economic studies	Optimal allocation of production factors (capital, land and labor) Market opportunities	Evaluate the economic performance of innovations Do market studies
Banana + Plantain + food crops (tomato, peppers, rice, cassava, eggplant, okra, etc.)	Replicated field trials	How to confirm the reliability of the results of the proposed methods	Statistical data in the different zones
	Participatory experimentation/ prototype development	How to spread over planting time? Weed control? Disease (Sigatoka, rust, coal) and pests (nematodes, weevils) control?	Scheduling of planting Search for the best climatic conditions
	Gender studies	What roles for women in the production and marketing system?	Survey and sensitization
	Modeling approaches	What are the appropriate models for evaluating the improved system?	Research formula for the best yield
	Economic studies	Optimal allocation of production factors (capital, land and labor) Market opportunities	Evaluate the economic performance of innovations Do market studies
Banana + Plantain + food crops (tomato, peppers, rice, cassava, eggplant, okra, etc.)	Replicated field trials	How to confirm the reliability of the results of the proposed methods	Statistical data in the different zones
	Participatory experimentation/ prototype development	How to spread over planting time? Weed control? Disease (Sigatoka, rust, coal) and pests (nematodes, weevils) control?	Scheduling of planting Search for the best climatic conditions
	Gender studies	What roles for women in the production and marketing system?	Survey and sensitization
	Modeling approaches	What are the appropriate models for evaluating the improved system?	Research formula for the best yield
	Economic studies	Optimal allocation of production factors (capital, land and labor) Market opportunities	Evaluate the economic performance of innovations Do market studies

Cropping system	Scientific approach	Questions to solve	Nature of the research
Monoculture of Plantain	Replicated field trials	How to confirm the reliability of the results of the proposed methods	Statistical data in the different zones
	Participatory experimentation/ prototype development	How to limit seasonal shortages? How to make farmer accept the monoculture? Weed control? Disease (Sigatoka) and pests (nematodes, weevils) control? Comment résoudre le problème de fertilité du sol ?	Develop irrigation practices Create of pilot plantations Search for cover crops or food crops - Trapping of weevils - Biological control - Use of biofertilizers - Search the best climatic conditions
	Gender studies	What roles for women in the production and marketing system?	Survey and population sensitization
	Modeling approaches		
	Economic studies	Optimal allocation of production factors (capital, land and labor) Market opportunities	Evaluate the economic performance of innovations Do market studies

4.5. GROUP 3

Systems summary

Cropping system	Research approach	Question to be addressed	Nature of research
Plantain-perennial (cocoa)	Replicated field trials	Does plantain density affect first harvest of cocoa?	Scientists analyse farmer variability (sample 50 fields) 500, 1000, 1500 plantains and replicated Conduct shade study Climate
	Participatory experimentation/ prototype development	Does plantain- perennial system cause soil nutrient unbalance?	Measure soil nutrient-nutrient inflow and out flow Nutrient capacity of the soil
	Social studies	How does quality planting material affect yield of system	Determine who decide on quality material

Cropping system	Research approach	Question to be addressed	Nature of research
			How does quality planting material determine
	Modeling approaches	Light interception, nutrient demand, water	Light interception, nutrient demand, water
	Economic studies	Economics and return of the system	Age of plantation and effect on the returns
Home gardens plantain systems	Participatory experimentation/ prototype development	Does the nutrient dynamics influence home garden systems	Determine home garden nutrient dynamics Determine nutrient inflow and out-flow in home garden Assess the optimum density in home gardens Nutrient capacity of the soil
	Social studies	Who initiates home gardens?	Use logic analysis What factors determine the crops in home garden?
	Modeling approaches	Light interception, nutrient demand, water	Light interception, nutrient demand, water
	Economic studies	Are home gardens market oriented or for food security?	Economic cost and returns
Associated crops with plantain	Participatory experimentation/ prototype development	Do associated crops and densities affect first harvest?	Determine nutrient dynamics Determine nutrient inflow and out-flow in home garden Assess the optimum density in the associated system Nutrient capacity of the soil Combination in that extend the plantation
	Social studies	Does plantain-perennial system cause soil nutrient imbalance?	Use logic analysis What factors determine the crops in associated system?
	Modeling approaches	How does quality planting material affect yield of system	Light interception, nutrient demand, water
	Economic studies	Light interception, nutrient demand, water Economics and return of the system	Economic cost and returns

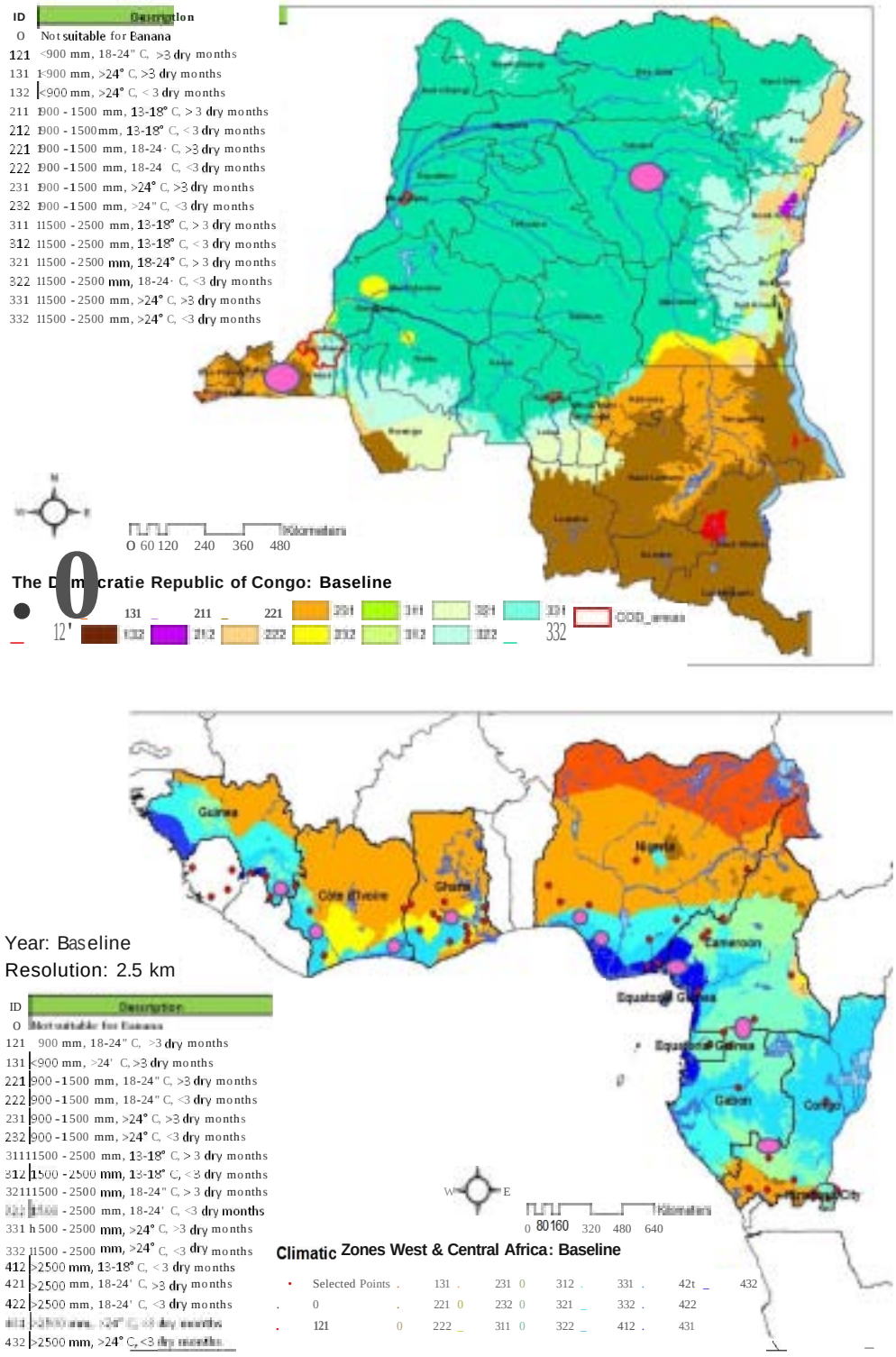
4.6. PROPOSED LIST OF 'HOMOLOGUE' ZONES/REGIONS SELECTED TO DEVELOP THE PROJECT

1. Center-South-Littoral-Cameroon/Nord Gabon
2. South Gabon /South Congo
3. South West RDC
4. High Plateaus West Cameroon
5. Forest zone of South-East of Côte d'Ivoire and (?) Central West of Ghana (Joaso-Konongo)
6. Forest Zone of West Côte d'Ivoire and South-East Guinea
7. Agbor (Delta State) Nigeria
8. Ondo (Ondo State) Nigeria
9. Lower Congo Basin (DRC)
10. Central Congo Basin (DRC)

Project planning proposal – activities in yellow and workshops as ☒

WP/year	**1**			**2**		**3**		**4**		
WP1	☒			☒						
WP2					☒					
WP3				☒		☒		☒		
WP4										☒
WP5										

☒ Workshop



Map of agroclimatic zones in West and Central Africa as described in legend. Pink circles show the proposed location of pilot sites representing both cropping systems as well as agroclimatic zones in West and Central Africa

5. Framework for a project concept-note (2014)

5.1. How do the different presentations contribute to each work package

5.1.1. WP1: Improved tools/methods for characterization of cropping system productivity, yield gaps, limiting factors, agroecological intensification and gender transformational potential

- Content for concept note will draw on:
  - Presentation by Taulya – one time surveys and repeated visit studies of plantain yields and linked limiting factors
  - Presentation by Depigny – mapping of all crops per plot, yields, inputs and practices tracked on yearly calendar
  - Presentation by Rietveld – understanding role of gender in current cropping systems
  - Presentation by Staver – parameters and tools for generating homologue zones
  - Presentation by Norgrove – experimental design for the identification of yield gaps and yield potential
- Implementation strategy
  - Initial workshop for review of existing methods (state of art review), discussion about best tools and methodologies to get better data on number of household, productivity (plantain + others), yield gap (potential/current), constraints (limiting factors: biotic, abiotic, socio-economics, etc.) and preparation of protocols (surveys, trials) and data bases to guide work in pilot sites
  - On-line forum for quarterly review of status of work and data base, status of methods use in different cropping systems
  - Final workshop to document modifications and finalize improved methods with case studies documented in RTB manual

5.1.2. WP2: Improved characterization of plantain yields, cropping system yields, yield gaps, production resource production and role of women in primary cropping systems of WCA

- Content for concept note will draw on:
  - Country presentations
  - Results of working groups on the characterization of major production zones
  - Analysis of agroclimatic zones and participatory zone formation
- Implementation strategy
  - Pilot site teams in inaugural workshop for protocol development
  - Surveys and experiments over at least on cropping cycle for plantain of at least 18 months: global and specific survey on identified zones, field and laboratory trials

- Exchange visits among pilot site teams
- Technical assistance visits by RTB lead organization scientists
- Workshop for presentation of results: main constraints explaining yield gap by main cropping systems and by main production regions
- Write up of results in articles and chapters

5.1.3. WP3: Tools/methods for understanding the principles of cropping systems intensification and piloting alternative prototypes for agroecological intensification depending on market accessibility, natural resource quality, household typologies and gender transformational potential

- Content for concept note will draw on:
  - Presentation of Philippe Tixier
  - Presentation of Marc Dorel
  - Presentation of Charles Staver
  - Presentation of Anne Rietveld
  - Group discussions on research questions by study methods
- Implementation strategy
  - workshop with specific experts by type of constraints (biotic, abiotic, social, economics, etc.) to define best tools and methods (protocols) to improve by ecological intensification methods the identified cropping systems (yield-gaps, socio-economics sustainability, land capacity, resources and inputs for production (water, fertilizers, …), etc.) and develop protocols and plans for intensification piloting in selected pilot sites co-located with other RTB initiatives (BBTV recovery, bacterial wilt, seed systems) and with Humidtropics and CCAFS;
  - On-line forum for quarterly review of status of work and data base, status of methods use in different cropping systems;
  - Technical visits and exchanges to monitoring and mutual learning;
  - Intermediate workshops based on working groups around specific modeling and field testing approaches to adjust and adapt proposed protocols;
- workshop to review work completed, write up compendium of improved methods to develop ecological intensification of the main cropping systems, and plan agenda for next generation of cropping system intensification research and prototyping.

5.1.4. WP4: Strengthening the scientific basis and piloting alternative approaches to market-linked, gender transformational agroecological intensification of mixed cropping systems with plantain in WCA;

- content of the concept note will draw on:
  - country presentations
  - analysis of agroclimatic zones and participatory mapping
  - working groups on research questions by cropping system/region

- implementation strategy
  - carrying out of plan of experiments and tests on cropping systems ecological intensification in the different 'homologue zones' and on main cropping systems : agroforestery, annual and perennial associations, monocrop with and without irrigation, … on, at least, 2 harvest stages, with models complement and projections,
  - Exchange visits among pilot site teams
  - Technical assistance visits by RTB lead organization scientists
  - On-line forum with progress reports and e-discussions
  - Final workshop to compile all the results, organize and publish technical recommendations, with various simplified technical guidelines, to transfer to all stakeholders (Ministry of Agriculture, development and extension agencies, NGOs, donors, …) and specific web sites.

5.1.5. WP5: Communication, capacity building, governance, management, dissemination, knowledge and data sharing, monitoring and evaluation during the project

- Content of concept note will draw on:
  - Group discussions during workshop
  - Experience of InnovatePlantain regional network
  - Discussions during InnovatePlantain workshop about collaboration with CORAF plantain innovation platforms for West and Central Africa
- implementation strategy
  - formation of management committee for planning, monitoring and evaluation
  - web platform communication through Innovate Plantain
  - bilingual English – French documentation
  - face to face workshops
  - on-line forums and data bases
  - scientific publications
  - practical research manuals
  - participatory farmer learning and experimentation curriculum
  - reporting back routine to national plantain and cropping systems platforms

5.2. TIMELINE FOR CONCEPT NOTE DEVELOPMENT

First draft of project concept-note (CIRAD-Bioversity): April 2014

Exchange within the participants and IITA: May 2014

6. Conclusions

1. While a general characterization of cropping systems with plantain can be based on the knowledge and experience of scientists from West and Central African agricultural research and teaching organizations, the data on total cropping system yields, yields of component crops and returns to production resources are limited;
2. Field surveys and field trials offer some insight into yield gaps and possible limiting factors. However, this information is preliminary and not linked to specific cropping systems and production zones;
3. Participants in the workshop agreed that women often play an important role in cropping systems decisions, invest their labor resources and may even have some control over resources, but quantitative and site-specific characterizations of social relations and mixed cropping systems with plantain are limited;
4. A range of tools are available for both diagnostic studies of yield gaps and limiting factors and cropping systems intensification research. While certain countries have active research programs dedicated to plantain, none have currently in place a strategy and financing for building the scientific basis and practical approaches for mixed cropping systems intensification with plantain. A major opportunity exists for a multi-country approach building bringing together RTB (IITA, Bioversity, CIRAD), plantain innovation platforms facilitated by CORAF, Innovate Plantain and country programs to build capacity and develop the first generation of prototypes for cropping system agrointensification.
5. A pilot zone approach based on cropping systems and different climate zones was visualized with up to 8 pilot sites from the forest zone of Guinea to Kisangani in DRC. These sites also coincide with emerging action sites of Humidtropics and with BBTD recovery sites for RTB.
6. The workshop participants proposed to take an ‘Alliance’ approach to present a research and development project on improved cropping systems intensification in mixed RTB systems with plantain in West and Central Africa. Grantees (CIRAD, Bioversity International and IITA) will develop a four-year research and development proposal for submission to RTB funding in 2014. This Alliance among RTB advanced research centers and country partners in West and Central Africa proposes to coordinate and carry out the project.

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8. Annexes

ANNEX 8.1. PRESENTATIONS BY WORKSHOP PARTICIPANTS

All the presentations listed below are available on the Innovate plantain website at http://banana-networks.org/innovate-plantain/resources/meetingsworkshops-materials/crp-rtb-workshop/.

These presentations can also be accessed individually by clinking on the links below, but may generate an information message asking whether the source can be trusted. This is not a warning message. Click on "yes: to proceed.

8.1.1. Cropping systems with plantain in Nigeria – NIHORT, Dr Sunday Akinyemi

8.1.2. Cropping systems with Plantain/Banana in Ghana – CSIR-Crops Research Institute, Dr Beloved. M. Dzomeku

8.1.3. Systèmes de culture avec le plantain en Côte d'Ivoire- CNRA, Dr Deless Thiemele

8.1.4. Systèmes de culture avec plantain et bananier au Congo - DGRST, Dr Simon Keleke

8.1.5. Systèmes de culture avec plantain et bananier en République de Guinée – IRAG, Dr Mathieu Lamah

8.1.6. Systèmes de culture avec plantain et bananier au Cameroun – CARBAP, Dr Moïse Kwa

8.1.7. Yield gap review of plantain production systems in West and Central Africa – Dr Lindsey Norgrove

8.1.8. Estimating yields and yield gaps: Experiences from East Africa – IITA, Dr Godfrey Taulya

8.1.9. Présentation des performances agronomiques des systèmes de cultures multi-espèces à base de bananiers plantain (SMEBP) – Exemple d'application à la zone de Mbanga-Loum (Cameroun, Littoral, Moungo) – CIRAD, Sylvain Dépigny

8.1.10. Plantain Collection and Morphological Characterization in the Democratic Republic of Congo – CIALCA, KUL, Bioversity, Dr Guy Blomme

8.1.11. Understanding gender roles in cropping systems with plantain in West and Central Africa – Bioversity International, Anne Rietveld

8.1.12. How do we target the management practices resulting from research – household types and climate? – Bioversity International, Dr Charles Staver

8.1.13. What to expect from modeling to assist the design of plantain based systems – CIRAD, Dr Philippe Tixier

8.1.14. Ecological intensification of banana cropping systems – Accompanying plants and agro-ecological services – CIRAD, Dr Marc Dorel

8.1.15. Intercropping Bananas with Coffee and Trees Prototyping Agroecological Intensification by Farmers and Scientist – Bioversity International, Dr Charles Staver

8.1.16. System intensification from a gender perspective: Tools and methods – Bioversity International, Anne Rietvelt

ANNEX 8.2. LIST OF PARTICIPANTS (BY COUNTRY)

	Nom/Name	e-mail	Institution	Position	Country
1	**FONDI Emmanuel**	fondi-emmanuel@gmail.com	CARBAP	Agro-généticien	Cameroon
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5	**ADIKO Amoncho**	adikoam@yahoo.com	CNRA	Coordinator, West and Central Africa Network (PIP)	Côte d'Ivoire
6	**KOFFI Camille**	kofficamille60@yahoo.fr	CNRA	Agro-économie	Côte d'Ivoire
7	**THIEMELE Deless**	delessthiemele@gmail.com	CNRA	Généticien Banane & plantain	Côte d'Ivoire
8	**TRAORE Siaka**	traoresiaka1@gmail.com	CNRA	Research scientist	Côte d'Ivoire
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10	**VANGU PAKA Germaine (Hermine)**	germainehermine02@gmail.com	UNIKIN	Research scientist	DR Congo
11	**BLOMME Guy**	g.blomme@cgiar.org	Bioversity International	Research scientist	Ethiopia
12	**DOREL Marc**	marc.dorel@cirad.fr	CIRAD	Agronomist	France (Guadeloupe)
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16	**STAVER Charles**	c.staver@cgiar.org	Bioversity International	Co-organizer	France
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20	**DARKEY Solomon Kodjo**	solodark559@yahoo.com	CSIR-Crops Research Institute - Kumasi	Research scientist	Ghana
21	**LAMAH Mathieu**	lamamathieu@yahoo.fr	IRAG	Chef programme Bananiers	Guinea
22	**DIALLO Amadou**	amadou53diallo@yahoo.fr	IRAG	Chef programme Biodiversité, CRRA Foulaya Kindia	Guinea

	Nom/Name	e-mail	Institution	Position	Country
23	**OLUSEYI AKINYEMI Sunday**	sosaking2002@yahoo.com	NIHORT	Research scientist	Nigeria
24	**AIYELAAGBE Isaac O.O.**	ola_olu57@yahoo.com	College of Plant Sciences (COPLANT), University of Agriculture	Professor	Nigeria
25	**SANGARE ABDOURAHAMANE**	abou.sangare@coraf.org	CORAF - PPAAO	Professor	Senegal
26	**RIETVELD Anne**	a.rietveld@cgiar.org	Bioversity International	Socio-economist	Uganda
Participation by Skype					
27	**DEPIGNY Sylvain**	sylvain.depigny@cirad.fr	CIRAD - CARBAP	Chercheur et responsable de projet	Cameroon
28	**TIXIER Philippe**	philippe.tixier@cirad.fr	CIRAD - CATIE	Chercheur et responsable de projet	Costa Rica
29	**TAULYA Godfrey**	g.taulya@gmail.com	IITA	Research scientist	Uganda
30	**NORGROVE Lindsey**	norgrove@airpost.net	Université Bâle	Consultant	Switzerland

ANNEX 8.3. GROUP PHOTOS

Above: Meeting session (C. Picq, Bioversity International)

Below: Field visit in Azaguié (M. Kwa, CARBAP)

ANNEX 8.4. PROGRAM OF THE WORKSHOP '

Sunday 10 November 2013: Arrival and inscription of the participants.

Monday 11 November 2013

Time	Activity	Who
8h30	Presentation of participants	
9h00	Review of expected outputs and program	CIRAD – T. Lescot
9h30	Presentation of RTB research program	Bioversity International – C. Staver
10h00	Cropping systems with plantain in West and Central Africa – (20 minutes each presentation)	Representatives Nigeria, Ghana, Côte d'Ivoire
11h30	Coffee break	
12h00	Presentations (continued)	Representatives Congo Brazzaville, Guinea
13h00	Lunch	
15h00	Yield gap review of plantain production systems in West and Central Africa	Lindsey Norgrove (by Skype or pre-recorded)
14h15	Presentations (continued)	Cameroon
15h30	What are results of priority assessment RTB	Bioversity – C. Staver
16h00	Facilitated discussion of data quality – yield estimates for crops and total system, yield gaps, limiting factors, framework of constraints	CIRAD/Bioversity
16h30	Coffee break	
17h00	Plantain collection and morphological characterization in the Democratic Republic of Congo	Bioversity - G. Blomme

Tuesday 12 November 2013

Time	Activity	Who
8h30	Estimating yields in mixed food and perennial crops systems with plantain	CIRAD - Sylvain Dépigny (by Skype)
9h15	Understanding gender roles in cropping systems with plantain – methods and examples	Bioversity/IITA – Rietveld
10h00	How do we target the management practices resulting from research – household types and climate?	Bioversity – C. Staver
10h30	Coffee break	
11h00	Work groups by cropping system and agroclimatic zone (by language) – proposal to increase our understanding of yields, yield gaps, limiting factors and gender roles	All participants
12h00	Estimating yields and yield gaps – experience from East Africa	G. Taulya - IITA with support from Piet van Asten (by Skype)
13h00	Lunch	

Time	Activity	Who
14h15	Inauguration	CNRA, CORAF, CIRAD, Bioversity
14h30	Presentations by 4 working groups	
15h15	Review and feedback on proposals – what else do we need to improve methods	CIRAD/Bioversity
16h30	Coffee break	
17h00	Modeling plantain growth and total system performance What to expect from modeling to assist the design of plantain based systems?	Ph. Tixier – CIRAD (by Skype)

Wednesday 13 November 2013

Time	Activity	Who
8h30	Ecological intensification for banana cropping systems – accompanying plants and agro-ecological services	Marc Dorel - CIRAD
9h15	Participatory prototyping of cropping systems intensification	C. Staver - Bioversity
9h45	Cropping systems intensification with a gender perspective	A. Rietveld - Bioversity/Kirscht
10h30	Coffee break	
11h00	Review contents of WP1 and WP2	T. Lescot - CIRAD
	Review of site selection	C. Staver - Bioversity
11.45h	Working group WP3 and WP4	
13h00	Lunch	
14h15	Working groups (continued)	
15h00	Presentations by working groups	
16h30	Coffee break	
17h00	Review of contents WP3 andWP4	
	Discussion on proposal and next steps	
18h00	Closing feedback and follow up actions (finalization of project proposal)	CIRAD/Bioversity

Thursday 14 November 2013: Field trip in Azaguié region and invited dinner

ANNEX 8.5. ESTIMATION 2010 OF PRODUCTION AND TRADE OF BANANAS AND PLANTAIN IN WEST AND CENTRAL AFRICA

(Source: T. Lescot, CIRAD Fruitrop No. 200 – May 2012)

Estimates in tonnes	Production					Exports		Imports	
	Cooking bananas		Dessert bananas		Total				
Production and commerce 2010 data + EU import export and USA 2011 (or 2009 data in italics)	Plantains AAB	Highland bananas + ABB + other AAB + AAA + AA				Cavendish	Plantain	Dessert banana	Plantain
West and Central Africa									
Angola	120 000	10 000	287 000	15 700	**432 700**			*20*	*100*
Benin	45 000	100	18 000	9 000	**72 100**		200	*201*	*2 100*
Burkina Faso	100	10	15 000	10	**15 120**	*210*		2 968	*5 600*
Cameroon	1 300 000	200 000	500 000	220 000	**2 220 000**	254 610	*40 000*	*36*	
Cape Verde	10	30	8 830	30	**8 900**			*3*	
Congo	81 100	3 000	27 000	3 000	**114 100**			*11*	*2 000*
Congo (Dem. Rep.)	1 045 000	205 000	292 472	24 000	**1 566 472**	1 848	*3 000*		
Côte d'Ivoire	1 500 000	205 454	400 000	6 000	**2 111 454**	257 042	35 000	*150*	
Gabon	110 000	10 000	12 600	1 000	**133 600**			*2*	11 000
Gambia	8	1	180	1	**190**			*380*	
Ghana	1 680 000	50 000	130 000	10 000	**1 870 000**	65 000	*447*		*200*
Guinea	445 700	16 000	181 700	20 000	**663 400**	*19*	20		
Guinea Bissau	36 000	4 000	4 900	400	**45 300**	1			
Equatorial Guinea	39 000	3 000	8 000	1 000	**51 000**	*4*			*9 000*
Liberia	45 500	5 000	40 000	10 000	**100 500**			*1*	*14*
Mali	6 500	500	90 000	500	**97 500**			21 290	5 500
Mauritania		1	70	1	**72**	*2*		4 193	
Namibia					**0**	*8*		2 805	
Niger			350		**350**			*688*	2 500
Nigeria	2 258 000	127 000	263 300	85 000	**2 733 300**		*1*		*1 000*
Central African Rep.	81 000	7 000	96 000	30 000	**214 000**				*2 000*
St Helena								*50*	
Sao Tomé & Principe	3 000	1 000	1 500	1 000	**6 500**				*10*
Senegal	200	100	46 600	100	**47 000**	*34*		16 513	*2 300*
Sierra Leone	29 900	2 000	9 000	1 000	**41 900**		1	*10*	
Chad			10		**10**			*15 000*	*1 500*
Togo	9 500	1 200	24 300	700	**35 700**	15	2	2	100
Total	**8 835 518**	**850 396**	**2 456 812**	**438 442**	**12 581 168**	**578 793**	**78 671**	**64 323**	**44 924**
	70.2%	6.8%	19.5%	3.5%	**100.0%**	23.6%	0.9%		

ANNEX 8.6. GROUP DISCUSSION GUIDELINES PER THEME

Guideline for discussion: WP 3/WP 4 Group ___:

Indicate the three most prevalent cropping systems with plantain for your proposed work sites:

1. _
2. _
3. _

For each priority cropping system, propose a question relevant to cropping systems intensification to be addressed using each of the research categories below:

- Replicated field trials
- Participatory experimentation/prototype development
- Gender studies
- Modeling approaches (crop growth, component interaction, pre-prototype designing)
- Economic studies

Cropping system 1	Research approach	Question to be addressed	Nature of research
	Replicated field trials		
	Participatory experimentation/ prototype development		
	Gender studies		
	Modeling approaches		
	Economic studies		
Cropping system 2	**Research approach**	**Question to be addressed**	**Nature of research**
	Replicated field trials		
	Participatory experimentation/ prototype development		
	Gender studies		
	Modeling approaches		
	Economic studies		

Cropping system 3	Research approach	Question to be addressed	Nature of research
	Replicated field trials		
	Participatory experimentation/ prototype development		
	Gender studies		
	Modeling approaches		
	Economic studies		

Abroad alliance of research-for-development stakeholders & partners