Breeding RTB products for end-user preferences (RTBfoods)

Annual Report Period 1 (Nov. 2017- Dec. 2018)

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Ethics: The activities, which led to the production of this document, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing practices. When external participants were involved in an activity, they were priorly informed about the objective of the activity and explained that their participation was entirely voluntary, that they could stop the interview at any point and that their responses would be anonymous and securely stored by the research team for research purposes. Written consent (signature) was systematically sought from sensory panelists and from consumers participating in activities.

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1 INTRODUCTION

1.1 RTBfoods Overview

Breeding Root, Tuber and Banana (RTB) products for end-user preferences (RTBfoods) is a Bill and Melinda Gates Foundation (BMGF) investment, which is cofunded by CIRAD, INRA, CIAT, CIP, and JHI, to encourage increased variety adoption of roots, tubers, and bananas (RTB) crops in sub-Saharan Africa (SSA) (see Box 1). It will develop high-throughput tools that will facilitate the selection of RTB varieties by breeders to meet end-users' requirements, thereby contributing to better variety adoption and improved food security. The investment aims to identify the quality traits that drive the adoption by users of new RTB varieties and takes a novel approach by directly involving consumers, processors, and researchers. The main challenge the project addresses is to translate RTB product profiles into market-led breeding initiatives that will develop new, end-user–focused, RTB varieties in SSA. The project will improve genetic insights into the quality traits along the value chain essential for successful RTB breeding and variety adoption. Multidisciplinary teams of social scientists and food technologists will capture these essential quality traits through surveys conducted with RTB crop users (i.e., processors and consumers), farmers, traders, and middlemen.

Research activities are organized in five work packages (WPs) that bring together the skills and expertise of several world-class laboratories. A sixth WP is dedicated to the management, financial and scientific coordination, monitoring, and communication of the project.

CGIAR Partners • **Bioversity International**, Rome, Italy • **International Center for Tropical Agriculture (CIAT)**, Cali, Colombia • **International Potato Center (CIP)**, Lima, Peru • **International Institute of Tropical Agriculture (IITA)**, Ibadan, Nigeria
European Partners • **French Agricultural Research Centre for International Development (CIRAD)**, Montpellier, France • **French National Institute for Agricultural Research (Inra)**, Paris, France • **The James Hutton Institute (JHI)**, Invergowrie, Scotland • **Natural Resources Institute (NRI)**, University of Greenwich, Chatham Maritime, UK
Regional and National African Partners • **Bowen University**, Bowen, Nigeria • **Centre Africain de Recherche sur Bananiers et Plantains (CARBAP)**, Djombé, Cameroon • **Centre national de recherché agronomique (CNRA)**, Abidjan, Côte d'Ivoire • **National Agricultural Research Organisation** (**NARO) (NaCRRI, NARL, Kazardi)**, Kampala, Uganda • **Université d'Abomey-Calavi (UAC/FSA)**, Cotonou, Benin
Consultants and Subcontractors • **Boyce Thompson Institute (BTI)**, Ithaca, New York • **Cornell University**, Ithaca, New York • **ENSAI**, Ngaoundéré, Cameroon • **North Carolina State University (NCSU)**, Raleigh, North Carolina

Box 1. RTBfoods partners

***WP 1: Understanding the drivers of trait preferences and the development of multi-user RTB product profiles*.** The evidence base for user preferences for RTB products will be identified through the use of interdisciplinary methods and lines of inquiry (food science, gender, and economics). This will examine preferences for different user groups in the product chain and identify the factors that influence these preferences for men, women, and other social segments, including how they are prioritized.

***WP 2: Biophysical characterization of quality traits*.** To characterize chemical compounds of interest in detail, specific biophysical analysis and sensory profiling protocols will be adapted or developed as needed.

WP 3:* High-throughput phenotyping protocols *(HTPP). On the basis of these primary quantitative analyses, the investment will build databases to establish predictive equations based on near-infrared spectroscopy (NIRS) data and to calibrate HTPP in the different RTB breeding programs in SSA. NIRS of new, elite breeding lines will enable simultaneous prediction of several quality traits, using a single in-situ spectral analysis of fresh RTB materials, to select the varieties most likely to be adopted by end-users.

WP 4: Integrated end-user–focused breeding for varieties that meet users' needs—VUE: variety (V); user (U); and socio-economic environment (E). These HTPP may also allow genetic association analyses, that is, genome-wide association study (GWAS) and study of genes for quality quantitative trait loci (QTLs). The investment will also significantly reduce phenotyping costs and allow low-cost analysis of the contribution of genetic factors, environmental factors, and cultivation and processing practices to the quality traits of RTB-based end products.

WP 5: Gender equitable positioning, promotion and performance. The most promising varieties (VUE) thus identified will be tested under real conditions with farmers, processors, and other users, including consumers, to validate the approach in partnership with the various RTB breeding programs in SSA.

During the RTBfoods kick-off meeting in Buea, Cameroon, in January 2018, 11 food products of particular importance for RTB-based staple diets (cassava, yam, sweetpotato, highland banana, plantain, and tropical potato) were selected (Table 1), in partnership with several SSA organizations in five countries: Benin, Cameroon, Côte d'Ivoire, Nigeria, and Uganda. Specific deliverables were assigned to and accepted by project partners that enable RTB food product profiles (i.e., profiling of biophysical and sensorial preferred RTB end-products in a socioeconomic-specific context) to be developed and thus map activities between the different WPs and product profiles (Photo 1). Each partner contributes to the establishment of the 11 product profiles and the scientific coherence of the different WPs.

Table 1. RTBfoods selected RTB product profiles (main countries and partners)

RTB Crop	RTB Food Product Profile	Primary Country	Spillover Countries	National Partners	International Partners
Cassava	Boiled and pounded cassava	Uganda, Colombia	Benin	NaCRRI, NARL, UAC/FSA	CIAT, CIRAD, INRA, NRI
	Gari, attiéké, eba	Nigeria	Cameroon, Benin, Côte d'Ivoire	CNRA, UAC/FSA NRCRI, ENSAI	IITA, CIRAD, NRI
	Fufu	Nigeria	Cameroon, Uganda	NRCRI, NaCRRI, ENSAI	IITA, CIRAD, NRI
Cooking banana	Boiled plantain	Cameroon	Côte d'Ivoire, Nigeria	CARBAP, CNRA	CIRAD, INRA, Bioversity, IITA, NRI
	Matooke (East African Highland banana)	Uganda		NARL	Bioversity, CIRAD, IITA, NRI
	Fried plantain Aloco	Nigeria	Cameroon	CARBAP	IITA/CIRAD
Sweetpotato	Boiled sweetpotato and puree	Uganda		NaCRRI	CIP, JHI, NCSU, NRI
	Fried sweetpotato	Uganda	Côte d'Ivoire,	NaCRRI,	CIP, CIRAD, NRI

RTB Crop	RTB Food Product Profile	Primary Country	Spillover Countries	National Partners	International Partners
			Uganda	CNRA	
Yam	Boiled yam	Benin	Côte d'Ivoire, Nigeria	Bowen U., UAC/ FSA, CNRA, NRCRI	CIRAD, IITA, INRA, NRI
	Pounded yam	Nigeria	Côte d'Ivoire, Benin	Bowen U., UAC/ FSA, CNRA, NRCRI	CIRAD, IITA, INRA, NRI
Potato	Boiled and fried potato	Uganda	Kenya	Kazardi	CIP, JHI

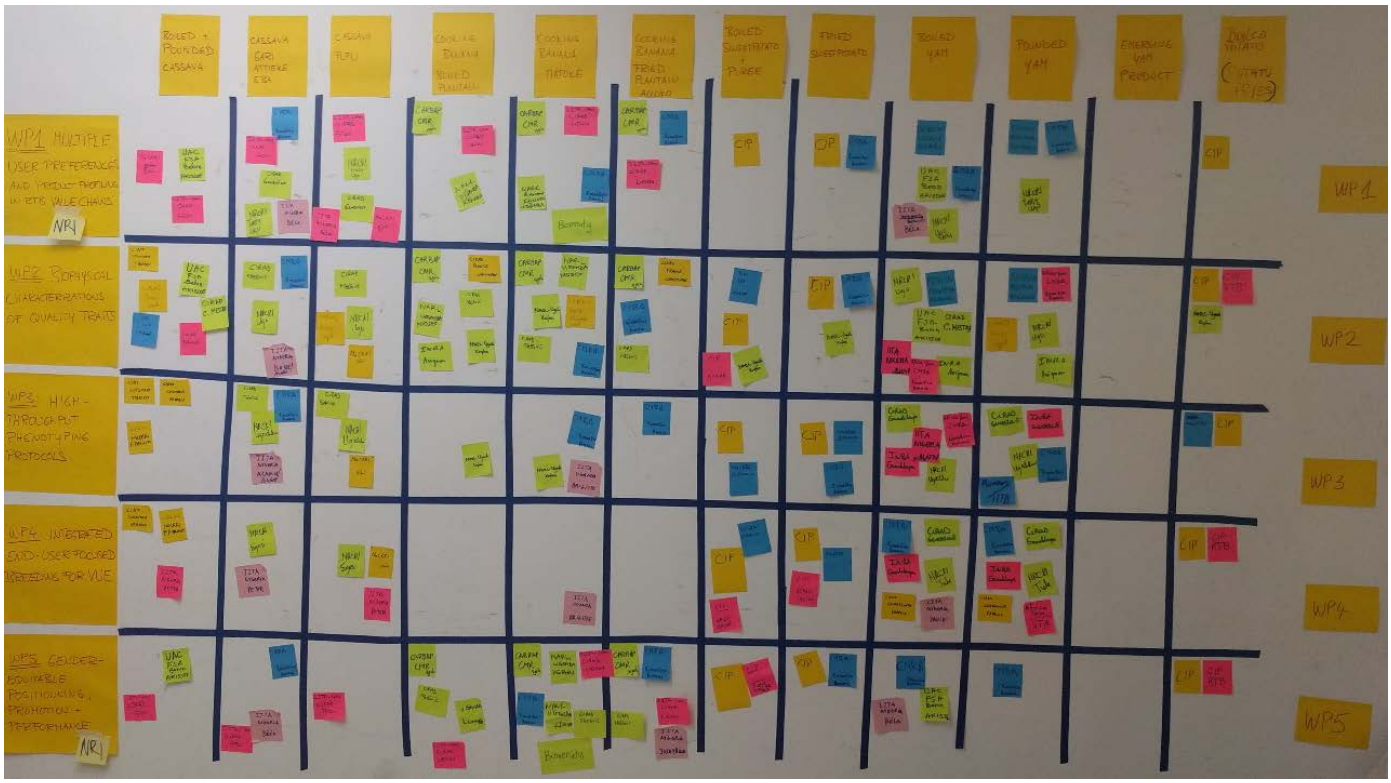

Photo 1. Mapping exercise of each partner by WP and product profile.

1.2 RTBfoods Interaction with Other RTB Breeding Investments

The RTBfoods project is designed to complement the many other investments in breeding programs in SSA (i.e., NextGen, BBB, SASHA, Genomic Tools for Sweetpotato Improvement [GT4SP], AfricaYam, and HarvestPlus; see below) in order to improve and/or optimize the impacts of these ongoing investments.

1.2.1 Next Generation Cassava Breeding

The Next Generation Cassava Breeding (***NEXTGEN***) project aims to significantly increase the rate of genetic improvement in cassava breeding and unlock the full potential of cassava, a staple crop central to food security and livelihoods across Africa. The project will implement and empirically test

a new breeding method known as genomic selection. This method relies on statistical modeling to predict cassava performance before testing in the field and dramatically accelerates the breeding cycle. The successful adoption of new cassava varieties generated in Phase 2 will depend on identifying and meeting the spectrum of different user preferences and acceptability criteria. Consumer-testing and sensory evaluation studies will qualitatively establish key quality attributes, whereas lab analyses will reveal any correlation to measurable lab variables. For winning quality traits that are heritable and high priority in key market segments—but for which there are no current high-throughput phenotyping methods—NextGen and RTBfoods will together invest in specific new tools, based on spectral calibration. Biophysical analysis, sensory evaluation, and consumer testing will be carried out by RTBfoods supporting the NextGen project in Nigeria and Uganda.

1.2.2 Sweetpotato Action for Security and Health in Africa

The overall objective of the Sweetpotato Action for Security and Health in Africa (***SASHA***) project is to develop the essential capacities, products, and methods to reposition sweetpotato in food economies to alleviate poverty and undernutrition in Africa. Some specific objectives of the SASHA project are to:

- Establish efficient population improvement programs at subregional level in SSA, linked with participatory varietal development at national level, to enable short- and long-term production of new, locally adapted varieties that significantly improve farmer incomes and deliver nutritional benefits to consumers.
- Provide convincing evidence that novel delivery systems can cost-effectively benefit the poor, especially women and children, through (1) combating vitamin A and other nutritional deficiencies in the use of sweetpotato in food-based approaches, and (2) responding to a growing urban food market and expanding market opportunities for sweetpotato.

RTBfoods and SASHA will co-invest together in Uganda and Nigeria to increase sweetpotato adoption rates by meeting end-user preferences. High-throughput methods will be develop for preferred trait prediction on sweetpotato breeding populations, in collaboration with NARO (NaCRRI) in Uganda and other breeding platforms in Ghana and Mozambique.

1.2.3 Enhancing yam breeding for increased productivity and improved quality in West Africa (AfricaYam)

The overall objective of the AfricaYam project is to increase yam productivity while reducing production costs and environmental impact by developing and deploying varieties with higher yield, greater resistance to pests and diseases, and **improved quality**. Some specific objectives of the project are to:

- Breed for high yield, good quality, nematode, and resistance to diseases (anthracnose and yam mosaic virus).
- Perform regional testing of promising breeding selections currently available.
- Phenotype for bi-parental population mapping and GWAS for key agronomic and quality traits.

RTBfoods and AfricaYam have created a synergy to better understand the acceptability of the new yam lines produced. Surveys on consumer preferences and identification of quality traits, leading to better adoption, are being undertaken in Benin, Côte d'Ivoire, and three regions of Nigeria. A co-investment for the development of a method for predicting quality traits, such as boiling preferences or yam poundability (smooth dough), is underway.

1.2.4 Improvement of banana for smallholder farmers in the Great Lakes Region of Africa

The improvement of banana for smallholder farmers in the Great Lakes Region of Africa (***BBB: Breeding Better Bananas***) project seeks to improve the production and productivity of banana in Tanzania and Uganda. This is done through the development and delivery of hybrid banana varieties that are expected to have 30% higher yield than the current varieties grown by farmers under the same conditions. BBB is structured in four WPs, one of which is more concerned with market and acceptability aspects and intends to develop a system for better tailoring breeding products and **increasing adoption** of new cultivars through **end-user feedback systems** and **participatory evaluation** of improved banana germplasm. Using a multilocation **participatory varietal selection (PVS)** approach, 27 promising East African highland (EAHB) hybrids, called NARITAs, will be tested. Regional testing of the hybrids using multilocation field trials in the range of expected **end-user environments** provides an ideal experimental design to understand how site conditions interact to affect the performance and adoption potential of each hybrid. Working in close collaboration with farmers in Tanzania and Uganda allows the quantification of the suitability of each cultivar to local farming conditions. **At the same time, sensory evaluations with consumers** provide feedback on **taste and other organoleptic features and on processing potential.** Besides generating data on these 27 EAHB hybrids, RTBfoods and BBB will provide valuable feedback to the NARO-IITA breeding program on key criteria that farmers and consumers use for adoption or rejection of new cultivars to guide breeding investments. Standardized protocols and tools for evaluation and data sharing are being developed in both projects. We expect that the multilocation PVS approach will provide an efficient mechanism for the evaluation of the new EAHB hybrids, lead to higher and faster adoption of the new hybrids, and thus maximize the impact of these new hybrids.

1.3 Project Management Structure

CIRAD, in Montpellier, France, leads project coordination, with sub-awards to specialized partner organizations that target specific product profiles. Project coordination covers monitoring and evaluation (M&E), communications, financial management, and technology transfer. It also supports the project Advisory Committee, organizes annual meetings and scientific meetings, and prepares overall project plans and reports. An internal CIRAD Monitoring Committee has been set up to facilitate internal communication within the organization (CIRAD's scientific, financial, and administrative departments).

The Project Management Unit (PMU) is composed of the following persons and functions:

- **Dr. Dominique Dufour**, food technologist, RTBfoods project coordinator
- **Eglantine Fauvelle**, agronomist, RTBfoods project manager—monitoring, evaluation, and learning (MEL) position
- **Dr. Philippe Vernier**, yam agronomist, RTBfoods/CIRAD internal Monitoring Committee manager
- **Cathy Méjean**, RTBfoods project assistant
- **Delphine Marciano and Anne Laure Perignon,** RTBfoods financial project managers
- **Marion Mille and Ghislaine Volle,** RTBfoods contract and technology transfer managers

The PMU facilitates the smooth running of the project at scientific, logistical, and financial levels. The PMU regularly organizes follow-up meetings with the WP coordination teams (leaders and co-leaders), the various partners, and, in particular, the focal points of each institution as well as with the champion products (Table 2). The PMU meets monthly with the WP coordinators, at the request of the various partners or product profile champions, and according to their needs. This close

interaction is essential for good project communications.

Table 2. RTBfoods scientific responsibilities

WP Leaders	Partner Focal Points	Product Champion Leaders
WP 1. Lora Forsythe (NRI)	Bioversity: Pricilla Marimo	Boiled cassava: Robert Kawuki (NaCRRI)
WP 1. Co-leader: Geneviève Fliedel (CIRAD)	Bowen U.: Bolanle Ategbayo	Gari, attiéké, eba: Busie Maziya Dixon (IITA)
WP 1. Co-leader: Hale Tufan (Cornell U.)	BTI: Lukas Muller	Fufu: Ugo Chijioke (NRCRI)
WP 2. Tawanda Muzhingi (CIP)	CARBAP: Gérard Ngoh Newilah	Boiled Plantain: Gérard Ngoh Newilah (CARBAP)
WP 2. Co-leader: Christian Mestres (CIRAD)	CIAT: Thierry Tran	Matooke: Kephas Nowakunda (NARL)
WP 2. Co-Leader: Thierry Tran (CIAT/CIRAD)	CIP: Tawanda Muzhingi	Fried Plantain, Aloco: Delphine Amah (IITA)
WP 3. Fabrice Davrieux (CIRAD)	CIRAD: Dominique Dufour	Boiled sweetpotato/pure: Robert Mwanga (CIP)
WP 3. Co-leader: Emmanuel Alamu (IITA)	CNRA: Michel Kouakou Amani	Fried sweetpotato: Jane Low (CIP)
WP 3. Co-leader: Thomas Zum Felde (CIP)	Cornell U.: Hale Tufan	Boiled yam: Noël Akissoé (UAC/FSA)
WP 4. Hana Chair (CIRAD)	ENSAI: Robert Ndjouenkeu	Pounded yam: Bolanle Ategbayo (Bowen U.)
WP 4. Cassava co-leader: Robert Kawuki (NaCRRI)	IITA: Busie Maziya Dixon	Boiled/fried potato: Thiago Mendes (CIP)
WP 4. Cassava co-leader: Hernan Ceballos (CIAT)	Inra: Agnès Rolland Sabaté	
WP 4. Sweetpotato co-leader: Robert Mwanga (CIP)	JHI: Mark Taylor	
WP 4. Banana co-leader: Brigitte Uwimana (IITA)	NaCRRI: Robert Kawuki	
WP 4. Potato co-leader: Thiago Mendes (CIP)	NARL: Kephas Nowakunda	
WP 4. Yam co-leader: Asrat Amele (IITA)	NCSU: Suzanne Johanningsmeier	
WP 5. Edward Carey (CIP)	NRCRI: Ugo Chijioke	
WP 5. Co-leader: Gérard Ngoh (CARBAP)	NRI: Lora Forsythe	
	UAC/FSA: Noël Akissoé	

For reporting purposes, on an annual basis each WP leader, partner focal point, and product champion leader produce a report that is consolidated by the PMU to produce the RTBfoods annual report. Each project deliverable is also made available on the RTBfoods platform, before validation for open access distribution.

1.4 Project Phasing

It was unfeasible to start all socioeconomic studies concerning each product profile at the same time during Period 1. Thus we decided to hold a kickoff meeting in Buéa to initiate studies on at least 6 of the 11 product profiles. WP 1 and WP 2 will work simultaneously on the perception of quality in relation to the quality traits to be measured by biophysical methods. The other 5 profiles will be started gradually in Period 2 and continued in Period 3 (mentioned in the File Results Tracker Framework).

Activities of WP 4 and WP 5 will be phased in gradually from Period 2 to Period 5, as and when outputs from WP 1–WP 3 become available (see Fig. 1). Nevertheless, the five WPs worked

simultaneously on the state of knowledge (SoK), lab and genetic resources inventories, standardization, and methodological developments to be implemented in the project.

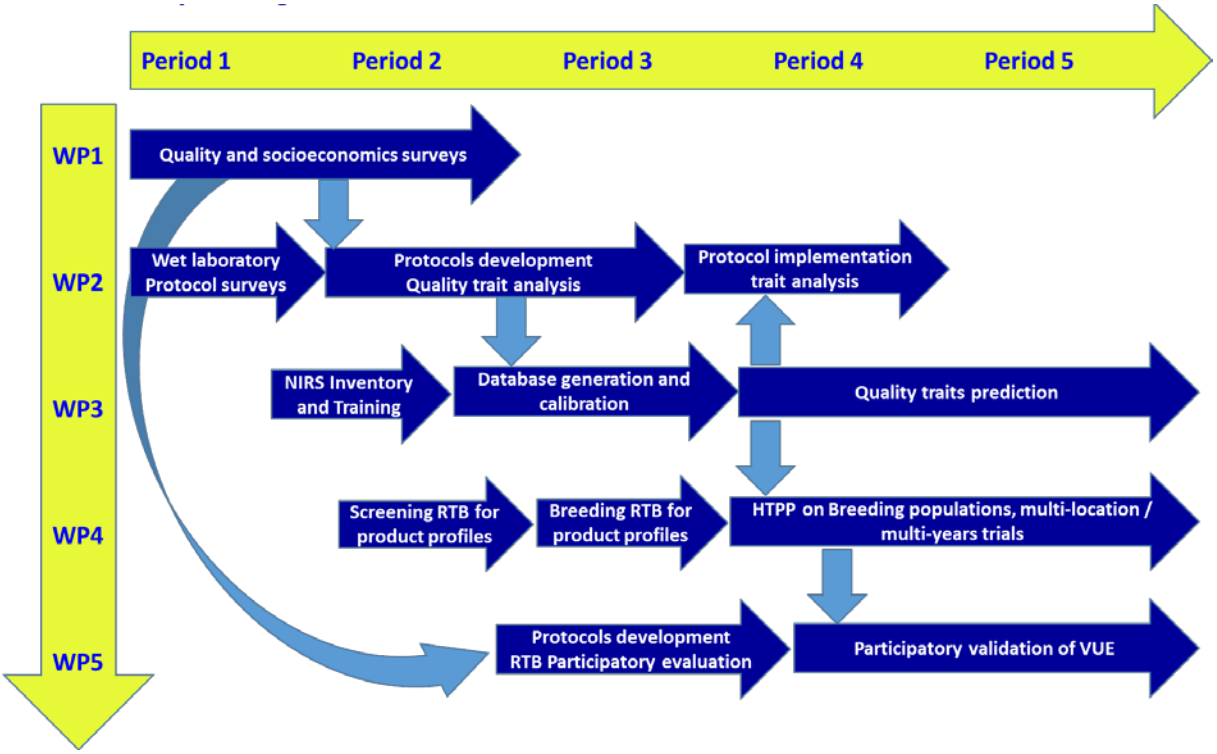

Figure 1. RTBfoods phasing.

2 PROJECT PROGRESS PERIOD 1

In Period 1 research teams were established across the different scientific disciplines involved. A considerable effort has been made to structure each research team by developing methodologies and protocols common to all project participants. WP 1 studies carried out in the different countries are based on a common survey methodology, developed and shared during Period 1. For sensory analyses, training was organized so that all project participants were trained in product profiling in WP 2. Methodology and equipment surveys have been carried out in order to standardize analyses and calibration among the various project partners.

In this section we describe the main achievements made by each of the RTBfoods WPs and partners and our progress toward the achievement of projects outputs and contribution to outcomes (see Box 2). In addition, detailed milestone-by-milestone assessment of progress is provided in the Results Tracker updated after the completion of Period 1 work plans. At the end of this section, a synthesis table presents the activities conducted and deliverables produced with the related project outputs.

Surveys on RTB consumption habits and gendered preferences:

- 10-day capacity-strengthening workshop organized with 31 partners from 6 countries; 1 methodological toolkit with 4 guidance manuals developed to capture RTB users' quality preferences along the food chain.
- 9 partner teams conducted surveys on RTB consumption habits and preferences covering 8 RTB food product profiles. To date, 738 individuals interviewed (300 males, 438 females) and 127 focus groups in 66 locations across 17 regions in the 5 targeted African countries (Benin, Cameroon, Côte d'Ivoire, Nigeria, and Uganda); raw data (questionnaires) are securely stored on the project platform and a secured repository, together with consent forms signed by each respondent.
- 10 SoK studies on food science, gender, and market demand completed on 7 out of the 11 targeted RTB food product profiles.

Food science and biochemistry:

- 5-day workshop on sensory panel training with 41 partners; 1 methodological manual produced (in French and English) on standardized methods for conducting sensory testing and generate lexicon on RTB products in low-equipped context.
- 10 SoK studies on sensory quality traits for the 11 targeted RTB food product profiles. These sensory quality traits inventoried will be further consolidated with the key findings on user preferences into one synthetic document disaggregated by RTB food product profile.
- 1 inventory of 15 partner biophysical laboratories' facilities (equipment), competencies (human resources), and methods and protocols used for physicochemical characterization of RTB crops and products achieved.

High-throughput phenotyping:

- 5 training sessions performed with staff from 6 partners, in 3 countries, on principles of NIRS, data treatment, and calibration development.
- 1 SoK study on previous HTPP applications on the targeted RTB crops and products completed.
- Description of existing and ongoing spectral databases and calibrations for prediction of quality traits developed or used routinely by 7 partners (CIP, INRA-CIRAD, IITA, NaCRRI, NARL, and NRCRI) for the 5 targeted RTB crops.
- New spectra in Period 1: 3,270 for cassava (at CIAT, IITA, NRCRI, and NaCRRI); 16,190 for sweetpotato (at CIP); 4,050 for yam (at IITA and INRA-CIRAD); 16 for potato (at CIP); and 120 for cooking banana (at NARL/NaCRRI/IITA).

Breeding and participatory assessment of new hybrids against users' preferences

- 1 document compiling a state of the art on quality informing breeding in past and ongoing RTB breeding programs for the 5 targeted crops and for 7 partners (CIAT, CIP, CIRAD, CNRA, IITA, NaCRRI, and NRCRI).
- 16 new hybrids from partner breeding programs assessed with methodologies developed by these programs: cassava (3), yam (6), and sweetpotato (7).

Coordination and MEL

- 1 Global access strategy developed
- 1 secured collaborative and sharing platform implemented for daily use by project partners

Box 2. Key project achievements in 2018.

2.1 Key Progress Achievements in Period 1 by WP

2.1.1 Understanding the drivers of trait preferences & the developments of multi-user RTB product profile (WP 1) - Key progress achievements

(see WP 1 Extensive Activity Report for Period 1 in Annex 1 p.43)

WP 1 OBJECTIVES AND STRATEGY. WP 1 provides the evidence base for end-user preferences for characteristics of focus products. The primary goal is to enhance the capacity of RTB breeding programs to define and implement demand-led and gender-responsive breeding priorities, integrating traits to meet multi-user demands and needs, and adding value. The WP 1 approach uses interdisciplinary methods and lines of inquiry (food science, gender, and economics) to collect evidence on the preferences of RTB product characteristics for different user groups in the product chain and identify the factors that influence these preferences for men, women, and other social segments, and how they may be prioritized differently.

WP 1 carried out three major activities in Period 1, which revolve around the development and implementation of a common, interdisciplinary methodology. The methods are grounded in a food science approach developed from a previous project under the CGIAR Research Program (CRP) on

Roots, Tubers and Bananas (RTB). But the approach was adapted to include a socioeconomic and breeding focus in addition to product profile development, and applied with rigorous and robust sampling. Three accomplishments for this year are described below.

- **SoK on users' preferred characteristics for RTB crops and products**

  Studies on the current SoK on targeted RTB products were carried out to establish what is currently known about these products and gaps in knowledge (*contribution to Output 1.1.1 through Del. A.1.1–A.1.9*). For this activity, the coordination team produced guidance (*Del. A.2.1*) for developing a knowledge base from a disciplinary perspective, to identify gaps in knowledge to be addressed by the project. This SoK guidance document developed by the WP 1 coordination team and other collaborators is structured in three modules: food science, gender and social context, and demand. Nine product-based SoK reports covering seven products were developed by 11 partner teams, with support from the WP 1 coordination team and other collaborators (*Del. A.1.1–A.1.9*). The reports will inform the fieldwork and surveys to be carried out in WP 1 in Period 2, and also the knowledge gaps to be addressed in WP 2 and WP 5. A summary of each product on established characteristics, knowledge gaps, and how they are addressed by RTBfoods is provided in the full WP 1 Extensive Activity report for Period 1 (Annex 1).

- **Capacity Strengthening and Sharing Materials workshop**

  A methodology was developed by the WP 1 coordination team and other partners as part of a collaborative process. It was documented as four comprehensive manuals (*Del. A.2.3, A.2.4, A.2.6, and A.2.7*). The delivery of the material was conducted at the Capacity Strengthening and Sharing Materials workshop held on 16–25 April 2018, in Cotonou, Benin. Inputs were received on an ongoing basis for adaptation throughout the year, from management, crop breeders, other WPs, and partner teams. The current versions of the manuals are available on the project platform for all RTBfoods partners. They will be shared with a wider scientific community when finalized at the end of Period 2 with a specific DOI created. The 10-day workshop was the first project event following the inception meeting. All WP 1 teams, including 31 participants from six countries, attended. A report on how the workshop met its objectives was produced (*Del. A.2.2*). A capacity-strengthening kit, including the four methodological manuals mentioned above, were shared with project partners, together with all presentations and learning materials (*Del. A.2.9*).

- **Fieldwork for gendered product mapping**

  WP 1 teams carried out surveys on RTB consumption habits and preferences in rural communities where people grow, process, and consume the targeted RTB crops (*contribution to Output 1.1.1*) (Table 3). This activity involved key informant interviews with community leaders, focus group discussions (FGD), individual interviews, and rural-level market interviews. In Period 1, nine WP 1 partner teams have started and/or completed field surveys, covering 8 out of the 11 targeted RTB processed products.

Table 3. Countries where field surveys on gendered product mapping for targeted RTB products were started, if not completed, in Period 1

Crop	Product Profile	Primary Country	Spillover Countries
Cassava	Boiled and pounded cassava	Uganda (boiled)	Benin
	Granulated cassava: gari, eba, attiéké	Nigeria (gari, eba)	Cameroon (gari), Côte d'Ivoire (attiéké)
	Fufu	Nigeria	
Cooking	Boiled plantain	Cameroon	

Crop	Product Profile	Primary Country	Spillover Countries
banana	Matooke	Uganda	
	Fried plantain, alloco		
Sweetpotato	Boiled sweetpotato and puree	Uganda (boiled)	
	Fried sweet potato		
Yam	Boiled yam	Benin	Nigeria
	Pounded yam	Nigeria	

To date, nine product teams (including 11 partners) covering eight processed products have uploaded their raw data and consent forms signed by interviewees onto the RTBfoods platform (*contribution to Output 1.5.1 through Del. I.1.1–I.1.10*). The WP 1 coordination team and collaborators organized support visits during piloting in Benin, Nigeria, Uganda, and Côte d'Ivoire. Lessons learned documents for Nigeria and Uganda were developed and shared with other WP 1 partner teams (*Del. A.2.10*).

The WP 1 coordination team, with the support and feedback from the Benin UAC/IITA team and WP 2, is also currently finalizing data analysis guidance (*Del. A.2.5*). The document includes a description of how mixed-methods data can be analyzed, how the data can feed into the first iteration of the product profile, and priority data required for WP 2. This will be circulated to teams prior to the RTBfoods 2019 annual meeting. In alignment with RTBfoods Global Access Strategy (Annex 22, p. 237), WP 1 also developed a document describing the process and principles of data management, which provides guidance to partners on specific data issues relating to WP1 activities (*Del. A.2.8*).

2.1.2 Team coordination and interactions with other WPs

WP 1 has also achieved a number of partner-led collaborations, whereby teams have joined together to revise and test the methods and tools and conduct fieldwork together (e.g., Ugandan and Nigerian teams). We have also had extensive collaboration with NextGen, ongoing discussions with Excellence in Breeding (EiB), and participation of WP 1 coordinators in CGIAR Gender and Breeding Initiative (GBI) workshops. WP 1 has also had numerous successful interactions with other WPs, specifically in the sharing of tools and methodology. This includes WP 1 roadmap; all manuals, and data analysis guidance. Two conference calls were held with WP 2 leadership to define the type of data necessary from WP 1 to inform WP 2 activities. In addition, there is permanent communication with the project manager for MEL.

2.1.3 Outlook for Period 2

For Period 2 the following activities are planned: (1) capacity strengthening of partners for gendered product mapping and data analysis; (2) data analysis for RTB products surveyed in Period 1; (3) planning and commencement of participatory processing and consumer testing with close coordination with WP 2 and WP 5 for products surveyed in Period 1; and (4) achieving field surveys on quality characteristics of RTB products that have not been completed in Period 1 and/or in missing targeted countries, whether they are primary or spillover countries. RTB food products on which fieldwork to collect users' preferred characteristics that were not initiated in Period 1 will be prioritized in Period 2 (see Table 4).

Table 4. List of targeted RTB products and countries to be surveyed in Period 2

Crop	Product Profile	Primary Country	Spillover Countries
Cassava	Boiled & Pounded cassava	Uganda (pounded ?)	
	Granulated cassava: Gari, eba, attiéké		Cameroon (gari)—to be completed
	Fufu		Cameroon
Cooking banana	Boiled plantain		Nigeria, Côte d'Ivoire
	Fried plantain, alloco	Nigeria	Cameroon
Sweetpotato	Fried sweet potato	Uganda	Côte d'Ivoire, Nigeria
Yam	Boiled yam		Côte d'Ivoire
	Pounded yam		Côte d'Ivoire, Benin
Potato	Boiled potato and potato fries	Uganda	

2.1.4 Biophysical characterization of quality traits (WP 2) - Key progress achievements

(See WP2 Extensive Activity Report for Period 1 in Annex 2, p. 81)

WP 2 OBJECTIVES AND STRATEGY. The main objective of WP 2 is to translate the user traits already known and those captured in the food product profiles from WP 1 into laboratory-based quantitative assessments of biophysical and functional properties (*Output 1.2.2*), which will then be used as reference values for developing HTPP in WP 3. RTB crops are nutritious, but their sensory properties and the drivers of sensorial preference/desirability which affects their adoption are not clearly established to date. Therefore, the development of a sensory lexicon for RTB crops (*Output 1.3.2*) will assist with characterization of their sensory properties (*Output 1.3.1*) and assist in the understanding of key consumer-preferred attributes (*Output 1.2.2*). These consumer insights will help breeders to understand the impact of color, flavor, and texture of RTB-based products on consumers' preference and acceptance. The texture and food quality of the RTB end-products depend on the initial characteristics of raw material and on processing techniques. This multidimensional aspect requires assessing the relationship of raw RTB crops and processed/cooked products for their dry matter content, starch and fiber content, pectins and cell wall components, and postharvest deterioration among others (*Output 1.2.2*). During Period 1, existing information was used as a starting point for research conducted within this WP (*contribution to Output 1.3.1 and 1.3.2*) while waiting for feedback from WP 1.

KEY RESEARCH FINDINGS ON THE BIOCHEMISTRY OF QUALITY TRAITS FOR RTB CROPS AND PRODUCTS. The feel, appearance, or consistency of a surface or a substance (texture) issues are not adequately addressed in RTB crops (banana, cassava, potato, sweetpotato, and yam) in Africa. It is important to note that texture must be measured on freshly cooked products in parallel to sensory analyses and/or results from WP 1 The same products (same cultivar and same processing/ preparation conditions) must be analyzed by instrumental (texture measurement) and by human subjects in order to clearly establish correlations arising between sensory and instrumental characterizations (*contribution to Output 1.3.2*) and to design instrumental methods that accurately reflect the human perceptions of the products (*contribution to Output 1.3.1*). It was acknowledged that users traits can be grouped into different categories: traits relating to raw products; traits relating to cooked/processed products; and traits relating to handling RTB crops after harvest (e.g., shelf-life and deterioration, logistical issues, storage conditions, size and shape of RTB for optimum packing and processing, and peeling, for example). Agronomic traits are also of importance, albeit less in focus for WP 2 activities. An initial list of priority traits to characterize was generated: dry matter (DM), removal of fibers, cell-wall structures and composition, starch content, cooking ability,

fermentation ability, and cyanogens (in the case of cassava). Texture is potentially determined by a combination of several factors, including cell walls, starch content, starch granules structure, and amylose content (due to its retrogradation properties). Categories of traits will be classified and developed by agronomic, sensorial, and processing ability for each RTB crop. Aside from texture, taste is a major driver of adoption for RTB crops and products. Health and nutrition traits are important but are not the major focus of our activities within RTBfoods. From a logistical point of view, for WP 2 activities reliable protocols need to be developed and shared among partners for sampling, transport, and handling of samples for analysis of raw and cooked products (*contribution to Output 1.3.1*). This inventory of protocols, methodologies, and capacities by partners was successfully conducted in Period 1 (*Del. E.1.1*).

Texture is a key criterion for the sensory quality of boiled cassava, and it relates to traits such as hardness (or softness after cooking), cooking time, mealiness, and friability (see Box 3). Varieties that do not cook well remain hard even after a prolonged period of cooking, thereby compromising the product's acceptability (*contribution to Output 1.3.2 through Del. F.1.1*).

Genotypic Diversity Sheds Light on How Texture Develops during Cassava Boiling

In 2018, 270 genotypes representative of the genotypic diversity of cassava in Latin America were harvested and characterized at CIAT. Texture analysis revealed two distinct stages in the development of texture during boiling.

First, hardness dropped quickly within the first 10 minutes, with an average decrease of 77% from the initial hardness (measured at total area under the texture curve). All genotypes, in spite of the diversity of origin and specific hardness, behaved in a remarkably similar way on this aspect, with a coefficient of variation of 7.6% for the loss of hardness, compared with a coefficient of variation of 27.4% for the hardness after 10 minutes' boiling. This points to an underlying molecular mechanism nearly identical for all genotypes, most probably starch gelatinization.

Second, in spite of this major change in hardness, further boiling until "optimum cooking time" was necessary to achieve the mealy texture preferred by consumers. Whereas the initial drop in hardness was similar among all genotypes, optimum cooking time was highly diversified, ranging from 15 up to 60 minutes with a coefficient of variation of 40%. Some genotypes never actually reached the target mealy texture. These observations confirmed the distinct roles of starch (general drop in hardness) and of other components such as pectins and cell-wall materials (CWM) in developing the final texture of boiled cassava. Given the higher variability in cooking time, the key determining factor of cooking ability and quality seems to be the CWM fraction (and its composition and changes during boiling), rather than the starch fraction.

Complementary medium infrared (MIRS) analyses on a subgroup of 30 genotypes tentatively showed a link with cooking time. In Period 2 we will expand these analyses to include the full set of genotypes and texture data, and investigate the potential of MIRS to predict cooking ability and quality.

Box 3. Boiled cassava activities in Colombia.

The aspect and color analysis of potato chips is used to evaluate for various color and textural features to characterize and classify their appearance, and to model the quality preferences of a group of consumers (*contribution to Output 1.3.2 through Del. F.1.10*). Features derived from image texture analyses contain better information than color features to discriminate both the quality categories of chips and consumers' preferences. The sweetness and texture of boiled sweetpotato are factors impacting their eating quality and are linked to their starch content and beta-amylase activity (*contribution to Output 1.3.2 through Del. F.1.7*). Although cooked potato tuber texture is an important trait that influences consumer preference, a detailed understanding of tuber textural properties has identified tuber pectin methyl esterase activity (PME) as a potential factor impacting on textural properties in potato but not in sweetpotato, cassava, yam, and banana. Another point that appears important to understand the texture of a product is its structure: the residual cellular structure of pounded yam has thus been tentatively related to its texture (*contribution to Output 1.3.2 through Del. F.1.8 and F.1.9*). Frying imparts desirable taste and textural properties to RTB crop products. Frying is reviewed as a structuring process, and methodologies to determine texture in fried potato products need better understanding in RTB crop products. Moisture uptake during post-

frying is critical in the loss of crispness (limpness) of fries and in softening of potato chips (*Del. F.1.10*). Fermented products (Gari, Attiéké) also require characterization of specific traits such as softening during fermentation, processing ability, sour taste, and so on (*contribution to Output 1.3.2 through Del. F.1.2 and F.1.3*).

2.1.5 Team coordination and interactions with other WPs

During the RTBfoods kickoff meeting (Buea, January 2018), side meetings were held with all members of WP 2 to define in more detail the who, what, where, when, and how of WP 2. Also discussed were the proposed interactions between partners working in WP 2 and how information and feedback from other WPs will be received and integrated into WP 2 work plans. It was noted that interactions with WP 1, WP 3, and WP 4 were crucial for WP 2 activities. The WP leaders also highlighted communication, reporting, and information-sharing as important activities are linked up and are interdependent. For example, WP 4 will provide WP 2 with the plant materials for sensory panels and biochemical and biophysical analyses. Also, a joint training of WP 2 and WP 4 for sensory panels was successfully conducted in Uganda (September 2018) (*contribution to Output 1.3.2 through Del. F.2.1 to F.2.3bis*). WP 1 started working on the current state of knowledge reviews and field activities, and their results also feed into WP 2's year 2 activities. WP 3 members participated in a WP 2 coordination meeting in order to start working on HTPP techniques. Initial cross-WP 2-WP 3 research on the feasibility of using NIRS to predict the cooking time and/or texture of boiled cassava was conducted in the second half of 2018 (*contribution to Output 1.4.2*). The breeders in WP 4 agreed to share their planting calendar with WP 2 for the planning of WP 2 activities.

2.1.6 High-throughputs phenotyping protocols (WP 3) - Key progress achievements

(See WP 3 Extensive Activity Report for Period 1 in Annex 3, p.96)

WP3 OBJECTIVES AND STRATEGY. WP 3 of the RTBfoods project consists of eight teams from different institutes (INRA, CIAT, CIP, IITA, NaCRRI, NARL, NRCRI, and CIRAD) over seven countries (Uganda, Nigeria, Colombia, Peru, Guadeloupe, Ghana, and France). The main activities conducted during Period 1 were (1) an inventory of HTPP facilities of partner laboratories (equipment, human resources) *(contribution to Output 1.4.1 through Del. G.1.1 to G.1.9)*, 2) training workshops on NIRS routine analysis (*contribution to Output 1.4.1 through Del. G.2.1 to G.2.4)*; 3) a state of knowledge on HTPP methods applied to RTB crops *(contribution to Output 1.4.2 through Del. H.1.1);* 4) an inventory of existing RTB spectral databases at partner level (contributions to Output 1.5.3 through Del. K.1.1 to K.1.10); 4) an inventory of existing and ongoing calibrations for quality traits of RTB raw and processed products *(contribution to Output 1.4.2 through Del. H.3.1 to H.3.11).*

KEY ACHIEVEMENTS IN CAPACITY STRENGTHENING OF PARTNERS. Fourteen NIR spectrometers were found across the eight teams. Except NARL in Uganda, each team owns at least one NIR spectrometer available for the project. Instruments come from two brands (Foss and ASD), 10 instruments are benchtop models covering the spectra range of 400–2,500 nm (visible and NIR), 2 instruments are portable (ASD QualitySpec and LabSpec), and 2 are miniatures (SCIO spectrometers) *(Del. G.1.1–G.1.9).*

For capacity-strengthening purposes *(Output 1.4.1)*, five training sessions were performed with the following main objective: to improve knowledge on principles of NIRS; data management, data treatment, calibrations development, and validation procedures; and needed laboratory conditions. The trainings took place in Uganda *(Del. G.2.2 & G.2.4)* (2), Nigeria *(Del. G.2.1)* and Peru *(Del. G.2.3);* 1–19 participants were involved in the training sessions depending on the place and purpose.

RESEARCH FINDINGS ON NIRS APPLIED TO RTB CROPS AND PRODUCTS. The SoK report *(Del. H.1.1)* highlights the potential of nondestructive techniques to qualify, sort, and/or characterize nutritional quality of RTB crops. A large part of the techniques refers to vibrational spectroscopy in the wavelength range from visible to mid-infrared light. Other noninvasive techniques, such as nuclear magnetic resonance, Raman spectroscopy, imaging, ultrasound technology, and X-ray, have shown their potential for successful applications in quality monitoring of fruits, vegetables, roots, and tubers. Researches using nondestructive techniques have evaluated fresh and processed products qualities. Most of the time, quality control or process monitoring is reached through the quantification of biochemical compounds, such as carbohydrate composition, including different starches and sugars, protein, vitamins, minerals, carotenoids, moisture, phenols, and fat. Other studies refer to physical properties such as specific gravity, skin color, and texture. Some researches focus on contaminant quantification such as acrylamide in processed products or concern different quality aspects and potential uses (e.g., external or internal defects, greening, bruises, enzymatic browning, and non-enzymatic browning) and physiological disorders. The products were analyzed in different conditions and presentations or forms (intact, peeled, sun-dried, freeze-dried, mashed, crushed, sliced, cooked, deep frying, chips, crisp, etc.). The quality characterization of RTB crops and products using HTPP techniques is well documented. The challenge for the RTBfoods project is translation of the quality traits of interest into measurable variables or indirect correlated variables in order to choose the right techniques and to develop a strategy for relevant calibrations to meet end-user–preferred traits and the challenges faced by RTB crop breeders.

INVENTORY and CHARACTERIZATION OF EXISTING SPECTRAL DATABASES AND CALIBRATIONS FOR RTB CROPS AND PRODUCTS. Different calibrations are already applied in routine analysis *(contribution to Output 1.4.2 through Del. H.3.1–H.3.11).* The calibrations were developed within the framework of different projects linked to the RTBfoods project. For fresh cassava, two calibrations—DM and total carotenoids content (TCC)—are used, in Colombia at CIAT *(Del. H.3.3 and H.3.5)*, in Nigeria at IITA *(Del. H.3.11)*, and NRCRI *(Del. H.3.10)*. Another one is at very early stages of development in Uganda (NaCRRI). For yam flour, a calibration (DM, starch, protein) is developed by IITA in Nigeria *(Del. H.3.1)* and another one in Guadeloupe by INRA-CIRAD for quantification of DM, sugars, starch, amylose, and protein *(Del. H.3.2)*. CIP has calibrations for sweetpotato flour (freeze-dried and milled samples) *(Del. H.3.6)* and aimed at quantifying protein, starch, glucose, fructose, sucrose, maltose, beta-carotene, iron, and zinc contents. CIP recently started working on fresh material, fresh raw sweetpotato (fresh, cut/blended roots) applied to quantification of DM, TCC, and beta-carotene content *(Del. H.3.8)*; this is still at the stage of feasibility study. The number of samples associated with chemistry data is indeed too small to be considered as a database at this stage. CIP has been developing calibrations for cooked dried, ground sweetpotato in Ghana *(Del. H.3.9)*. However, these calibrations need improvement and updates through an application to many more local samples from other countries than the current limited testing sets from Ghana and Uganda. The calibration will be applied to quantify starch and individual sugars contents. These calibrations were established from existing or ongoing databases of spectral data and metadata which were inventoried in Period 1 *(contribution to Output 1.5.3 through Del. K.1.1–K.1.10).* Databases for fresh cassava are developed by CIAT, IITA, and NRCRI *(Del. K.1.1, K.1.3, and K.1.7).* INRA develops a database for yam flour *(Del. K.1.4)*, and IITA develops a database for both dried and fresh yam *(Del. K.1.2 and K.1.10).* CIP has been developing a database for freeze-dried milled sweetpotato for many years *(Del. K.1.5)* for which a database is also available from CIP *(Del. K.1.6).* NARL, in collaboration with IITA and NaCRRI, started to develop a database for cooking banana *(Del. K.1.9)*.

TEAM COORDINATION AND INTERACTIONS WITH OTHER WPs. The main challenge faced in coordination of WP 3 was to overcome the diversity of the teams: eight different teams from more than five countries. These teams are diverse in their background knowledge on HTPP methods and especially NIRS, in human resources ready to be mobilized in the project, and in capacities (different equipment or no equipment) (see Box 4). This first challenge was partially resolved by having an inventory of capacities and facilities of all partner countries and institutions *(contribution to Output*

1.4.1), along with visits of the three WP 3 leaders to facilities where teams work. An effort has been carried out on capacity development through a series of trainings. However, this current support through visiting of the teams and training sessions should be reinforced and strengthened for the project's second year, especially during the measurement joint campaigns with WP 2. The second challenge was to know exactly what was already done on HTPP and RTB crops by the different teams. This was also addressed by compiling a complete description of the existing database and existing calibrations applied to RTB realized by each partner *(contribution to Outputs 1.4.2 & 1.5.3).* This work will be a solid base to adapt protocols for relevant quality traits *(Output 1.4.2).* The third challenge is inherent to the project and consisted in starting an analytical activity. Sampling designs and measurement protocols were implemented, even though the criteria to be measured were not defined yet. The existing know-how and knowledge of the work done on RTB crops and HTPP methods by the teams will help to define the strategy and the choice of the methods in Period 2. But, to be efficient, this should be done as soon as the relevant quality traits become known in collaboration with WP 1 and WP 2. To do the best, the WP 3 leaders and team leaders will have a meeting in order to define the priorities and organize the work in Period 2. This first year, interactions with other WPs were limited and concern mainly WP 2, for capacities and facilities inventory and for sharing protocols, work plans, tools, and materials. The main gap in interaction with WP 2 was probably that there were not enough meetings between team leaders due to time concerns and limited resources. Regarding WP 4, next year we need a common calendar of availability of plant materials. The interactions were regular with WP 6 through face-to-face meeting or mails or Visio conferences.

SHARING NIRS INSTRUMENTS AND COMPETENCIES: THE CASE OF THE NaCRRI-NARL-IITA PARTNERSHIP

In an RTB meeting in Uganda in May 2018, it was agreed that the NIRS instrument and competencies at NaCRRI be used by partners to develop HTPP for different RTB crops. It was also agreed that partners work out modalities for handling samples and in turn, the partners provide modest facilitation for acquiring services. To kick start this, NaCRRI, through the nutrition and bioanalytical lab, partnered with the IITA banana-breeding team to provide NIRS services for banana spectral acquisition and analysis.

In essence, the partnership process was straightforward and coordinated at laboratory level. The banana-breeding team is tasked with the delivery of the samples to the laboratory every Monday for analysis. The same samples are shared with NARL and used for undertaking physicochemical analyses. NaCRRI's assigned technician then handles the samples and provides feedback on the samples numbers and their state before spectral acquisition. On arrival at the lab, the banana fingers are selected from the clusters, peeled, and blended. Spectra are acquired from the blended samples. The data generated belong to the banana-breeding team at IITA; NaCRRI has no specific rights to share the data or in any way use them for any purposes. Therefore, any analyses involving such data are the responsibility of the IITA breeding team. The team is meant to pay a modest fee to cater for labor and sundry services in the lab. However, such modalities are still being discussed.

So far, we have scanned more than 120 banana samples with respective spectra available at NaCRRI NIRS

Box 4. Cross-crop organization for high-throughput trait prediction in Uganda.

2.1.7 Outlook for Period 2

The main objective of Period 1 was successfully achieved through an exhaustive inventory of the facilities with a description of human resources and their background knowledge *(contribution to Output 1.4.1).* This inventory was completed by five trainings adapted to needs of the teams. WP 3 took advantage of the background knowledge of researchers to share experience and to boost the team through these training sessions. Finally, this approach was completed by a description of the existing and ongoing development of calibrations and databases on RTB products *(contribution to Outputs 1.4.2 and 1.5.3).* At the end of this first period, the joint analysis of the state-of-the-art on HTPP phenotyping tools applied to RTB products, and the description of the teams, should support decision-making in the choice of equipment and its sharing. Indeed, sharing an instrument between NaCCRI, IITA, and NARL was decided for banana in Uganda. The decision regarding new

instruments is postponed to Period 2, after the annual meeting in March 2019 in Abuja, Nigeria. The reason is that we need more information about consumers' preferences-related quality traits which influences the choice of new HTPP technologies not yet available in the RTBfoods community. The perspectives for Period 2 are to go ahead with the training sessions with more intensive trainings for the development of calibrations *(contribution to Outputs 1.4.1)*, to continue to upgrade the existing and ongoing databases *(contribution to Outputs 1.5.3)*, to set up and implement measurements protocols as soon as the preference traits are known for each product, and to start calibration in close collaboration with WP 2 for the relevant parameters *(contribution to Outputs 1.4.2)*. During this second period we will have to choose, buy, and/or develop needed complementary HTPP techniques *(Output 1.4.1).*

2.1.8 Integrated end-user focused breeding for VUE – Variety; User: socio-economic Environment (WP 4) - Key progress achievements

(See WP4 Extensive Activity Report for Period 1 in Annex 4, p. 116)

WP4 OBJECTIVES AND STRATEGY. The goals of WP 4, as written in the proposal, are to (1) assess the variability for quality traits that exist in current breeding populations *(contribution to Output 2.1.1)*, (2) support development of complementary populations when necessary to apply HTPP in order to determine the genetics of the trait and the possibilities for marker-assisted selection, and (3) identify and rank the most promising accessions already available to be used as released varieties and/or progenitors *(contribution to Output 2.2.1).* As described in the narrative, the inputs of WPs 1–3 are strategic for breeders and geneticists to properly define the genetic architecture of quality traits and for the development of sensible breeding strategies to improve them. To date, little knowledge is available regarding the genetic make up of RTB crop quality traits valued by processors and end-users.

KEY ACHIEVEMENTS IN IDENTIFICATION OF RTB BREEDING POPULATIONS TO BE USED WITHIN the RTBfoods PROJECT. In Period 1 the different teams involved in WP 4 worked to identify the populations to be used for the implementation of HTPP *(contribution to Output 2.1.1 through Del. M.2.1).* These teams are already involved in different projects and have several populations (genome sequencing, biparental, GWAS, etc.) to establish marker-trait associations. The challenge was to identify the most suitable for RTBfoods (i.e., the one encompassing enough variability for the targeted product profile to be used for the implementation of the HTPP and the genetic architecture dissection). The teams have also already started working on product quality, since it is part of most of the ongoing projects (e.g., AfricaYam, NextGen, SASHA, etc.) using the common methods of phenotyping. Depending on the equipment available, the proximity of food quality laboratory, and the knowledge, the progress of the teams is not the same.

A population tracker was developed to monitor WP 4 progress *(Del. M.2.1).* We first reported the context (institute, product profile, persons involved), then the origin of the population(s) which will be made available for RTBfoods activities (developed within the project or within ongoing bilateral project) and the traits related to quality measured this year. This tracker will be complemented each year in order to summarize our activities, showing the synergies and the progress. It is a tool to monitor the activities and to keep all the partners and other WPs (1–3,5, and 6) informed on ongoing breeding activities. It will also be a good tool for quickly identifying threats or weaknesses, so that we can deal with them early.

A STATE OF ART ON BREEDING FOR QUALITY IN RTB BREEDING PROGRAMS. Each team has written a state-of-the-art on the breeding for quality for the crop it is working on (*Del. M.1.1)*. It was the opportunity to review what has been achieved to date. The fact that each team reported activities that have not been published elsewhere before was a way to inform each other in order to encourage sharing approaches and methods. In this document, gap analyses were identified for each crop. It

was one of the objectives of the SoK document. Some gaps are shared while others are not. During subsequent periods, RTBfoods should address this lack of knowledge and try as much as possible to fill the gaps. We expect at the end of the project to increase our knowledge on the breeding for quality traits by identifying the key traits involved in quality, their heritability, and the genomic regions underlying these traits *(Output 2.1.1).*

TEAM COORDINATION AND INTERACTIONS WITH OTHER WPs. For team coordination purposes, the coordinator for WP 4 visited Uganda, Nigeria, and Guadeloupe, to meet all the collaborators working on cassava, sweetpotato, and matooke in Uganda, and cassava and yam in Nigeria. The objective was to know more precisely the activities carried out by the different partners within the other projects they are already involved in. The WP 4 leader also visited the Food Technology Laboratories in these countries to get a better idea of the facilities available for the breeders. During these visits, WP 4 objectives for each crop were discussed with partners; populations that will be involved in the RTBfoods project were identified so as to avoid duplication with other ongoing projects. To complement this work, the WP 4 coordinator plans to visit Côte d'Ivoire and Colombia in Period 2. Intra-WP 4 coordination has two types of challenges. First, the limited availability of breeders involved in partners' breeding programs affected their ability to react promptly. Besides, WP 4 partners felt it was difficult to identify populations to be used in the RTBfoods project without compromising previous commitments in partner breeding programs nor duplicating activities. Communication with other WPs could and should be reinforced, especially because WP 4 breeders are keen to get feedback on their strategy and their varieties as early as possible. A more efficient communication strategy should be defined for Period 2 during the next RTBfoods annual meeting between WP 4 breeders and other WP partners.

2.1.9 Perspectives for Period 2

In terms of perspectives for Period 2, and to continue to contribute to Output 2.2.1 through the identification of the genetic architecture of users' preferred quality traits, field trials will be repeated in 2019 in the different identified environments for genome by environment (GxE) studies. The traits will be adjusted after the annual meeting at Abuja, following the discussion with WP 2, WP 3, and other colleagues from WP 4 in order to measure the more relevant traits before the HTPP method is made available. Data storage and management will be on the agenda of the annual meeting in order to define the best practices.

2.1.10 Gender equitable positioning promotion & performance (WP 5) - Key progress achievements

(See WP5 Extensive Activity Report for Period 1 in Annex 5, p. 129)

WP5 OBJECTIVES AND STRATEGY. WP 5 represents the advanced testing stage prior to release. The main objective is to develop useful protocols for effectively evaluating and getting feedback on performance of advanced clones from users (producers, processors, consumers) *(Output 3.1.1)* in order to ensure that only acceptable varieties are released and promoted by breeding and seed programs *(Output 3.1.2).* The organization of activities under the RTBfoods project anticipated major efforts in other WPs in the year 1 of the project. Critical information was gathered on validation of product profiles, methods of engaging with processors and consumers to determine preferred attributes, understanding the basis of preferred attributes, introducing selection for these in breeding programs through the use of HTPP methods, and ultimately molecular approaches to selection. There were, however, some opportunities to take advantage of the ongoing advanced testing of genotypes by research teams interested in systematically engaging with processors and consumers, in addition to the usual engagement with producers through on-farm trials.

In Nigeria multidisciplinary IITA/NRCRI/CIRAD teams in WP 5 engaged with cassava processors,

producers, and consumers through Mother–Baby trials (MBT) conducted under the NextGen project. The trials provided substantial information on varietal suitability for gari and fufu, as well as insights on engaging with users *(contribution to Output 3.1.1)*. Similar work was conducted in Nigeria on evaluation of yam genotypes under the Africa Yam project for boiling and pounding. In Uganda on-farm trials of sweetpotato genotypes under the Meals for Nutrition Uganda (MENU) project, funded by HarvestPlus, provided the opportunity for engagement with processors and consumers to conduct evaluations of boiled and fried sweetpotato. In Uganda methods for engagement with users in the evaluation of bananas for matooke were also underway by the NARL/Bioversity team, but results are not yet in. Elsewhere, WP 5 activities were deferred until the effective engagement with the RTBfoods WP 1 team could be assured so as not to rush ahead without agreed protocols. However, preparations were underway for WP 5 activities on targeted crops and products in each of the remaining RTBfoods countries, including Cameroon, Benin and Côte d'Ivoire, and Uganda. In the case of banana, this was largely through identification and multiplication of genotypes for inclusion in WP 5 trials in coming years.

Preliminary reports of cassava and yam assessments from Nigeria and from sweetpotato assessments from Uganda were received and salient points of methods used are summarized here:

- The cassava trials used MBT and a multidisciplinary approach to evaluate gari-eba and fufu at locations in two states in Nigeria (Osun and Imo). Between 20 and 25 genotypes were evaluated, including widely grown Nigerian varieties, experimental genotypes (some from the NextGen project), and local preferred checks. The Mother trials included all genotypes in replicated 60-plant plots, which were used to gather agronomic data and provide three expert processors at each location with roots for processing into gari and its cooked product, eba. In Osun State, cassava was also processed into two types of fufu. During the processing operations, detailed data on relevant processing attributes and conditions such as time of peeling, yield of gari, toasting temperature, etc., was taken by researchers, while processors were interviewed on their assessment of processing quality of each cultivar for each product. Eba quality was also evaluated by processors. Baby trials were established with 20 producers in each state and used to engage with a diversity of carefully selected users chosen to represent different social groups. A subset of experimental genotypes and local checks was used in smaller, replicated trials at each farm, with all experimental genotypes evaluated at an equal number of farms. Regular visits during growth and after harvest provided insights on the genotype performance by the various users. Detailed data collection protocols and forms were developed and used by the team for both the MBT and processing trials, and used rating scales, ranking and detailed probing to elucidate producer and processor assessments. Preliminary report and forms are posted on the RTBfoods portal.
- Similar trials were conducted for boiled and pounded yam using expert processors at three locations in Oyo and Ondo states in Nigeria. Results, although yet to be reported, have certainly generated a wealth of information on genotype performance and provided input to each of the WPs.
- Sweetpotato trials in Uganda expanded on standard CIP on-farm trial methods, which included community engagement under the MENU project, a project aimed at evaluating and promoting orange-fleshed sweetpotato varieties in selected districts. A set of genotypes, including local white-fleshed check, were evaluated boiled or fried. Three tests (hedonic, just-about-right, and check all that apply) were used. Preliminary results indicated preferred genotypes for both boiled and fried sweetpotato. However, in some cases, sweetpotato yields were very poor and did not permit the full range of anticipated consumer sensory assessments.

TEAM COORDINATION AND INTERACTIONS WITH OTHER WPs. The first reporting period has seen intensive activity across the project, with major efforts undertaken to a greater extent in WPs other than WP 5. During the initial stage of project implementation, there will be a need for strong interaction of WP 5 with WP 1 and WP 2 for development of protocols for user assessment and provision of materials for physicochemical analysis. However, WP 5's ultimate objective is to provide standard, easily implementable protocols to elicit producer, processor, and consumer feedback on advanced materials prior to release *(Output 3.1.1)*. Standard methods will certainly include use Mother trials and collaboration with expert processors. The use of citizen science approaches, including the triadic comparison of technologies (tricot) Climmob methods developed by Bioversity, also appears to offer promise. The potential to use this method to complement and amplify the results of Baby trials will be systematically investigated as a WP 5 method in the coming seasons.

2.1.11 RTBfoods Coordination, Monitoring, Evaluation & Learning - MEL (WP 6) - Key progress achievements

(See WP6 Extensive Activity Report for Period 1 in Annex 6, p. 137)

ADMINISTRATIVE, FINANCIAL, AND LOGISTICAL SUPPORT. During the first months of Period 1, the PMU and finance teams actively helped establish contractual relationships with partner and budget transfers to partners. At the end of Period 1, the finance team developed the Period 1 financial report and checked the alignment of expenses reported by partners with the budget initially planned and the narrative on activities conducted. During Period 1 the PMU actively supported the logistical and administrative organization of the two workshops held in Benin and Uganda by partners.

THE DEVELOPMENT OF THE RTBfoods GLOBAL ACCESS STRATEGY. As project coordinator, CIRAD's PMU was responsible for the development of the project global access strategy (Annex 22, p. 237). This document, required by the BMGF, details the principles and the process by which the results produced will be made publicly available. Data will be stored long term on secured, open-access repositories. Compliance with the current international regulations (e.g., the EU General Data Protection Regulation) was addressed in specific sections. The global access strategy document was shared with, and approved by, partners prior to validation by the Foundation.

IMPROVING THE ACCURACY OF THE RESULTS FRAMEWORK AND RESULTS TRACKER. The activities around MEL within RTBfoods started at the inception meeting, during which a whole day was dedicated to refining the project Results Framework. Partners organized in WPs were asked to revise the list of outputs they would produce and outcomes they will contribute to within the project. These lists were then reworked during Period 1 by the PMU after receiving the WPs' work plans. It was necessary to check the alignment between work plans and the RTBfoods Results Tracker against which CIRAD committed to report annually to the Foundation. The PMU worked closely with R. Ofei from IITA to revise the Results Framework and Results Tracker that were submitted for approval to the Foundation. Each proposed change was explicitly justified and documented. Most of what was submitted for validation were changes in wording (i.e., better formulation for outputs and outcomes, most of them were initially phrased activities or deliverables in the first version from July 2017 attached to the project narrative). Milestones that were missing in the first version of the Results Tracker were defined with clear qualitative and quantitative indicators for M&E purposes. The new versions of the Results Framework and Results Tracker were agreed by the Foundation on 16 November 2018. Reporting for Period 1 will be done on these versions.

DEVELOPMENT OF MONITORING AND REPORTING TOOLS. For monitoring purposes, and to ensure an operational workflow between teams and an efficient production of deliverables by partner teams, the PMU developed a panel of monitoring tools. These tools facilitated a weekly tracking of the progress of each WP toward the completion of the activities listed in the work plan and the production of deliverables. For reporting purposes and to share the project outputs outside the RTBfoods framework, the PMU also set up on online platform enabling open access to all project deliverables

through specific hyperlinks. In parallel, a survey on breeders practices was designed by the PMU to inform the initial situation prior to RTBfoods project. This survey is to be used at the beginning and end of the project to assess the progress toward achieving outcomes. Breeding partners will be first interviewed during the Period 1 annual meeting before targeting a broader RTB breeding community.

DEVELOPMENT OF A COLLABORATIVE PLATFORM FOR KNOWLEDGE AND DOCUMENT SHARING. The project assistant and the project manager led the development of the RTBfoods sharing and collaborative platform used by partners to securely store their working documents, protocols, and literature references. In the perspective of the development of a secured RTBfoods dataverse repository for the storage of socioeconomic, physicochemical, and spectral data in the long term, the PMU team attended a 2-day training organized internally at CIRAD in Montpellier.

EXTERNAL COMMUNICATION AND STRENGTHENING LINKS WITH PARTNER PROGRAMS AND INSTITUTIONS. The project leader was invited to participate in meetings and visits organized by partner projects, members of the RTBfoods Advisory Committee and partner institutes. Among others, he attended the AfricaYam, NextGen, SASHA 2018, and HarvestPlus cassava breeders annual meetings and was invited to the discussions prior to BBB Phase 2, by the BBB project leader Rony Sweenen. The project manager and the project leader also participated in the Symposium of the International Society of International Root Crops in Cali, Colombia. These meetings with the RTB breeding community of practice (CoP) were the opportunity to remind the complementarities between the partner RTB breeding programs and to identify opportunities for joint activities and/or new collaborations. The project leader was also invited by Dr. Hans van Doorn, who is a member of the RTBfoods Advisory Committee, for a 2-day visit of HZPC laboratories in The Netherlands. The PMU also received a delegation of Nestlé, member of the Advisory Committee, at CIRAD offices, in Montpellier. Among other topics discussed the parties reminded their willingness to collaborate within RTBfoods framework.

2.1.12 Outlook for Period 2

During the first months of Period 2, WP 6 partners will complete the RTBfoods Consortium Agreement report and share it with partners for feedback and signature. This document will describe the roles and responsibilities (with a focus on reporting duties) of the project parties at three different levels, tailored to RTBfoods framework (i.e., WP leaders, product champions, and partner focal points). The PMU will continue to develop the project strategy for external communication and develop a tool/interface that can also be used for knowledge management by project partners. In Period 2, WP 6 members will start, if not complete, writing a data management plan (DMP) to describe more precisely how and on which repositories the different types of data produced (i.e., socioeconomic, physicochemical, spectral, phenotypic, and genotypic) will be securely stored in the long term. This DMP will also detail the process and the responsible person(s) for the transfer to the repositories identified. The management of data produced will be addressed during the next RTBfoods annual meeting and discussed with the BTI (Ithaca, New York) in charge of the existing crop-specific databases for RTB crops (RTBfoods Global Access Strategy in Annex 22, p. 237). In early stages of Period 2, the PMU will also develop a monitoring plan to check that activities are carried out in alignment with the project Results Framework and in coordination across WPs and countries in particular for teams working on the same product profile. The monitoring plan should also address how to better assess and monitor the progress toward project outcomes. For this purpose, the PMU will conduct a baseline survey on RTB breeding practices, targeting RTBfoods partner breeders and RTB breeders outside of the project. Such a survey will be used for the endline assessment of the project's contribution toward outcome.

2.2 Progress Achievements in Period 1 by Product Profile

The matrix structure of the project (by WP, partners, and product profile) leads us to ensure that the work progresses seamlessly along the three axes. In Period 1 we decided to focus on the progress of the WP teams and each partner. During our next annual meeting, the role of the product champions (leader of a product profile, see Table 1) will be strengthened. The champion products are the "product" correspondents and follow the progress of the work on their own product profile within the different WPs and with the different project partners. The "product champions" are the experts in profiling the preferred clones and know about the progress made in the development of high-throughput tools for predicting the quality traits of the product profile they are in charge of. A speed talk by product profile will be organized during the project's annual meeting (11 product champions). Reports on the progress of knowledge on product profiles will be requested during Period 2 to each product champion.

2.3 Key Progress Achievements in Period 1 by Partner Institution

2.3.1 Bioversity International key progress achievements

(See Bioversity Synthesis Report for Period 1 in Annex 7, p. 145)

In Period 1 Bioversity partners were responsible for the production of deliverables A.1.4 and I.1.5. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) Bioversity is involved in WPs 1, 2, and 5 in Uganda. During Period 1 activities related to WPs 1 and 2 were conducted. This section highlights the activities and achievements of Bioversity and partners in these WPs, which were jointly coordinated with NARL. Bioversity participated in the project inception meeting held in Cameroon in January 2018, WP 1 Pretesting of Tools workshop in September in Uganda, and WP 2 Sensory Panel Training workshop in Uganda in September. As part of WP 1, Bioversity and NARL completed an SoK review, focusing on desired product characteristics, demand segments, trends, and socio-cultural context for cooking banana. They participated in piloting of tools and conducted farm-level individual surveys and FGD to characterize food consumption habits and preferences for men and women in Central and Western regions. In WP 2, Bioversity contributed to the SoK. Two master's students, Moureen Asasira (Makerere University) and Nelson Willy Kisenyi (Kyambogo University), were recruited; research costs will be shared with NARL. Moureen's thesis will focus on the trait preferences of urban banana value chain actors, and she is finalizing her proposal and working on the data collection tools under WP 1. Nelson will work on laboratory characterization and consumer preferences of local EAHB and hybrid varieties under WPs 1 and 2. He is currently working on his thesis proposal. Bioversity is complementing RTBfoods activities with the BBB project.

2.3.2 Bowen University key progress achievements

(See Bowen University Synthesis Report for Period 1 in Annex 8, p. 150)

In Period 1 Bowen University partners were responsible for the production of deliverables A.1.1, F.1.9, and I.1.1. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) Bowen University team attended the inception meeting at Buea in Cameroon in January 2018, as well two capacity-building trainings: (1) WP 1 members Bolanle Otegbayo (food technologist), Oroniran Oluyinka (food technologist), and Fawehinmi Olabisi (gender specialist/economist) attended on 15–26 April 2018. Attending the sensory panel training workshop

in Kampala, Uganda on 17–21 September, were WP 2 members Bolanle Otegbayo and Oroniran Oluyinka. The Bowen team was involved in writing the SoK report on pounded yam, which was delivered for both WP 1 and WP 2. The conclusion of the SoK for WP 1, which included document review and information from interviewing key informants, is that textural quality is an important index of yam food quality to farmers, consumers, and processors, and that consumers prefer food products made from boiled and pounded yam from stored yam tubers than from fresh yam tubers. The WP 2 SoK report, which was mainly a document review, concluded that there is a relationship between chemical composition (amylose, DM, starch, calcium, pectin) of yam tubers and histological structures (starch granules, cell shape, cell size) that may be used to predict the textural quality of pounded yam, as reported by various authors. Several authors used different instrumental methods to measure textural quality of pounded yam. The RTBfoods project should establish the best method for measuring preferred textural quality attributes of pounded yam. We were also involved in the food product profiling and gender mapping survey (activity 3) of WP 1. The questionnaires and the Excel data have been forwarded to the coordinator and are available on the RTBfoods platform.

2.3.3 CARBAP key progress achievements

(See CARBAP Synthesis Report for Period 1 in Annex 9, p. 155)

In Period 1 CARBAP partners were responsible for the production of deliverables A.1.8, F.1.5, and I.1.8. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) During Period 1 CARBAP delivered an SoK review on boiled plantain (activity 1, WP 1). The review focused on food science, gender, and demand context. CARBAP actively participated in the Capacity Strengthening workshop (Activity 2, WP 1), held in Cotonou, Benin on 16–25 April 2018. From 5 to 20 September, surveys on boiled plantain were carried out in the West and Littoral regions of Cameroon within the framework of activity 3 of WP 1. In each of these regions, four localities were of interest, and the participants were selected randomly based on their ability to grow, prepare, or consume plantain. Finally, eight key informant interviews, 16 FGD, 78 individual interviews, and eight market interviews were conducted (activity 3, WP 1). Excel spreadsheets, consent forms, and filled questionnaires were submitted. Concerning WP 2, an SoK review was reported by CARBAP on the composition and structure of raw bananas and plantains, processing conditions of plantain pulps, sensory analysis and consumer preferences, boiled plantain characterization, and relationship with sensory evaluation. CARBAP also participated in the Sensory Panel Training workshop held at NARL in Kawanda, Uganda, on 17–21 September. For WP 5 meetings were organized in collaboration with IITA to develop the protocols for the validation of agronomic and user-preferred traits in selected genotypes. We settled on the locations for trial setup, the plantain hybrids and local cultivars to be evaluated, the number of accessions, and the agronomic practices.

2.3.4 CIAT key progress achievements

(See CIAT Synthesis Report for Period 1 in Annex 10, p. 160)

In Period 1 CIAT partners were responsible for the production of the following deliverables: G.1.4, H.3.3–H.3.5, and K.1.1 and largely contributed to M.1.1 and M.2.1. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) During Period 1 CIAT has implemented the following activities. First, a database of biophysical traits (composition, cooking time, and texture of raw and cooked roots) and NIRS spectra was established for 150 genotypes of cassava harvested in 2018, in preparation for investigating correlations and predictive algorithms between NIRS and biophysical data. This database will be expanded to 450–500 entries by adding data from upcoming harvests in 2019 and 2020. We expect this number will allow for the identification of robust correlations, and hence reliable HTPP predictions by NIRS of some of the quality traits of boiled cassava. As part of this work, to better describe the texture of cassava roots, a new texture

protocol was developed by screening several types of probes and measurement conditions to identify the configuration that optimizes coefficients of variation. This protocol was used to generate the texture data in the database of biophysical traits of boiled cassava. Second, exploratory research was conducted to extract CWM from cassava roots and investigate correlations between CWM and quality traits of boiled cassava (texture, etc.). An extraction protocol of CWM was established and CWM from 30 genotypes with contrasting cooking times (from 15 min to more than 60 min) were extracted. The extracts were characterized by NIRS and MIRS, and potential correlations with texture are being investigated. Third, seven standard operating protocols (SOPs) in use at CIAT for biophysical characterizations of cassava roots were inventoried and made available on the RTBfoods online platform. Fourth, genotypes with short-to-long cooking times, together with low cyanide, were selected and planted for crossings, to determine the heritability of the trait short-cooking ability. Flowering and crossing are expected during the first quarter of 2019.

2.3.5 CIP key progress achievements

(See CIP Synthesis Report for Period 1 in Annex 11, p. 166)

In Period 1 CIP partners were responsible for the production of the following deliverables: A.1.9, F.1.7, F.1.10, F.2.1, G.1.6, G.1.7–G.1.9, G.2.2, G.2.3, H.3.6–H.3.9, I.1.9, K.1.5, and K.1.6 and largely contributed to M.1.1 and M.2.1. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) CIP contributions to the RTBfoods project encompass WPs 1–5. CIP successfully coordinated WP 2 and WP 5 while also contributing collaboratively to other WPs, working with and supporting RTBfoods NARS partners to deliver on the objectives set out in the WPs. In WP 1 CIP established successful collaborations with NARO in Uganda, produced three SoK reviews for boiled and fried sweetpotato, and jointly conducted WP 1 field activities. In WP 2 CIP teams worked with partners to develop SoK reviews for potato and sweetpotato. Protocols for biochemical and biophysical characterization in WP 2 were identified and new ones pretested with partners at NCSU, JHI, and ETHZ. CIP staff contributed to the successful Sensory Panel Training workshop in Uganda. In WP 3 CIP conducted NIRS trainings for breeding and quality technicians in Uganda and Peru. Laboratory facilities and available calibrations were evaluated. A webinar with Brimrose Corp. on field-based NIRS for raw sweetpotato and potato was conducted. In WP 4 CIP breeders compiled an inventory on previous sweetpotato breeding for root quality traits and identified two mapping populations developed under the GT4SP project for RTBfoods. CIP potato breeders, in partnership with NARO–Uganda, identified quality traits and breeding populations and timelines in collaboration with WP 1 and WP 2. In WP 5 CIP conducted consumer taste tests in Lira Town, Kamwenge Town, and in Byabasambu Parish, Kamwenge District. Six clones obtained from the MENU project trials were used during the tests.

2.3.6 CIRAD key progress achievements

(See CIRAD Synthesis Report for Period 1 in Annex 12, p. 172)

In Period 1 CIRAD partners were responsible for the production of the following deliverables: A1.7, A.2.1–A.2.10, E.1.1, F.2.2, F.2.2bis, F.2.3, F.2.3bis, G.1.2, G.1.4, G.2.4, H.1.1, H.3.2, K.1.4, M.1.1, and M.2.1. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) In Period 1 CIRAD staff were actively involved in the following activities: methodological development (inventories of existing methodologies and protocols used by partners in WPs 2–4); production of methodological manuals for partner use and intended to be shared later with a broader scientific community (WP 1 and WP 2 manuals); scientific and technical support to partner activities (guidance and support in knowledge capitalization and production in WPs 1–4); support provided to partners in the implementation of field activities (WP 1 and WP 5); logistical support to workshop and training organization by WP leaders (WP 1 and WP 2); project coordination and monitoring (visits to partners, organization of regular meetings between the PMU and WP leaders

and face-to-face meetings with partners in parallel to international conferences or symposiums, facilitation in the organization of regular intra- and cross-WP coordination meetings, and production of monitoring tools shared with WP leaders). CIRAD is part of the WP 1 coordination team; as such during Period 1 CIRAD researchers were heavily involved in the adaptation of an existing methodology to RTBfoods framework and its specific outputs. They largely contributed to the production of a set of guidance documents for partner use. After the organization of a common training on WP 1 methodology with all WP 1 teams, CIRAD researchers provided methodological support to WP 1 partner teams in conducting surveys with RTB users. CIRAD is involved in the WP 2 coordination team. Consequently, CIRAD researchers supported the writing of SoK reports on biophysical measurement of quality characteristics for the 11 targeted RTBfoods products. They also supervised the inventory of methods and protocols used by partner laboratories for biophysical analysis on RTB crops and products. Finally, CIRAD sensory experts led a workshop to train WP 2 partners to set up sensory panels on RTB products in the perspective of sensory-profiling activities to be conducted in Period 2. A methodological manual compiling all training material was written by these experts and specifically adapted to fulfill RTBfoods commitments. CIRAD coordinates RTBfoods WP 3. As such, the team was mainly involved in the training of partner teams on the use of HTPP tools, and was responsible for an SoK on previous use of HTPP protocols on the RTB crops and products targeted within RTBfoods. The CIRAD team developed templates to centralize the information on existing and ongoing spectral databases on RTB crops and products from all partners involved in breeding activities. CIRAD coordinates RTBfoods WP 4. In this regard, CIRAD coordinated the production of a state-of-the-art on previous examples of breeding for quality in the different partner programs and/or institutes involved in RTBfoods. CIRAD's leader for WP 4 coordinated the development of a population tracker to be used all project long to inventory and monitor information related to RTB populations to be used within the project framework. CIRAD is involved in WP 5 activities. In Period 1 CIRAD staff supported the IITA team in the assessment of NextGen new cassava hybrids. WP 6 is composed of CIRAD staff responsible for project coordination. As such, during Period 1 the team developed several tools to manage project budget, to monitor WP activities and progress toward achievements of outputs and outcomes, and more globally to facilitate communication and collaboration with and between partner teams.

2.3.7 CNRA key progress achievements

(See CNRA Synthesis Report for Period 1 in Annex 13, p. 191)

In Period 1 CNRA partners were responsible for the production of the following deliverables: A.1.6, F.1.3, and I.1.7 and largely contributed to M.1.1 and M.2.1. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) Activities were conducted in WP 1, WP 4, and WP 5; most of them concerned were in WP 1. Attiéké, a product made of cassava, is the leading product for Côte d'Ivoire, and all the activities of WP 1 concerned this product. A preliminary survey was conducted in two regions (Bingerville-Dabou in the south and Yamoussoukro-Bouaké in the center). After that, a survey was conducted in Bingerville-Dabou region, where attiéké is a traditional staple dish. In the villages Akradio and Opoyounem 226 (136 females, 90 males) persons were interviewed. As regards to Bingerville, five villages (Bregbo, Eloka-Té, Achokoi, Akradio, and Opoyounem) were investigated. An SoK study was performed for WP 1 focusing on three areas (demand, gender, and food science) to identify attributes that are important for a cassava variety that makes good attiéké and important descriptors for a good attiéké. Data from leader interviews, Focus Group Discussions (FGD) of men and women, market interviews, individual interviews, and transect in these locations were gathered and disaggregated. We also produced a WP 2 SoK. The main objective of WP 2 is to translate the user traits captured in the food product profiles from WP 1 into laboratory-based quantitative assessments of biophysical and functional properties that can be used as reference values for developing high-throughput products. CNRA provided the inventory of material and equipment existing at the institution and the methods of analysis that are used. CNRA

participated in the kick-off meeting in Buéa and the WP 1 workshop in Benin.

2.3.8 IITA key progress achievements

(See IITA Synthesis Report for Period 1 in Annex 14, p. 196)

In Period 1 IITA partners were responsible for the production of the following deliverables: A.1.2, A.1.7, F.1.2, G.1.1, G.2.1, H.3.1, H.3.11, I.1.3, K.1.2, K.1.3, and K.1.10 and largely contributed to M.1.1 and M.2.1. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) Within the scope of WP 1 IITA has produced SoK reports for *gari* (Benin, Nigeria, and Cameroon) and boiled yam product (Nigeria). Furthermore, staff were trained on the WP 1 methodology in Cotonou, Benin. Following a standardized sampling frame for WP 1, IITA carried out fieldwork including questionnaires and FGD in Nigeria and Benin for all the products separately. In addition, yam advanced clones under on-farm evaluation for commercial deployment were profiled for boiled and pounded yam food product quality characteristics. This was done in collaboration with WP 5 and the cassava team. In WP 2 and WP 3, 200 clones of yam (*Dioscorea rotundata* and *D. alata*) from two growing environments (Ibadan and Ubiaja) were provided by the AfricaYam project. Some 200 genotypes of cassava roots from NextGen diversity trials, also from two growing environments (Ibadan and Ikenne), were collected. The samples were analyzed for DM, starch, color, and protein for yam and cassava to generate reference data for the calibration profile development for NIRS in connection with WP 3 deliverables. Cyanogenic potential was included for cassava. Within the scope of WP 5 (evaluation of varieties with stakeholders), IITA has developed a methodology for evaluating promising clones and which they have done so with stakeholders in Nigeria for cassava and yam based on existing yam and cassava trials. In Period 1 of RTBfoods, IITA banana and plantain teams were scheduled to work on cooking bananas (matooke) under WP 4 and to conduct a survey on study the impact of the released plantain hybrids in West Africa. Under WP 4, on cooking bananas (matooke), IITA has produced a report on SoK for quality traits in matooke at IITA (WP 4, Period 1 deliverable M1.1). IITA has made an inventory of the available material to be used by different WPs working on matooke quality. On the basis of this information, we have populated the Results Tracker for WP 4 (WP 4, M2.1). IITA has also collaborated with NaCRRI and NARL to set up the stage in defining matooke quality in sensory and physico-chemical (WP 2 by NARS) and NIRS analyses (WP 3, NaCRRI). An impact/adoption study on plantain hybrids was planned to begin in Period 1; however, the budget was too small for such a study. After meetings were held to devise a way forward, we decided to replace the study with a plantain consumer preference study based in Nigeria. This will be conducted in Period 2 of the project.

2.3.9 INRA key progress achievements

(See INRA Synthesis Report for Period 1 in Annex 15, p. 203)

In Period 1 INRA partners were responsible for the production of deliverables G.1.2, H.3.2, and K.1.4. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) For INRA PACA UMR SQPOV Avignon, Period 1 involved defining and organizing future activities to be conducted on yam and banana products in Avignon and analyzing bibliography and protocols. Preliminary tests were conducted for the extraction of cell-wall polysaccharides from raw banana. Partners were consulted to set the conditions to obtain materials, define samples, and experiments. For INRA (ASTRO-URZ unit of research) and CIRAD–Guadeloupe in Period 1, we organized the different activities to be conducted on yam. The objective was to quantify the phenotypic and genetic relationships between yam (*D. alata*), vegetative growth, and tuber quality (DM, starches, proteins, sugars, amylose, amylopectin, browning, shape and size of starch granules, and textures parameters, etc.) in contrasted environments. Two types of plant material were assessed: (1) a varietal panel representative of *D. alata* genetic diversity from 12 (in 2017) and 40 (in 2018) accessions for GxE interaction study, and (2) a biparental population (300 accessions from

AfricaYam project) aiming at QTL identification.

2.3.10 JHI key progress achievements

(See JHI Synthesis Report for Period 1 in Annex 16, p. 210)

In Period 1 JHI partners were involved in the production of deliverables F.1.7 and F.1.10. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) Research at the JHI has focused on boiled sweetpotato texture. To compare different genotypes and to accurately characterize differences between genotypes, an accurate and reproducible method was required. Appropriate instruments for measuring sweetpotato texture were investigated. We established that the QTS25 texture analyzer (Brookfield Engineering, Harlow, UK) using an acrylic wedge (Pat TA7, approx. 8, 3 mm wide x 60 mm long and angle 40) met the criteria for throughput, accuracy, and reproducibility. An important aspect was the cooking method; several approaches were assessed. The most successful method involves cooking the sweetpotato tuber in a vacuum-sealed bag at 80°C. The method development was carried out on test tubers purchased in the UK. To investigate the variability in cooking time/texture, samples were obtained from CIP partners in Kenya and Uganda. Seven genotypes were analyzed that showed a wide range in cooking time/textural properties. The DM content of tubers was measured. An important finding was that there was no correlation between cooking time, texture parameters, and DM content within these seven genotypes.

2.3.11 NaCRRI key progress achievements

(See NaCRRI Synthesis Report for Period 1 in Annex 17, p. 213)

In Period 1 NaCRRI partners were responsible for the production of the following deliverables: A.1.3, F.1.1, G.1.3, K.1.8, I.1.4, and K.1.9 and largely contributed to M.1.1 and M.2.1. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) During the past year (November 2017–November 2018), NaCRRI helped implement five major activities. First, compilation of an SoK for WP 1 “State of knowledge report for boiled cassava. A case of Uganda.” This report highlighted (1) important product variations were boiled cassava, mashed cassava, and “katogo”; (2) segments for demand of boiled cassava in rural and urban communities; and (3) profitability estimates for boiled cassava. A second major activity, activity 3 for WP 1, was conducted on boiled cassava in two locations, Luwero (central region) and Apac (northern region). Data were collected using individual interviews, FGD, and key informant interviews. This survey was conducted following harmonization of tools and sampling methodologies as guided by WP 1 leadership. Third, an SoK report was consolidated for WP 2 and NaCRRI participated in the sensory panel trainings at NARL. The fourth major activity was under WP 3 for which we hosted a 5-day training workshop on Near infrared Spectroscopy: Theory and Application. Nineteen participants attended this training, which was conducted by Dr. Davrieux Fabrice. Consequently, it was agreed that the NIRS instrument and competencies at NaCRRI be used by partners to develop HTPPs for the different RTB crops. To kick start this, NaCRRI, through its Nutrition and Bioanalytical Lab, partnered with the IITA banana-breeding team to provide NIRS services. Finally, under WP 4 NaCRRI compiled and submitted the SoK report “Cassava State of Art on Breeding Quality Traits in Uganda.” In addition, NaCRRI established two field trials at Namulonge (central region) and Serere (eastern region) for purposes of identifying RTB varieties that meet users’ needs, with a focus on V, U, and E. These trials comprised both elite and popular landraces. Relevant documents associated with the abovementioned activities have all been submitted to the respective WP leaders. It also suffices to note that both RTBfoods and the NextGen projects being implemented by NaCRRI offer excellent opportunities for sharing lessons, techniques, and knowledge. In fact, we have (and continue to have) to optimally exploit this project partnership for the benefit of stakeholders involved in the cassava production-processing-marketing-consumption continuum.

2.3.12 NARL key progress achievements

(See NARL Synthesis Report for Period 1 in Annex 18, p. 217)

In Period 1 NARL partners were responsible for the production of deliverables F.1.6, I.1.5, K.1.8, and K.1.9. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) From November 2017 to November 2018, NARL participated in project inception and planning meetings in Cameroon. WP 1 methodology development training in Benin aimed at harmonizing sampling approaches, pretesting tools, role play for FGD, data analysis, and final report writing. NARL, together with Bioversity, also completed the SoKs for WP 1 and WP 2. (Reports are uploaded on the RTBfoods platform.) NARL successfully hosted and participated in the Sensory Panel Training workshop, led by CIRAD. The training equipped NARL, together with Bioversity. These two institutes have also jointly completed farm-level end-user–preference profiling surveys under WP 1 (a summary table submitted to WP leader) and are scanning and uploading questionnaires and FGD reports to RTBfoods platform). NARL has recruited a socioeconomics master's student (Moreen Asasira), attached to Makerere University. Her thesis will contribute to the understanding of traits preferred by market- and urban-based value chain actors such as retail traders, restaurant operators, and consumers. She has completed her research proposal and is currently working on data collection tools. Another master's student, Nelson Willy Kisenyi, attached to Kyambogo University, will contribute to the laboratory characterization and quantification of consumer-preferred traits under WP 2. He is shared between NARL and Bioversity International. NARL has successfully coordinated with IITA–Uganda, NaCRRI, Bioversity, and CIP to implement RTBfoods activities. The sharing of personnel and equipment such as the NIRS has helped us cope with budget limitations. During Period 2 NARL will continue to work closely with the IITA–NARO BBB project, Bioversity, CIP, and NaCRRI. All the activities planned for Period 1 were completed.

2.3.13 NRCRI key progress achievements

(See NRCRI Synthesis Report for Period 1 in Annex 19, p. 221)

In Period 1 NRCRI partners were responsible for the production of the following deliverables: A.1.1bis, F.1.4, G.1.5, H.3.10, I.1.2, I.1.10, and K.1.7 and largely contributed to M.1.1 and M.2.1. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) NRCRI–Umudike within Period 1 produced the SoK report on the demand, preferred sensory characteristics, and socio-cultural context of gari and boiled and pounded yam in Southeast Nigeria (WP 1 activity). We documented and delivered the SoK report on biophysical and sensory characterization of fresh cassava and fufu (WP 2 Period 1 deliverable). We collaborated with IITA–Ibadan and Bowen University to prepare a draft of the protocol for determining the cooking, pounding ability, sensory, textural, and biophysical properties of some yam varieties. NRCRI conducted and delivered the report of the survey on gender product mapping and user profile survey for gari, eba, fufu, and boiled and pounded yam. The study was carried out in eight villages within six senatorial zones of Imo and Ebonyi states in the South-Geo-political region of Nigeria (WP 1 activity 3). In collaboration with IITA–Ibadan, NRCRI used 23 NextGen cassava varieties planted in the Mother trial at Imo State to conduct and develop the protocol and methodology for participatory evaluation of new hybrids (WP 5). The NextGen cassava Mother trial was replanted in Imo State for validation of the WP 5 protocol. Samples of fresh cassava roots and gari from this Mother trial were analyzed using wet lab methods and table-top NIRS (WP 2 activity), in collaboration with IITA–Ibadan. An inventory of state-of-the-art within the yam-breeding population was undertaken and submitted to the WP 4 leader. We organized training for NRCRI and IITA staff on use of hand-held NIRS for high-throughput analysis of fresh cassava roots. NRCRI participated in a capacity-strengthening workshop organized by WP 1 in Benin, sensory evaluation training in Uganda by WP 2, and the in-country coordination meeting held at IITA–Ibadan.

2.3.14 NRI key progress achievements

(See NRI Synthesis Report for Period 1 in Annex 20, p. 226)

In Period 1 NRI partners were responsible for the production of the following deliverables: A.2.1–A.2.10. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) NRI is responsible for the overall coordination of WP 1 and for contributing to WP 5. Achievements for year 1 are mainly in WP 1 due to activity sequencing. In collaboration with CIRAD and Cornell University, NRI has led the achievement of the following project outputs: (1) the development of WP 1 interdisciplinary methodology, resulting in four manuals used by all 11 implementing partners and shared with external projects and stakeholders; (2) the organization, development, and delivery of the Capacity Strengthening and Sharing workshop on WP 1 methodology for WP 1 partners, with resources made public at project end; (3) development of the interdisciplinary WP 1 SoK guidance document that has structured and informed the development of 10 product-based SoK reports to identify key evidence-based research gaps to be addressed by RTBfoods; (4) development and dissemination of the WP 1 data management plan for WP1 partners; and (5) WP 1 data analysis guidance for activity 3, aimed at strengthening qualitative skillsets among the teams. NRI has also provided continual, timely, and tailored in-country and virtual support to WP 1 partners and led in proactive communication with other WPs, particularly WP 2. NRI has been involved in strategic partnerships external to the project, including participation in Excellence in Breeding symposium, CGIAR's GBI; NextGen Cassava, and the Global Cassava Partnership 21 Conference.

2.3.15 UAC-FSA key progress achievements

(See UAC-FSA Synthesis Report for Period 1 in Annex 21, p. 233)

In Period 1 UAC-FSA partners were responsible for the production of deliverables A.1.5, F.1.8, and I.1.6. (Hyperlinks to access these files are available in Table 7 p. 40 of deliverables disaggregated by project output.) During Period 1 the UAC-FSA team has been working on WP 1 and WP 2 activities. These activities are related to field work and capacity strengthening (training). Concerning WP 1, we gathered the SoK of boiled yam from literature review and key informant interviews; the report was validated by the WP 1 coordination team. In addition, the UAC-FSA and IITA–Benin research teams collaborated to carry out the survey (activity 3) on boiled yam and boiled cassava in eight rural communities. Regarding WP 2, the SoK on the physico-chemical, biophysical, and nutritional quality of boiled yam was reported and validated by the WP 2 coordination team. The list of laboratory procedures was also provided on the RTBfoods website. We participated in the Capacity Strengthening and Building Common Methodologies workshop held in Cotonou, Benin, on 16–25 April 2018. We also attended the Sensory Panel Training workshop in Ouganda. We are now in the process of the activity 3 data analysis.

2.4 Project Coordination and MEL Components

The team in charge of the daily project coordination is composed of thee full-time staff from CIRAD dedicated to the project: the RTBfoods project coordinator, the project manager for MEL, and the project assistant.

COORDINATION MEETINGS AND MISSIONS TO PARTNERS. After the RTBfoods inception meeting in January 2018, partners and teams organized in WPs were required to provide the PMU with specific roadmaps for Period 1. Throughout the year—on average every 2 months—Skype calls were set up by the PMU with WP coordination teams (i.e., WP leaders and co-leaders) to monitor the progress in these work plans. These coordination meetings are essential to enable the PMU and WP coordinators to monitor activities carried out by all project teams, to keep all partners informed of

major changes or decisions made by the PMU in a consistent and uniform way (e.g., project strategies, documents, and deadlines), and to get their feedback on strategic orientations or adjustments to be made at project level and/or in a specific WP. Complementary virtual meetings were organized by the project manager with each WP coordination team with a timeframe and an adaptive agenda customized for different WPs according to their needs and to the amount of activities to be carried out in Period 1. Some cross-WP calls were facilitated by the project manager, in particular between WPs and teams that needed to coordinate in activity planning or agree on a process for sharing results. Finally, satellite RTBfoods coordination meetings were organized during international scientific events on RTB crops attended by most RTBfoods partners (i.e., IVth International Cassava Conference—GCP21, 18th Triennial Symposium of International Society for Root and Tuber Crops (ISTRC), and RTB annual meeting).

In Period 1 the project coordinator and the project manager visited partners and targeted countries during missions in Nigeria, Uganda, Benin, and Colombia. In parallel with visits of laboratory facilities and field/experimental trials, RTBfoods coordination meetings were organized during these missions to follow up on partners' progress and address challenges faced in the development of activities. Most of the time, all partners based in the country participated in these meetings. These meetings allowed the PMU to identify gaps and risks in coordination of activities between teams, partners, and/or WPs. These missions to partner countries were key moments for the PMU to adapt its coordination and monitoring methods and tools and to develop strategies to mitigate risks to an effective collaborative work. Missions to partner countries and regular meetings with WP coordination teams, partner focal points, and product champions at their request are the main methods used by the PMU to continuously adapt its coordination and to ensure an efficient flow of information between partners.

DEVELOPMENT OF MONITORING AND REPORTING TOOLS. In parallel with the regular coordination meetings organized by the project manager and each WP coordination team, tools were developed to specifically monitor the progress on work plans and to interact with WP coordinators. The minutes of each coordination meeting were shared with the participants and made available to project partners on the RTBfoods collaborative and sharing platform. For these purposes, online interactive spreadsheets were developed for each WP, simplifying and summarizing the project Results Framework and Results Tracker and aligning them with the work plan. These files have been used throughout the year by the project manager to follow up on activities carried out with WP leaders. They were progressively completed with the list of deliverables partner teams committed to deliver at the end of Period 1. The PMU also developed templates for partners to report on activities carried out and main achievements at two levels for Period 1: partner institute and WP. The PMU committed to report annually on an additional level (i.e., the product profile level), coordinated by product champions. For Period 1 the PMU agreed to ask only partner focal points and WP coordinators to contribute to reporting; the exact role of product champions will be implemented during the next annual meeting. For reporting purposes, an online MEL platform was set up to be used throughout the duration of the project to provide open access to its products and results. This platform is already used by the CGIAR to store and give access to deliverables produced by its different programs. Once uploaded on the MEL platform, each RTBfoods deliverable is made open access and downloadable through a unique hyperlink. In this process of mapping under MEL platform, the RTBfoods project manager for MEL went to Nigeria to be supported by Richard Ofei, MEL manager at IITA. The project manager also participated in two workshops. The first organized in Nigeria by RTB's PMU on methods to enhance results-based management within RTB programs. The second workshop was organized in Italy by the CGIAR's CoP–MEL and impact assessment on the occasion of its annual meeting.

IMPLEMENTATION OF A COLLABORATIVE PLATFORM FOR KNOWLEDGE AND DOCUMENTS-SHARING. The development of strategy to ensure that documents and knowledge are shared among partners was one of the recommendations made by the RTBfoods Advisory Committee at the

inception meeting in Cameroon in January 2018. This was also a demand coming directly from project partners themselves. This question was quickly addressed by the PMU. A secured, collaborative online platform was developed and personal accounts were created for all project participants. In Period 1 partners used this platform mainly to store their working documents and to share protocols and literature references. The PMU used the platform to store meeting minutes and project documentation that need to be accessible to partners, such as the RTBfoods global access strategy. This storage platform could be replaced soon by an online project and knowledge management system with private and public spaces. This would allow a single tool (Liferay software) to serve both internal and external communication purposes at the same time. Finally, in the perspective of the development of a secured RTBfoods dataverse repository to store socioeconomic, physicochemical, and spectral data long term, the PMU attended a 2-day training organized internally at CIRAD. The implementation of this dataverse repository by PMU is planned for Period 2.

FINANCIAL AND TECHNICAL SUPPORT TO PARTNER ACTIVITIES. During the first 6 months of the project, the CIRAD team involved in WP 6 was strongly involved in the contracts process with the 14 partner institutes. CIRAD is responsible for the annual financial reporting to the Foundation for the RTBfoods project as a whole. For this purpose, the team developed templates to be completed by the financial services of partner institutes at the end of Period 1. The PMU was also strongly involved in the organization of the WP 2 workshop on sensory panels in Uganda and in logistical support to the partners hosting the workshop.

THE RTBFOODS GLOBAL ACCESS STRATEGY. During the first months of Period 1, the PMU produced a document describing how the Foundations's open-access strategy will be implemented and put in place in RTBfoods, and how this strategy will impact partners in the development of their activities. For instance, a template to inform participants on RTBfoods project activities and another template to collect their free-consent prior to an activity were developed and attached to the global access strategy (Annex 22 p. 237).

RTBFOODS STUDENT INVOLVEMENT AND PARTNER TRAINING WORKSHOPS PARTICIPATION. An international team of students has joined the RTBfoods project team to carry out the studies and research necessary to achieve the project objectives (Table 5). A list of trainings and workshops attended by partners in Period 1 is shown in Table 6.

2.5 Trained Students in RTBfoods Project

Table 5. Students involved in RTBfoods activities in Period 1

Country	Host Institute(s)	Dipl.	Student	Title	University	Start	End	Tutor(s)
Uganda	Bioversity/ NARL	MSc	Nelson Willy Kisenyi	Biophysical and physicochemical characterization of cooking bananas and consumer preferences	Kyambogo University	09/18	09/19	Pricilla Marimo (Bioversity), Moses Matovu (NARL), Kephas Nowakunda (NARL), Beatrice Ekesa (Bioversity)

Country	Host Institute(s)	Dipl.	Student	Title	University	Start	End	Tutor(s)
Uganda	NARL/ Bioversity	MSc	Moreen Asasira	Urban consumer's preferences for cooking banana	Makerere University	09/18	09/19	Kenneth Akankwasa (NARL), Pricilla Marimo (Bioversity), Kephas Nowakunda (NARL)
Cameroon	CARBAP	PhD	Kendine Vepowo Cédric		University of Dschang			Dr. Ngoh Newilah
Cameroon	CARBAP	MSc	Takam Ngouno Annie		University of Dschang			Dr. Ngoh Newilah
Cameroon	CARBAP	PhD	Yong Lemoumou Judeon		University of Dschang			Dr. Meli Meli
Colombia	CIAT	PhD	John Belalcazar	High-throughput methods for selection of boiled cassava genotypes	Universidad Nacional Palmira	01/19	12/21	Dr. Eduardo Muñoz, Dr. Thierry Tran, Fabrice Davrieux
Colombia	CIAT	MSc	Dhaouadi Nourdène	Extraction and analysis by NIRS of cell walls from cassava roots	Supagro Montpellier (France)	04/18	09/18	Jhon Larry Moreno Thierry Tran
Kenya	Cip	PhD	Linly Banda	Molecular biology and biotechnology	Pan African University, Juja, Kenya	11/18	11/20	T. Muzhingi
Kenya	CIP	MSc	Marilyn Muthee	Food Science	Egerton University, Nakuru, Kenya	11/18	06/19	T. Muzhingi
Côte D'Ivoire	CNRA	MSc	Guehayibi Gouleble Linda Syntiche Gougnan	Study of the plantain development in nursery and in the field at Anguédédou (South Côte d'Ivoire)	Institut Polytechnique Rural de Formation et de Recherche Appliquée (IPR/IFRA) Katibougou (Mali)	07/18	12/18	Traore Siaka
Côte D'Ivoire	CNRA /CIRAD	PhD	Emmanuel Ehounou	Development of NIRS for prediction of yam textural quality attributes	Felix Houphouet-Boigny	01/18	07/18	Gemma Arnau

Country	Host Institute(s)	Dipl.	Student	Title	University	Start	End	Tutor(s)
Cameroon	CIRAD	Postdoc.	Franklin Ngoualem Kégah	Understanding the drivers of quality characteristics and the development of multi-user RTB product profiles	University of Ngaoundéré - ENSAI	06/18	-	Geneviève Fliedel
Uganda	NARL	MSc	Moureen Asasira	Consumer preference for cooking banana traits in Uganda: A case of urban consumers	Makerere University	09/18	09/19	K. Akankwasa K. Nowakunda
Uganda	NARL	MSc	Nelson Willy Kisenyi		Kyambogo University	01/19	01/20	Kephas Nowakunda, Moses Matovu, Priscilla Maremo
Benin	UAC-FSA	PhD	Laurenda Honfozo	Structural and biophysical characteristics of cassava and yam determining the quality and preference of derived products	UAC-FSA	09/18	11/22	Noël Akissoé
Benin	UAC-FSA	MSc	Francis Hotegni	Biophysical characteristics of boiled yam	UAC-FSA	09/18	02/18	Noël Akissoé

Table 6. Training and workshops attended by partners in Period 1, in the framework of RTBfoods

Workshop Title/Topic	WP	Country	Dates (2018)	List of Participants, Disaggregated by Institute
Capacity strengthening on identifying user preferences for RTB breeding under RTBfoods by WP 1 coordination team	1	Uganda	10–14 Sept.	Bowen University: Otegbayo, Bolanle Otegbayo, Fawehinmi, Olabisi, Oroniran, Oluyinka CARBAP: Ngoh Newilah Gérard, Kendine Vepowo Cédric CIP: Sarah Mayanja CIRAD: Fliedel Geneviève (trainer), Bouniol Alexandre (trainer & logistics) CNRA: Kanon Alban Landry, Ebah Djedji B. C. IITA: Durodola Owoade, Bello Abolore, Adebowale Osunbade, Busie Maziya-Dixon, Béla Teeke, Floriane Nguembou, Hubert Noel Takam Tchuente, Adetonah Sounkoura NaCRRI: AnnRita Nanyonjo NARL: Edgar Tinyiro, Kenneth Akankwasa NRCRI: Tessy Madu, Ugo Chijioke NRI: Lora Forsythe (trainer); Ulrich Kleih (trainer); Caroline Troy (trainer) UAC-FSA: Noël Akissoe; Joseph Hounhouigan; Laurent Adinsi
Sensory panel training workshop by WP 2 coordination team and CIRAD experts	2	Uganda	16–22 Sept.	Bioversity: Beatrice Ekesa, Nelson Willy Kisenyi, Moureen Asasira Bowen University: Bolanle, Oroniran, Oluyinka CARBAP: Ngoh Newilah Gérard CIP: Tawanda Muzhingi and CIP staff involved in WP 1 to WP 5 from CIP–Lima, Ghana, Kenya and Mozambique, representing breeding, food science, gender and post-harvest research. CIRAD: Christian Mestres, Christophe Bugaud (trainer), Nelly Forestier-Chiron (trainer), Cathy Méjean (logistics) CNRA: Ebah Djedji B. C., Diby Affoue Sylvie IITA: Durodola Owoade, Bello Abolore, Adebowale Osunbade, Amiebhor Blessings, Adebowale osunbade NaCRRI: AnnRita Nanyonjo, Hamba Sophia, Micheal Kanaabi NARL: Edgar Tinyiro, Elizabeth Khakasa, Mose Matovu, Gloria Aguti, Moreen Asasira NRCRI: Ugo Chijioke, Nwamaka Ogunka UAC-FSA: Laurent Adinsi, Laurenda Honfozo
NIRS training by WP 3 coordination team • Principle and theory of NIRS • Initiation to multivariate analysis • Calibration development • Spectral acquisition and measurement protocols	3	Uganda	23–28 May	CIP: Tawanda Muzhingi, Andrew Senyonjo, Moses Asiimwe, Reuben Ssali, Robert Misanga CIRAD: Fabrice Davrieux (trainer) IITA: Brigitte Uwimana NaCRRI: Robert Kawuki, Ephraim Nuwamanya, Esuma Williams, Hellen Apio, Enoch Wembabazi, Fatumah Babirye, Ann Ritah Nanyonjo, Arnold Katungisa, Yusuf Mukasa, Betty Nalukwago, Rose Amwano, Jacinta Akol Jane Aol NARL: Sarah Kisakye, Evans Atwijukire
NIRS training by WP 3 coordination team • Principle and theory of NIRS • Configuration and data collection using a portable NIRS • Management and processing of NIRS data	3	Nigeria	12–14 June	IITA: Michael Adesokan, Toyin Olaniyan, Adedapo Folorunsho, Adebowal Osunbade, Kayode Ogunpaimo, Uba Ezewanyi, Udo Enobong, Esther Olaniyo NRCRI: Ugochukwu Ikeogun (trainer)

Workshop Title/Topic	WP	Country	Dates (2018)	List of Participants, Disaggregated by Institute
NIRS training by WP 3 coordination team • Principles of NIRS • Needed lab conditions • Data management • Application of NIRS analysis to evaluate macro- and micronutrient concentration, routine analysis of freeze-dried sweetpotato samples	3	Uganda	11–12 Oct.	CIP: Thomas zum Felde (trainer), Edwin Serunkuma
NIRS training by WP 3 coordination team • Refresher on field sampling and sample preparation of potato, sweetpotato for HTPP • NIRS basics, calibration development, validation procedures, and applications • Hands on!	3	Peru	11–13 June	CIP: Thomas zum Felde (trainer), Eduardo Porras (trainer), Gabriela Burgos, Clara Chacaltana, Paola Sosa, Lupita Munoa
NIRS training by WP 3 coordination team • Principle and theory of NIRS •Configuration and data collection using a portable NIRS •Management and processing of NIRS data	3	Nigeria	4–8 June	9 persons NRCRI: Ugochukwu Ikeogun (trainer)
Training “Enhancing Results-Based Management in RTB ME&L systems”	WP6	Nigeria	28–31 June	CIRAD: Eglantine Fauvelle
Annual Meeting of the MELIA (Monitoring & Evaluation, & Impact Assessment) community of practice at CGIAR	WP6	Italy	5–8 Nov.	CIRAD: Eglantine Fauvelle

3 CONCLUSIONS

Activities carried out by RTBfoods partners in Period 1 contribute to 10 out of 17 outputs that the project committed to produce at the end of 5 years (see the RTBfoods Results Framework) and to six out of the nine targeted outcomes. These activities were carried out by partner teams organized into five WPs. At the beginning of Period 1, each WP developed a work plan listing activities to be carried out to progress toward the achievement of project outputs. A first draft list of research products to be delivered at the end of Period 1 was provided in the WPs' work plans in alignment with the list of activities to be conducted. Most of Period 1 deliverables were refined during the year by WP coordinators and WP partners. Deliverables produced by RTBfoods partners in Period 1 are listed in Table 7, disaggregated by type of activity and by output.

Table 7. Synthesis of activities carried out and deliverables produced in Period 1, disaggregated by activity type and project output

Output 1.1.1: Gendered knowledge produced on quality characteristics, demands, and consumption patterns for 11 RTB foods/ processed products in 5 African countries	
Activities	*Desk literature review* *Interviews involving experts*
Deliverables	*A.1 SoK by food product:* *A.1.1: Boiled and Pounded Yam in Nigeria (food science module)* *A.1.1bis: Boiled and pounded Yam in Nigeria (gender and market modules)* *A.1.2: Gari/Eba in Nigeria (food science, gender and market modules)* *A.1.3: Boiled Cassava in Uganda (food science, gender and market modules)* *A.1.4: matooke in Uganda (food science, gender and market modules)* *A.1.5: Boiled Yam in Benin (food science and gender modules)* *A.1.6: Attiéké in Côte d'Ivoire (food science, gender and market modules)* *A.1.7: Gari in Cameroon (food science and market modules)* *A.1.8: Boiled Plantain in Cameroon (food science and market modules)* *A.1.9: Sweetpotato in Uganda (food science, gender and market modules)*
Activity	*Capacity-strengthening and building common methodologies workshop*
Deliverables	*A.2 Capacity-strengthening kit:* *A.2.1: State of Knowledge Guidance* *A.2.2: Capacity Strengthening and Sharing Workshop Report* *A.2.3: Guidance Report Part I – Introduction, sampling and food product profile* *A.2.4: Guidance Report Part II – Activity 3 Gendered product mapping* *A.2.5: Guidance on Data Analysis - Activity 3* *A.2.6: Guidance Report Part III – Activity 4 Participatory diagnosis and quality characteristics* *A.2.7: Guidance Report Part IV – Activity 5 Consumer tasting in rural and urban user segments* *A.2.8: WP1 Data management plan* *A.2.9: WP1 Capacity Strengthening and Sharing Materials: Workshop Presentations - Period 1* *A.2.10: Additional learning material - Period 1*
Output 1.3.1: High-quality SOPs to characterize and understand key users-preferred quality traits developed	
Activity	*Inventory of partner laboratories' facilities, competencies, and biophysical methods used for characterization of RTB products and capacity-building needs*
Deliverable	*E.1.1: Synthesis on partner laboratories' facilities, competencies, and biophysical methods used for characterization of RTB products and capacity-building needs*

Output 1.3.2: Standardized ontology established for major quality traits for 11 RTB foods/processed products with objective goal defined for each attribute	
Activity	*Desk literature review*
Deliverables	*F.1 SoK on traits of fresh crops and processed products:* *F.1.1: Boiled & Pounded Cassava* *F.1.2: Gari /Eba* *F.1.3: Attiéké* *F.1.4: Fufu* *F.1.5: Boiled Plantain* *F.1.6: Matooke* *F.1.7: Boiled & Fried Sweetpotato* *F.1.8: Boiled Yam* *F.1.9: Pounded Yam* *F.1.10: Boiled & Fried Potato*
Activities	*Training workshops on sensory panels (with experts on the subject)* *Validation of a standardized ontology for uniform sensory testing on 11 products and 5 countries*
Deliverables	*F.2.1: Training of trainers for conducting sensory testing (training report)* *F.2.2: Standardized methods for conducting sensory testing (and generate lexicon) (in English)* *F.2.2bis: Standardized methods for conducting sensory testing (and generate lexicon) (in French)* *F.2.3: Sensory Analysis Presentation (in English)* *F.2.3bis: Sensory Analysis Presentation (in French)*
Output 1.4.1: Screening capacity for users-preferred quality traits developed in key countries	
Activity	*Capacity inventory of HTPP facilities of partner laboratories (equipment, human resources)*
Deliverables	*G.1 Capacity inventory of HTPP (equipment, human resources):* *G.1.1: IITA Nigeria* *G.1.2: INRA/CIRAD Guadeloupe* *G.1.3 : NaCRRI Uganda* *G.1.4 : CIAT Colombia* *G.1.5: NRCRI Nigeria* *G.1.6: CIP Mozambique* *G.1.7: CIP Peru* *G.1.8: CIP Ghana* *G.1.9: CIP Uganda*
Activities	*Training workshops on NIRS routine analysis*
Deliverables	*G.2 Training reports:* *G.2.1: IITA Nigeria* *G.2.2 : CIP Uganda* *G.2.3 : CIP Peru* *G.2.4 : NaCRRI, NARL & CIP Uganda*
Output 1.4.2: Operational HTP (or MTP) protocols platform for screening users-preferred quality traits developed	
Activity	*Desk literature review*
Deliverable	*H.1.1 SoK on HTPP work done on RTB crops and products*
Activity	*Description of existing/ongoing calibrations at partner level*
Deliverables	*H.3 Description of existing/ongoing calibrations:* *H.3.1: Dried yam (flour) at IITA, Nigeria* *H.3.2: Dried yam (flour) at INRA/CIRAD, Guadeloupe* *H.3.3: Fresh Cassava for Dry Matter Content at CIAT, Colombia* *H.3.4: Fresh Cassava for Total Beta-Carotene at CIAT, Colombia* *H.3.5: Fresh Cassava for Total Carotenoids Content at CIAT, Colombia* *H.3.6: Freeze dried milled sweetpotato at CIP, Peru, Ghana, Mozambique, Uganda* *H.3.7: Potato flour (freeze dried, milled) at CIP, Peru* *H.3.8: Raw and Fresh, cut/blended sweetpotato at CIP, Peru* *H.3.9: Cooked sweetpotato (freeze dried, milled) at CIP, Peru, Uganda, Ghana, Mozambique* *H.3.10: Fresh Cassava at NRCRI, Nigeria* *H.3.11: Fresh Cassava at IITA, Nigeria*

Output 1.5.1: Gendered socioeconomic databases on consumer/user preferences for 11 RTB foods/processed products in 5 African countries	
Activities	*Uploading Raw data + Coded Data + Processed/Analyzed Data on secured repositories*
	I.1 Raw data from surveys on RTB consumption habits and preferences (Questionnaires + Consent forms): *I.1.1: Boiled and pounded yam* *I.1.2: Boiled and pounded yam at NRCRI* *I.1.3: Gari/Eba at IITA* *I.1.4: Boiled cassava at NaCRRI* *I.1.5: Matooke at NARL* *I.1.6: Boiled yam at UAC-FSA* *I.1.7: Attiéké at CNRA* *I.1.8: Boiled Plantain at CARBAP* *I.1.9: Boiled Sweetpotato at CIP* *I.1.10: Gari/Eba & Fufu at NRCRI*
Output 1.5.3: RTB databases developed/enriched for users-preferred quality traits with spectral data on 5 RTB crops and 11 RTB foods/processed products	
Activities	*Spectra acquisitions on RTB food products and fresh crops* *Development/Enriching of large RTB databases with spectral data on users-preferred quality traits*
Deliverables	*K.1 Descriptions of existing spectral databases for RTB products:* *K.1.1: Fresh Cassava at CIAT, Colombia* *K.1.2: Dried Yam at IITA, Nigeria* *K.1.3: Fresh Cassava at IITA, Nigeria* *K.1.4: Dried Yam at INRA/CIRAD Guadeloupe* *K.1.5: Dried Milled Sweetpotato at CIP, Peru, Ghana, Mozambique, Uganda* *K.1.6: Dried Milled Potato at CIP, Peru* *K.1.7: Fresh Cassava at NRCRI, Nigeria* *K.1.8: Fresh Cassava at NaCRRI, Uganda* *K.1.9: Cooking Banana at NaCRRI/NARL/IITA, Uganda* *K.1.10: Fresh Yam at IITA, Nigeria*
Output 2.1.1: Genetic architecture of users-preferred quality traits for V,U,E improvement in RTB breeding programs identified	
Activity	*State-of-the-art on breeding populations and breeding for quality*
Deliverable	*M.1.1: State of Art on previous works on quality traits informing breeding (for each targeted RTB crop)*
Activity	*Unravelling genetic architecture of traits for V,U,E improvement in RTB breeding programs*
Deliverable	*M.2.1: Breeding population tracker in Period 1*
Output 3.1.1: Methodology for participatory assessment of V,U,E acceptance developed	
Activities	*Participatory evaluation of new hybrids (from partner RTB breeding programs) with adapted WP1 Guidance*
Deliverable	*For Period 1, preliminary results are summarized in the WP5 Synthesis report for Period 1.*
Output 3.1.2: Acceptability of V,U,E validated by RTB users (farmers, processors, retailers, and consumers)	
Activities	*Inventory of ongoing or planned on-station or on-farm assessments of advanced selection prior to release*
Deliverable	*For Period 1, a summary of ongoing or planned on-station or on-farm assessments is provided in the WP5 Synthesis report for Period 1.*

4 APPENDICES

4.1 Annex 1: WP1 Extensive Activity Report

Activities Conducted, Key Research Findings & Perspectives

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This synthesis refers to the following teams

	Partner Institution(s)	***Country***	***RTB crop(s) of interest for RTBfoods***	***Processed/Food Product(s) of interest for RTBfoods***	***Names of people involved in the team for this WP***
Team 1	IITA-Benin	Benin	Yam	Boiled yam	Sounkoura Adetonah Jules Bakpe
Team 2	UAC	Benin	Yam, Cassava	Boiled yam, boiled cassava	Noel Akissoe Laurent Adinsi Laurenda Honfozo
Team 3	ENSAI/IITA/ CIRAD	Cameroon	Cassava	Gari	Robert Ndjouenkeu Franklin Ngoualem Kégah
Team 4	CARBAP	Cameroon	Plantain	Boiled plantain	Gérard Ngoh Cédric Kendine
Team 5	CNRA	Côte d'Ivoire	Cassava	Attiéké	Catherine Ebah Landry Kanon Ernest Depieu
Team 6	NaCRRI	Uganda	Cassava	Boiled cassava	Anne-Ritah Nanyonjo Sophia Hamba
Team 7	Bioversity/ NARO/NARL	Uganda	Banana	matooke	Pricilla Marimo Kenneth Akankwasa Samuel Edgar Tinyiro
Team 8	CIP	Uganda	Sweet potato	Boiled sweetpotato	Sarah Mayanja
Team 9	NRCRI	Nigeria	Cassava, yam	Eba, boiled yam, fufu	Ugo Chijioke Tessy Madu
Team 10	IITA-Nigeria	Nigeria	Cassava	Eba	Bela Teeken Bello Abolore
Team 11	Bowen University	Nigeria	Yam	Boiled yam	Bolanle Otegbayo Olayinka Tinuke

4.1.1 Abstract

of the full document summarizing each section *(NB: This section will be copied & pasted in the Annual Report delivered to BMGF). (2 pages)* HIGHLIGHT MAJOR ACTIVITIES, OUTPUTS AND IF RELEVANT OUTCOMES

Work Package 1 (WP1) provides the evidence base for end-user preferences for characteristics of focus products. The primary goal is to enhance the capacity of RTB breeding programs to define and implement demand-led and gender responsive breeding priorities, integrating traits to meet multi-user demands and needs, and adding value. The WP1 approach uses interdisciplinary

methods and lines of inquiry (food science, gender and economics) to collect evidence on the preferences of RTB product characteristics for different user groups in the product chain and identify the factors that influence these preferences for men, women and other social segments, and how they may be prioritized differently.

We had four major activities this year, which revolve around the development and implementation of a common, interdisciplinary methodology. The methods are grounded in a food science approach developed from a previous CRP-RTB project (2015), but adapted to include a socio-economic and breeding focus, in addition to product profile development, and applied with rigorous and robust sampling. The accomplishments for this year are as follows:

WP1 State of Knowledge Review (SoKs) (Activity 1): the aim of this activity was to establish what is currently known about the product and gaps in knowledge. For this activity the Coordination team developed guidance for developing a knowledge base from a disciplinary perspective, to identify gaps in knowledge to be addressed by the project. This activity resulted in two outputs:

- **SoK Guidance document** developed by the WP1 Coordination team and other collaborators, which is structured in three modules: food science, gender and social context, and demand.
- **Nine Product-based SoK reports** covering 7 products, were developed by 11 partner teams, with support from the WP1 Coordinator team and other collaborators. The reports will inform the fieldwork for WP1, but also the knowledge gaps addressed in WP2 and WP5.
- **Summary for each product** on established characteristics, gaps in knowledge and how they are addressed by RTBfoods is provided in the full WP1 Extensive activity report.

WP1 Capacity Strengthening and Sharing materials and workshop (Activity 2): The WP1 methodology was developed by the WP1 Coordination team and other partners in a collaborative process and documented in the form of four, comprehensive manuals. The delivery of the material was conducted at the Capacity Strengthening and Sharing workshop held from 16-25 April, 2018 in Cotonou, Benin. The outputs under this activity are:

- **4-part 'living' manual:** Inputs were received on an ongoing basis for adaptation through the year, from management, crop breeders, other work packages and partner teams. The current versions of the manuals are available on the project platform for all RTBfoods partners to use and will be shared with a wider scientific community when finalized at the *end of year two* and a DOI has been created. The manuals consist of:
    - WP1 Introduction and product profile
    - Activity 3: Gendered product mapping
    - Activity 4: Community-based RTBfoods processing/preparation diagnosis
    - Activity 5: Consumer taste tests in rural and urban market segments

- **10-day WP1Capacity Strengthening and Sharing workshop, report and kit:** The workshop was the first project event following the inception meeting and was attended by all WP1 teams, including 31 participants from six countries. The outputs of the workshop were: a workshop report on how the workshop met objectives; revised methodology, as presented in the four manuals, a Capacity Strengthening and Sharing Kit, including all presentations and learning materials, such as:
    - RTBfoods overview
    - WP1 approach and methods
    - Building on the State of Knowledge
    - Scope and sampling
    - Ethics
    - Qualitative Data Analysis - full session

- Qualitative Data Analysis - simplified
- Product Profile
- Activity 3 Gendered Product Mapping
- Activity 4 Processing methods and measurement
- Activity 5 Consumer testing
- Activity 5 Consumer testing - data analysis

Fieldwork for Gendered food mapping (Activity 3): This activity involves consultation in rural communities where people grow, process and consume the crop in important consumer geographies, and involves key informant interviews with community leaders, focus groups discussion, individual interview and rural-level market interviews.

To date, **9 out of 11 WP1 partner teams, covering 8 RTB food products, have started and/or completed fieldwork for Activity 3.** As part of Activity 3, partners have delivered the following outputs with support from the WP1 Coordination team and other collaborators:

- **9 product-teams covering 8 food products have uploaded their raw data and consent forms** to the RTBfoods platform* (9 product teams include 11 partners)
- **6 databases from 9 teams** were received and reviewed by the Coordination team.

As part of Activity 3 fieldwork, the WP1 Coordination team and collaborators organized support visits during piloting in Benin, Nigeria, Uganda and Côte d'Ivoire. **Lessons learned documents** for Nigeria and Uganda were developed and shared with teams.

WP1 Coordination team, with the support and feedback from the Benin UAC/IITA team and WP2, is also currently finalizing **Activity 3 Data Analysis Guidance**, a document that includes description of how mixed method data can be analyzed, how the data can feed into the first iteration of the product profile, and priority data required for WP2. This will be circulated to teams prior to the March annual meeting in 2019.

WP1 also achieved the **WP1 Data Management Plan**, a document describing the process and principles of data management for WP1 purposes, which provides guidance to partners on specific data issues relating to WP1.

WP1 has also achieved several **partner-led collaborations**, whereby teams of joined together to revise and test the methods and tools and conduct fieldwork together (e.g. Uganda and Nigerian teams). We have also had extensive collaboration with NextGen, ongoing discussions with Excellence in Breeding (EiB) and participation of WP1 coordinators in CGIAR Gender Breeding Initiative (GBI) Workshops.

WP1 has also had **numerous successful interactions with other WPs**, specifically in the sharing of tools and methodology. This includes: WP1 roadmap; all manuals, and Activity 3 Data Analysis guidance. Two calls with held with WP2 leadership to define type of data necessary from WP1 to inform WP2. The Nextgen evaluation of mother-baby populations in the field were used as a model for WP5 population processing protocol. In addition, there is daily communication with the Project manager for Monitoring and Evaluation.

For period 2, the following activities are planned:

- Activity 3, data analysis and reporting.
- Preparation and presentation at the Second Annual RTBfoods Meeting.
- Capacity strengthening for Gendered Food Mapping, Activity 3, data analysis at the Second Annual RTBfoods Meeting.
- Planning and commencement of participatory demonstrations, Activity 4 and 5, with close coordination with WP2 and WP5.

4.1.2 WP1 Results Tracker: Activities & Milestones achieved

Output 1.1.1 : *Gendered knowledge produced on quality characteristics, demands and consumption patterns for 11 RTBfoods/processed products in 5 African countries*

Activities conducted	***Deliverables***
Desk literature review *Interviews involving experts*	A.1 - State of Knowledge (SoK) by food product: Note: teams conducted either an 'Extensive SoK' (food science, gender and demand modules completed) or an 'Abbreviated SoK' (one to two modules completed) depending on the resources available to the team. A.1.1- Boiled and Pounded Yam in Nigeria (food science module) A.1.1bis- Boiled and pounded yam in Nigeria (gender and market modules) A.1.2- Gari/Eba in Nigeria (food science, gender and market modules) A.1.3- Boiled Cassava in Uganda (food science, gender and market modules) A.1.4- matooke in Uganda (food science, gender and market modules) A.1.5- Boiled Yam in Benin (food science and gender modules) A.1.6- Attiéké in Côte d'Ivoire (food science, gender and market modules) A.1.7- Gari in Cameroon (food science and market modules) A.1.8- Boiled Plantain in Cameroon (food science and market modules) A.1.9- Sweetpotato in Uganda (food science, gender and market modules)
Capacity Strengthening and building common methodologies workshop	A.2- Capacity strengthening kit: A.2.1- State of Knowledge Guidance A.2.2- Capacity Strengthening and Sharing Workshop Report A.2.3- Guidance Report Part I – Introduction, sampling and food product profile A.2.4- Guidance Report Part II – Activity 3 Gendered product mapping A.2.5- Guidance on Data Analysis - Activity 3 A.2.6- Guidance Report Part III – Activity 4 Participatory diagnosis and quality characteristics A.2.7- Guidance Report Part IV – Activity 5 Consumer tasting in rural and urban user segments A.2.8- WP1 Data management plan A.2.9- WP1 Capacity Strengthening and Sharing Materials: Workshop Presentations - Period 1 A.2.10- Additional learning material - Period 1

Output 1.1.1 Indicators	*Targets / Milestones*		
	Planned for Period 1	*Achieved*	*Variance & Brief Explanation*
Nb of studies conducted on quality characteristics, demands and consumption patterns for RTBfoods products	9 SoKs	10 SoK reports (extensive and abbreviated combined)	**10 SoKs completed.** At the inception meeting, teams stated if they would conduct an 'Extensive SoK' (food science, gender and demand modules completed) or an 'Abbreviated SoK' (one to two modules completed), depending on their available resources and expertise. However, some teams delivered beyond what was agreed at inception meeting, which is to be applauded. **There are varying levels of depth of the reports.** SoK guidance was developed to achieve standardization of the knowledge base collected on each product. However, literature was sparse for some products, particularly specific to geographical contexts. Partner budgets were also prioritized for WP1 fieldwork, and therefore partners had less time for the SoK. This approach was supported by the Coordination team and PMU.

Knowledge Baseline

- *Key findings from the SoKs (Del. A.1.1 to A.1.9): Gaps identified and Lessons learnt disaggregated by food product for the food product studied in Period 1 (NB: Please refer to each deliverable with the code mentioned above)*

The objective of the SoK exercise was to establish what is known and what the gaps are in relation to characteristic preferences, gender and social context and product demand. This provides formal documentation of the contribution of RTBfoods in addressing current gaps in knowledge.

The key findings from each of the SoK reports are provided below, by product and team. This is followed by 1) a table summarizing the lessons gained on key characteristics and 2) gaps in knowledge (food science, gender and demand) for each product and their relevance to RTBfoods.

Key Findings from WP1 SoKs

Boiled Cassava (Del. A.1.3) - Uganda (food science, gender and demand modules)

Food Science

The characteristics of raw cassava established in literature and key informant interviews as being important for a good boiled cassava were (in order of importance): sweet taste when bitten; roots should not be watery when chewed fresh, easy to chew; low fiber content, and a long and slender root shape. Other important characteristics were: a root of 12 to 18 months maturity; soft to break; disease free; pink cortex (associated with sweet taste). To prepare boiled cassava, the root is wrapped in banana leaves and steamed (central and mid-western Uganda) or boiled (Eastern Uganda). Important characteristics during processing are: self-retracting peel or easy to peel; roots glitter after washing; easy to cut without uneven breaks; quick cooking (30 minutes), nice aroma; soft to pound (without fibers or cut into fiber). Important characteristics for boiled cassava are: soft to bite and easy to chew; sweet taste; feeling energetic after eating; nice aroma or mild aroma; white or not so brown after pounding; less fiber- middle fibre only; mealy; friable- fluffy texture when pressed in the hand; doesn't stick in the hand- easily makes a depression when a finger is pushed in ponded cassava, and less starch.

The review identified gaps in information on preferred characteristics specifically for boiled cassava and disaggregated by sex and other factors of social difference. The evidence pointed to few differences in consumption patterns of boiled cassava by gender, but more significant differences by age. However, triangulated evidence is required.

Gender and socio-economic context

Cassava is commonly intercropped with crops of short maturity, particularly among women who experience land limitations and need to reduce weeding time. Women often farm on a separate garden and in some cases allocated land by their husbands to farm. However, in other places of Uganda, where cassava is the main staple (e.g. Eastern Uganda), it is often monocropped. There are clear distinctions in gender roles and activities regarding cassava production and processing, and a gap in knowledge on gender differences in adoption and varietal preferences. Information seems contradictory relating to gender roles and control over cassava processing income. Processing cassava is typically a women's role in Uganda, however there were differences in the literature about who in the household controlled processing income. A common perception is that men sell cassava and women use their cassava for household consumption.

NASE 14 and NAROCASS 1 are popular new varieties due to their high yields and CBSD and CMD tolerance. Nase 14 has high dry matter, nice taste, makes nice paste and has good storability in the ground. NASE 17 and NASE 13 were initially preferred in central Uganda due to its pink cortex associated with long shelf-life and mealiness, and sweetness, respectively. NASE 19 was preferred in northern Uganda because it makes a nice paste. NASE 13 also has low dry matter content and is grown where cassava is processed in to flour. However, these varieties are vulnerable to CBSD. Literature did not examine adoption by gender, but informants found that NAROCAS 1 and NASE 14 were widely adopted by men because stems were more marketable. Wealthy people in communities initially adopted improved varieties because stems are expensive. However, government programs such as operation wealth creation (OWC) which distributed free stems improved adoption.

Demand

Boiled cassava is the most common product consumed in Uganda followed by kalo and katogo. It is evident from the report that boiled cassava was common in Central and Northern Uganda while kalo was common in West Nile, Western and Eastern Uganda. There is also high and growing potential of cassava being used in industry. Consumers prefer boiled cassava from sweet varieties (that may be associated with low levels of cyanide). Some of the preferred varieties for preparing boiled cassava include: NASE 1, NASE 14, TME 14, TME 204, Bukalasa, Bao, Nyaraboke, Gwalanda, NASE 13 and Mufumba-Chai, as they are associated with a sweet taste and ease of cooking.

Boiled cassava for home consumption is mainly for the women and children as a snack since they

rarely eat away from home. While the boiled cassava supplied in restaurants, food kiosks and roadside points is mostly consumed by men. The men who consume away from home are associated with having low economic status. Urban areas have higher consumption of boiled cassava, but availability of the fresh cassava roots daily for preparing the product is challenging. There seems to be little difference in consumption of boiled cassava by gender but there are differences by age. There is need to evaluate the preference of the product across different ethnic groups and socio-economic status.

Granulated Cassava (Gari/Gari for Eba - Nigeria and Attiéké - Cameroon) (Del. A.1.2 ; A.1.6 ; A.1.7):

Nigeria (food science, gender and demand)

Food Science

The literature and key informant interviews found that there is a diverse range of preferences and processing styles for gari and eba, which are strongly related to ethnicity and socio-economic status. South West (SW) consumers generally like a soft, low elasticity Eba and a sour and an off-white, ivory, butter-like color for gari. South (SS) and South East (SE) consumers generally prefer hard, elastic Eba and non-sour, white or yellow gari, the latter achieved from the addition of palm oil, which in turn might reduce storability.

In terms of end product characteristics associated with varieties and processing, some key informants stated that there are differences in the glycemic index of fermented and unfermented gari/eba, differences in cooking time/rehydration, swellability etc., but this requires further evidence. Low starch cassava varieties may affect a gari that is traditionally cooked for a short time (SW), as after preparation there will not be enough rehydration of the starch to make the Eba hold together. Also, high starch and dry matter provide more gari yield. The drawability and hardness of the Eba seems majorly determined by the way Eba is made: longer cooking means more rehydration and complete gelatinization and a harder more drawing eba. A significant indicator of the quality of gari and Eba lies in the expertise with which it is processed, however, low dry matter /starch content and variety specific mash color after pressing can contribute to a lower quality product.

Other characteristics found to be important are the swelling of gari is important (the higher the density the greater the expansion from gari to eba). Swelling of gari in cold water is significantly higher for fermented gari. This is a preferred trait for people that drink gari. Granule size is also important, which is influenced by the equipment used, but mainly by the contact temperature between the mash and the roasting board/pan (controlled by the speed of stirring and amount added per batch). Granules that are fine but not too fine are most liked. Consumer preferences for granule size requires clarification. Attractiveness, particularly color, is highly valued, and is affected by fermentation, variety and sanitation during processing.

Additional information is required on how and what kind of gari from the rural areas is assembled in towns/suburbs before it is bulked and sold as wholesale in cities.

Gender and socio-economic context

Processing is a mainly considered to be a women's role and processing labor is mostly conducted by women. Processing equipment in processing centers is usually owned by men which women access through small fees. The future dynamics of this with regards to equity requires investigation. Cassava and gari have been an important historically providing a way for women in the SE and SS to empower themselves given the inequalities created by male dominated colonial rule. This still explains some gendered roles today. If we want to know the specific preferences of gari and Eba in relation to the production and especially the processing steps and product quality, it is mostly experienced women that we have to consult.

Demand

The Nigerian market for *gari* is characterized by perfect competition in that there are many buyers and sellers who are not in a position to influence marketing transactions by refusing to either sell or buy. This illustrates the high demand for *gari* in the country. Most of the *gari* traded is white *gari* but

a substantial part is yellow *gari* as a result of adding palm oil, and its market price is higher; not only because of the palm oil added but also because of the more limited shelf life. Almost all of the yellow *gari* comes from the South or South East. About one third to one fourth of the *gari* traded in Lagos is yellow *gari* according to the CAVA project. Kano in the North of Nigeria is a great hub for the export of *gari* from the Southern belt to the North: North Cameroon, Chad, Niger, Burkina Faso, and Mali. This shows the large role of *gari* in Nigeria, as a dry (transportable) and storable food product (in that respect comparable to rice).

There is some but limited qualitative information about how and what kind of *gari* from the rural areas is assembled in hubs in towns or suburbs of cities before it is bulked and sold as wholesale in cities. There is also little information on the specific quantities of each type of *gari,* and how they relate to different traditions. Divisions between coarse/sweet *gari* at the one hand and fine/sour *gari* on the other hand and *gari* where palm oil is added (mostly to the coarse/sweet type) are informative but do probably not do full justice to general trends and insights regarding the relation between *gari* product quality and cassava varieties.

Cameroon - food science and demand

Food Science

Gari, also spelled as *garri,* or *garry*, depending on the producing area, is a pregelatinized, fine to coarse granular product made from fermented cassava mash. The popularity of gari is mainly due to its affordability, good storage ability and its easiness to prepare. It is consumed either as snack after soaking in cold water with sugar, peanuts, or cooked in hot water to make a dough-like paste called "*eba*" in Nigeria or "*gari fufu*" in soups in Cameroon.

Its processing involves several successive steps: grating peeled cassava roots to produce a mash which is pressed to remove water, fermented, then sieved and roasted with or without palm oil. The pregelatinized granules are either yellow when roasted with palm oil or white when roasted without palm oil. Depending on the area, variations in the process can be observed: fermentation may occur simultaneously during dewatering, or before and separately with fermentation. Both processing practices are found, with simultaneous fermentation/dewatering common in all gari processing areas, while the second practice is mainly localized in the North-West Region. The fermentation duration in both processing practices varies between two and four days. Gari processing leads to high nutrient losses, certainly during dewatering and roasting. Processing yields rank between 25% and 30%.

Fermentation level resulting in acidic or sweet taste, color (white or yellow, depending on the use or not of palm oil during roasting) account among the main attributes of gari when buying. Grain size is another attribute considered by consumers. These attributes are differentially appreciated by consumers depending on their origin or culture. Anglophones seem to have a preference for sour gari, while Francophones should prefer sweet gari. Gari from the North-West Region seems to have higher demand.

Local cassava varieties are generally preferred because of their availability, their high dry matter content, their liked sweet taste and their ability to be kept in soil for long time after their maturity. In the North-West Region, almost 85% of cassava processors use improved cassava varieties for gari, particularly a variety named "six months", so called because it is physiologically mature at six months after planting. Cassava variety and age influence the acceptability of gari. Gari made from improved varieties harvested after 8 – 10 and 14 months, and local varieties harvested after 14 months were the most liked.

Factors influencing the acceptability of gari include the frying time (10 minutes + reduces the quality), frying temperature, quantity of palm oil, and the storage conditions of roots. Consumers most preferred gari was the one from Muyuka, regarding the fineness and uniformity of particles, its cleanliness, bright color, good swelling capacity and low sour taste.

In the SoK report from Cameroon team, no information was given on the methodology used for identifying quality characteristics of gari: surveys, measurement of processing parameters, physico-chemical characteristics of cassava varieties, sensory analysis, and consumer testing. Since few studies have been done in Cameroon, it should be interesting to give these precisions and go deeper in the list of characteristics already identified. It should be also important to draw up an inventory of

identified quality characteristics in Nigerian literature, to better visualize the gaps to be addressed by RTBfoods project. Cameroon team has already done an extensive literature review but has limited the report to Cameroon literature, according to WP1 demand.

Demand

Gari production and consumption in Cameroon vary from one area to another and seem to be linked to socio-economic and cultural habits. The term “gari” is mainly used in anglophone areas (North-West and South-West Regions), while the term “tapioca” is more common in francophone areas. The main areas of gari production are North-West, South-West, Littoral and Centre Regions, with the first two Regions (North-West and South-West) having the highest production. Gari consumption is most strongly associated to people originating from South-West and North-West Regions. This may be related to geographical proximity of these two regions with Nigeria, which is the largest gari producer and consumer.

Attiéké – Côte d’Ivoire (food science, gender and demand)

Food Science

Attiéké is a fermented cassava granular product, steamed with agglomerated appearance, obtained from fresh cassava roots after several successive operations: peeling, washing, crushing, grating, fermentation, dewatering, sieving, granulation, pre-drying, sieving, winnowing and steam cooking.

Processors distinguish three qualities of Attiéké: garba, standard Attiéké and abodjama. The difference between them related to the presence of fibers and granule size. Attiéké "Garba" is a product of inferior quality. It is obtained by the suppression of some steps (granulation, winnowing and drying) and a lower amount of added ferment (mangan). It is sticky with many fibers. Abodjama Attiéké is of superior quality: it is made as standard Attiéké, but with a calibration of the granules, small, medium, or coarse granules. The residual fibers are eliminated during this sieving step. The steam cooking is longer than for the garba and done in two steps.

The processing steps affect the final quality of Attiéké. The granule size increases with the water content of the pulp. The fermentation time of 24 to 36 hours with added ferment gives granules of good particle size. The addition of ferment at rates of 8 to 10% gives granules of texture similar to the standard ones. The Attiéké producers use three types of ferment: the "fresh mangnan", "braised mangnan " and boiled mangnan ". The last is the most used. The ferment is ready for use at a pH of 5.4 to 6.1 and at a temperature of around 30 °C. It is the basis of the sensory quality of the different types of Attiéké sold on the market. Lactic acid bacteria are one of the most important groups of microorganisms involved in the cassava fermentation step, mainly because of their known roles in the development of flavor and preservation of the food.

Cassava roots that provide a good quality Attiéké have a high yield (20 t/ha) and a high dry matter content (at least 30%), no or slight mechanical, pest, or insect damage, no decay, no physiological or microbial deterioration, a firm flesh texture, a fresh state (no more than 1 day after harvest), a fresh cassava root odor. The Improved Africa Cassava (IAC) variety is the most widely used (26 - 44%) in Côte d’Ivoire, especially in the traditional production areas (South of Côte d’Ivoire) because of its high dry matter content (36%) compared to Bonoua variety (29%) and because it has a good ability to be processed into Attiéké. Other cassava varieties are also used depending on the area: in Grand-Lahou, there is the variety Ahoussakplin, in Jacqueville, the variety Ghana, and in Dabou, the variety Bocou 1. Tinandjo is one of the oldest cassava varieties used in the Grand-Bridges region, however producers abandon it because of its long period before harvest (24 months) and lower yields. Among some improved high-yielding cassava varieties, those which gave the most appreciated Attiéké were the varieties Bonoua 2, I88/00158, TMS4 (2) 1425, IM84, and CM52.

The desired characteristics of cassava roots for making a good Attiéké are a high dry matter content, freshness (≤ 1 day after harvest), a good sanitary quality, an ease of peeling and absence of fibers.

A good Attiéké has a yellow chick color, absence of fibers and impurities, visible and well-rounded granules moldable in the hand, a hard texture, a pleasant and salty-sweet taste, and an odor of freshly cooked fermented cassava product.

Adjoukrou, Alladjan and Ebrié are the three ethnic groups in southern Côte d'Ivoire considered as the largest Attiéké producers and consumers. Attiéké Adjoukrou and Attiéké Alladjan have both a pleasant aroma, with loosely bound granules. However, Attiéké Alladjan has a more heterogeneous texture and Adjoukrou Attiéké has a sweeter and less sour taste. Attiéké Ebrié has a sharper taste than the others and it is less sweet. Attiéké Adjoukrou has a finer granule size.

In the SoK report from Côte d'Ivoire team, most of papers collected on Attiéké related to the effect of processing, mainly fermentation step and the important role of the ferment, on physicochemical characteristics of Attiéké. However, some papers reported on sensory quality of Attiéké, with a detailed methodology described by the team. Hedonic tests were conducted with no more than 50-60 consumers (with no details on gender, education, age, occupation) and sensory scoring by a panel were carried out on only global descriptors (appearance, taste, texture). The team is invited to propose a summary of quality characteristics of cassava roots and Attiéké at the end of the SoK, with an analysis of more papers already collected. RTBfoods WP1 activities will certainly provide more precise information on quality characteristics to deliver to WP2 activities by asking up to 300 consumers to describe different Attiéké products with 20-25 descriptors collected during Activity 3 & 4.

Gender and socio-cultural context

Cassava production is more typically done by women on separate plots to men. Men may be involved in some production activities, but women will take over the management role of cassava due to its important role in household food security. Cassava is typically planted in lines, which is easier for weeding, often considered a women's role. However, in the south, cassava is typically monocropped and in plots under one hectare for men and women, and intercropped (yam, rice and corn) in the rest of the country, including on cash crop farms (rubber, palm oil, cashew and cocoa). Production generally does not involve fertilizers and herbicides, however use is increasing. The activities under male control are cassava fresh roots harvest, and transport of cassava products (fresh roots, and distribution of Attiéké). The most popular cassava varieties for Attiéké are traditional varieties. There are also improved varieties such as Yacé and Bonoua that have been introduced recently but have low adoption. In particular, processors (predominately female) report that Bocou varieties do not make good Attiéké.

There is strong competition between Attiéké and placali, another product from cassava, however, placali has less tedious in processing compared to Attiéké. Cassava processing labor including the principle cassava products Attiéké and placali processing, are done by women who sometimes hire immigrant women (Burkinabe and Malian). The people of the South (Ébrié, Adjoukrou, Alladjan...) in Abidjan and its surroundings are dominant in Attiéké processing. Most wholesalers are typically from the ethnic groups in the south. However, retail sellers are from all ethnic groups and tend to be women between 20 and 40, with primary or secondary education. Most of the fresh placali is produced by women country wide from South to North. Marketing of cooked placali is women's tasks and is dominated by Baoulé ethnic group.

Attiéké processing is dominated by women because of the important of the product for household consumption. For some ethnic groups such as Ebrié and Avikam, attiéké processing influences the social status of women. But, as cassava is becoming a cash crop, more and more men are engaged in its production.

Constraints specifically for women are limited knowledge of the market, lack of market coordination, poor cassava yields, lack of access to credit, and lack of access to land There is a high demand for cassava yet it is difficult for processors to meet the demand due to their capacity. There may be opportunities for Attiéké processors in cooperatives to increase their income and reduce the drudgery of their work by pooling the efforts of individual – however currently cooperatives are weak.

In terms of gaps, there could be further investigation with key informants to fill gaps in knowledge. And while the review did uncover regional and ethic differences in farming, processing and marketing by gender, general findings need to be further evidence.

Demand

The national consumption of Attiéké is estimated at 100-110 kg/capita in 2016. National consumption of Attiéké is estimated at 2.475 million tonnes of fresh cassava equivalent. The local market is the

dominant market in terms of total revenue. However, consumers are increasingly demanding about quality and hygiene regarding the product. Studies have differed in how the Attiéké value chain is described. One example from a study are: 1) Producers, who are mainly women; 2) Carriers/transporters who transport by vehicle; 3) Processors who are mainly independent women or women organized into cooperatives; 4) Some industrial or semi-industrial units managed by men; 5) Wholesalers, 6) Retailers, 7) Caterers; 8) Haoussa traders; 9)

Exporters. At the same time, although the cassava/Attiéké value chain is well understood as a result of several recent studies, little connection appears to have been made between the characteristics of cassava varieties and the quality or value of the end product.

Boiled Plantain (Del. A.1.8)

Cameroon (food Science only)

Bananas and plantains constitute an important staple food to millions of people in the world. In Cameroon, fruit physicochemical characteristics such as fruit girth, fruit length and peel thickness are important criteria for consumers in the choice of plantain cultivars used for specific uses. This is supported by the fact that some consumers assume that plantain fruits with high peel thickness are easier to peel.

Other parameters such as pulp to peel ratio, pulp firmness, total soluble solids, pH, total titratable acidity and dry matter content which are evaluated during ripening are also of great importance. Using various sources of energy (firewood, gas or kerosene cooker), unripe and ripe plantain pulps are sometimes cooked with salt and specific average quantity of water within a well-defined time. The boiling time been dependent on the ripening stage of the pulp, its grade and the plantain cultivar. The steps involved in plantain pulps preparation are: (i) fruit peeling and scrapping off the tiny membrane covering the pulps; (ii) pulp washing and cutting into pieces if they are large enough; and (iii) pulp cooking with a sufficient quantity of water within a precise cooking time. Apart from the consumers' physical traits preferences in Cameroon, few or no information is given regarding the organoleptic characteristics and the quality of boiled plantain at each steps of processing. The supply system of plantain include producers, wholesalers, collectors, loaders and transporters. Plantains are an important source of income for smallholder farmers and sellers in west and central Africa.

Matooke (Del. A.1.4):

Uganda

Food Science

For matooke, a mature bunch of bananas is harvested (after 3-4 months of flowering) for preparation. Maturity is assessed by changes in finger size, shape, angularity, and peel colour. Strips of banana fibers and stalks are at the bottom of a cooking pan to avoid the boiling water the matooke. Peeled and washed (sometimes) banana fingers are tied up in a bundle of banana (fresh) leaves and placed into the pot with water to steam the leaves. After steaming, the bananas are smashed with the palm of the hand and served hot, usually with sauce (beans, meat, groundnut etc). Good quality matooke has a: golden yellow color, good aroma (some believe it is brought about by the leaves), good taste (e.g. no feeling of sap), soft texture (e.g. like chewing gum), smooth on the tongue (e.g. like a sponge), among others.

Traits/characteristics of varieties that make good matooke/traits before preparation are smooth peeling skin, soft peel/easy to peel and straight and big fingers which are easy to peel (e.g. Muvubo, Musakala and Nakitembe) in Luwero. In Mbarara it is: yellowish when peeled, straight and big fingers hence easy to peel e.g. Butobe, Embururu, Entaragaza and Enjagata, easy to cook, yellow when cooked, mature fast e.g. Entaragaza, big and fat fingers, attractive and appealing to the eye, makes good matooke even if not ripened (Embururu, Butobe and Enjagata can make nice matooke even when not fully mature unlike Kibuzi that can only make nice matooke when fully grown).

The main methods of the studies reviewed are surveys, focus group discussions (FGDs), participatory varietal selection (PVS), participatory rural appraisal (PRA) and sensory evaluations.

Studies with consumers collect data on preferred traits and cultivars using sensory evaluations and taste assessments of a variety of food or dishes prepared from a set of new/introduced cultivars in comparison with a local check. There is scanty data on gender disaggregated studies.

Gender and socio-economic context

matooke is the main staple food crop in Uganda and mainly cultivated for subsistence purposes and in the Central and Western regions. It is increasingly an important source of income for farmers and a main staple for urban consumers. There are few studies that have focused on various social aspects. Most studies indicate the preferences of a generalized group of participants but does not differentiate results for different social groups.

There were only four studies that reported gender-disaggregated trait preferences, indicating a significant gap in the literature. In some contexts, male and female banana farmers mention similar traits related to production constraints, such as host plant resistance to pathogens and pests, a common goal such as food security, marketability and preference for cultivars with ceremonial uses. Both mention preference for cultivars with big bunches and fingers, or cultivars with a commercial value. On the contrary, Musimbi (2007) found that women mentioned traits related to production (high suckering ability and early maturity because of the potential to earn income from selling suckers), whereas men emphasized consumption-related traits (good taste and color). Nasirumbi (2017) however also reports that men mentioned production related traits such as big bunch for the market whereas women mentioned traits related to consumption characteristics.

Both men and women grow cooking banana mostly for home consumption in the central region, but in the west it is mostly for commercial reasons. Banana is referred to as a ‘women’s crop’ in some areas e.g. in Eastern Uganda (Musimbi 2007). Commercial banana gardens controlled by men, planted further away for better yield, whereas bananas for food are grown by women close to the home in Masaka and Bushenyi districts (Karamura et al. 2004). Banana can be monocropped or intercropped with coffee and legumes. Commercial banana production is often monocropped, others intercrop due to land shortages.

Demand

Banana consumption (and production) in Uganda is concentrated in the Central and Western Regions with the latter having the highest consumption; consumption is least in the Northern Region. Production is mostly done by smallholder farmers who usually grow diverse varieties for home consumption. According to two studies, producers consume about 70% of harvested bananas in their homes whilst 20-25% is sold fresh to traders who supply local, national and urban markets. In a study in Western Uganda, researchers found that 65% of the banana produced is consumed and about 30% is taken to the market; 60% of the produce sold in the open markets in the urban centers goes to individual households, while the rest is sold to hotels and restaurants.

Kilimo Trust (2012) noted that women of all ages, including youth, dominated banana retailing in Uganda; most of these actors were relatively young entrepreneurs aged between 31-40 years. It is estimated that market vendors have a higher profit margin than farmers since their costs are on average lower. Another study (Nalunga et al., 2015) found that the most profitable node in the value chain is at the wholesale level and that men are predominantly positioned in the most profitable nodes of the value chains. The study provides a good contrast of profit margins between high and low seasons, between genders and bunch size of matooke. Small roadside food vendors also roast the green banana fingers as a snack that can be eaten with roasted goat or pork. Restaurant owners also use cooking bananas to make the above-mentioned food products.

Given the discrepancies within and between studies and the scanty literature, there is need to conduct a comprehensive study on demand and consumption trends for cooking banana in Uganda. It is suggested that the study should bring out the seasonal differences in the supply and demand of the crop and provide nationally representative and robust statistics.

Boiled sweetpotato (Del. A.1.9):

Uganda

Food Science

Sweet potato is the fourth most important crop in Uganda in terms of production volumes (1.8 million MT) after maize, cassava and bananas, and high per capita consumption 73kg/person/annum. Sweet potatoes are consumed in 3 main modes: boiled, mashed and fried. At household level, sweetpotatoes are mainly prepared in two ways; steaming in banana leaf wrapping and boiling in water till soft. Fried sweetpotato is the third most popular form of consumption after boiled/steamed and roasted and urban folk as well as medium income earners in the rural areas mainly consume it. For each of these consumption patterns, the characteristics of the desired raw materials are relatively well known: high dry matter content, optimal root shape, and color. Other studies have also identified different organoleptic criteria expected for each of these products. Nevertheless, they need to be consolidated over a larger number of varieties and consumers (Activity 5).

Finally, it should be noted that the studies conducted have shown that differences in product preferences exist between adult and child consumers. Disaggregating this element, along with by gender and other factors of social difference may constitute a GAP to be achieved during the project.

Other gaps that need to be addressed are: the specification of processing according to the proposed sampling scheme. In particular, various studies have made it possible to address the link between the level of dry matter content of the raw material and the physical properties of the finished products. This will be one of the main GAPs that the RTBfoods project will be able to achieve by working on a large number of samples (Activity 5 and WP2 link).

Gender and socio-economic context

The importance of sweetpotato for food security and income is increasing, particularly due to pest and disease problems with alternative staples such as cassava and banana. It is an important food security crop due to it drought tolerance, nutrition, early maturity and flexible growing season. Piecemeal harvesting is widely practiced and an attribute particularly valued by women There has been a significant push to promote Orange Fleshed Sweet potato (OFSP) in the county to target vitamin A deficiency; however, consumers have reported to dislike the taste and smell of the crop, its low dry matter content and perceptions that the crop is genetically modified and less drought tolerant. However, children have been attracted to the color. Ejumula and NASPOT varieties of OFSP are popular, due to their nutritional benefits, sweet taste and greater yield – which is linked to higher income.

Sweet potato planting material is often obtained through social networks. The crop is commonly planted on large mounds with five to six vines on land demarcated for food security, and rotated with maize, beans and groundnuts. Women tend to intercrop with beans, but not men. Women also perform most of the labor activities regarding production, harvesting, washing and peeling, and packaging for sale. Men will participate in selling if there is a surplus. Women are reported to have most of the knowledge on production activities and varieties, and also have an active role in decision making regarding sweetpotato but men influence decisions.

Constraints reported for women are drudgery in making ridges/mounds, weeding, harvesting, Post-slicing and drying SP, low bargaining power, prices, untrustworthy buyers, and chronic back ache. Men report limited access to mechanization (animal traction), quality herbicides, low prices, untrustworthy buyers.

There is a lack of evidence of preferences by gender and other factors of social differences, from production activities, processing labor and consumption. There also lacks more nuanced data on gender decision making, and greater amount of quantitative data attached to gender roles, linked to activities and preferences, in order to interrogate generalizations.

Demand

Uganda is the third largest producer of sweetpotato in Africa, and the demand and income-generation potential for sweetpotato and products is growing in the country. The high season occurs during Ramadan. Demand segments are urban and rural consumers consuming boiled sweetpotato

prepared at home. In urban areas, people commonly consume boiled or fried sweetpotato purchased from hotels or from roadside vendors. There is some indication that fried sweetpotato is preferred by men and in urban areas as a snack.

Sweet potato is very popular in eastern Uganda. Varietal preferences are Kampala, Boy, Socadido, Soroti and Tanzania varieties - the latter two are particularly valued by traders due to their longer shelf-life. In the central region (Buganda), sweetpotato with high dry matter content and high sugar content is preferred. Varieties that have deep roots because they can be piecemeal harvested with little damage by the weevils are also preferred. The crop is traded informally, particularly by women. Wholesale trade is an Activity conducted by men, however there is a lack of information on the scale of activities. Marketing constraints include the crops bulkiness, high perishability, high transport costs, minimal storage facilities, limited market information services and absence of processing. Although the crop is not commonly stored as it is mainly harvested on a piecemeal basis, improved storage techniques are being increasingly used, such as pit stores (favored by women) and clamp stores (favored by men).

In terms of gaps, while there is data available on production and consumption of sweetpotato it is not product specific. An overview of demand trends and consumer segments by product is needed, to understand how fried sweetpotato compares to other products in terms of scale of demand and important. Overall, there is a paucity of data specifically on fried sweetpotato.

Boiled Yam (Del. A.1.1; A.1.1bis; A.1.5)

Benin

Food Science

Boiled yam is considered an important food product in Benin, and throughout West Africa more generally. It is consumed for all meals (breakfast, lunch and dinner) and also as a street food in both rural and urban areas. However, not all yam varieties are suitable for cooking. The main quality characteristics looked for in raw yam are maturity of tuber, variety types, color, tuber size. The processing steps that are very important to make a high-quality boiled yam are that there is no oxidation or browning, an acceptable cooking duration, and is a white to milky boiling water. These characteristics are detailed in the full report.

The quality characteristics of yam tuber and boiled yam pieces were reported by several research works. Most of the research was collected through surveys or focus group discussion. Although, some surveys were designed at urban and rural levels, data were analyzed without focusing on those factors. In general practice, data obtained were not disaggregated between or by gender and other factors of social difference such as ethnicity, richness, age, marital status etc.

Furthermore, most of the mean ranges for the quality characteristics were not available from literature. As far as the SoK is concerned, the confidence in the information gathered along the food chain is high for some quality attributes of raw yam (maturity of tuber, variety types, color, tuber size), processing steps (no oxidation/no browning, cooking duration, white to milky boiling water) and boiled yam piece (color, texture, taste). However, the confidence in the information is still medium for other attributes. Thus, the WP1 activities will help confirming the confidence of the latter. No study integrating all food chain actors for quality traits identification is available.

Gender and socio-economic context

Yam is an indicator of wealth and well-being in rural areas and used to fulfil social and ritualistic obligations and represent social prestige. Yam is processed in to a variety of products, but also used in traditional pharmacopoeia, specifically treating high cholesterol and diabetes. Interestingly, in Couffo, women are more involved in production then men, whereas in other places in the country, it is only men. Assets required for yam include finance, well decomposed organic manure, seeds for yams and fertilizer. This is mostly the domain of men.

Preferred species of yam are Dioscorea alata (greater or water yam), Dioscorea rotundata (white guinea yam), Dioscorea cayenensis (yellow guinea yam). The most common varieties are Gangni, Gnidou, Laboko, Morukorou, Orukonai (early varieties); Kokoro and Florido-Dioscoreaalata (late

varieties) in the major production areas of Zou, Central and Northern Benin. There are specific varieties are used for cultural and ritualistic practices e.g. Laboko and Gangni, which were more likely to be grown by men. Women also prefer varieties that are less labor intensive, particularly for pounding, as they are mainly involved in processing.

Overall, there is a lack of information on gender roles for the yam products and at each production and processing step. More information on why differences in gender norms between regions exist, and how it influences yam preferences is required. This will in part be filled with the research conducted under RTBfoods.

Demand

Yam is of primary importance in West and Central Africa. Benin is part of the yam belt which extends from central Côte d'Ivoire to the mountain ranges of Cameroon. This zone produces about 90% of the world yam crop. Benin ranks fourth among producers on the African continent behind Nigeria, Ghana and Côte d'Ivoire. Regarding the quality criteria of boiled yam, texture, color, taste, smell and digestibility are the major drivers of the preferences of Béninese consumers. There are two categories of varieties: good varieties to make crushed or pounded yam, which make up the majority of the varieties and belong to the Dioscorea rotundata cayenensis complex. These varieties are also good for other forms of consumption (boiled, fried, stew….). Varieties that are not good for crushed or pounded yam and most of which belong to the species Dioscorea alata are just good to eat in boiled or stew form. Perceived values allow a categorization of yam varieties into two major groups: one group with varieties characterized by high socio-cultural and economic values and another characterized by low socio-cultural and market values, but high food security value. Between them, the two groups provide farmers and consumers with a range of technological and agronomic aptitudes and provide food at different periods of the year.

The yam trade historically declined in Benin with competition from Nigeria. There are three main yam markets – based on specific ethnic group for each market e.g. Fon traders tend to trade in fresh yams. The majority of traders are Bariba and Tchabè. Smaller traders are usually women, whereas wholesalers are mainly men, except in Bariba- Tchabè where they are mainly women. The main market issues are access to transportation, access to the marketplace and access to customers. Concerning boiled yam, women, young girls manly are the ones who make its sale although they are a minority compared to the ones who sell the pounded yam. Men are only involved rarely when they are hungry in the field or at home when their wives or children are not at home. They do not market it for the sake of honor because they say "It's the women's thing".

The drivers of the preferences of Béninese boiled yam consumers are presented in literature, however, there appears to be a dearth of information as far as recent studies are concerned, including on future trends of products, and the link between varieties of yam tubers and the quality of the end-product.

Pounded Yam (Del. A.1.1; A.1.1bis)

Food Science (Bowen University)

Physico-chemical composition of yam tuber such as the granule morphology, pasting properties, swelling, water binding capacity of yam starch, nutrient composition such as proximate, minerals, vitamins, and anti-nutritional factors in the yam tuber describes the food quality in yam. It is clear from the literature that textural quality is an important indicator of yam food quality. In this way, various works have identified the textural criteria of boiled yam (mealiness, waxiness, sogginess, stickiness and hardness) and pounded yam (stretchability, smoothness, cohesiveness, moderately adhesive and moderately soft). The SoK review also demonstrated that the quality and acceptability of pounded yam depend on the type of variety used to obtain it. In another way, it is known that yam storage duration impact positively the quality of the pounded yam.

There is the dearth of knowledge of what farmers, processors and consumers perceive as food quality characteristics, along with differences by gender or ethnicity. This is another gap that the RTBfoods project aims to address, is that according to the literature food quality to farmers is commercial profitability of the yam variety and ability to make the preferred yam food product. One

of the gaps that the RTBfoods project aim to address is to identify indicators in yam tubers, as raw material, which can predict the quality of the pounded yam.

Gender and socio-economic context (NRCRI)

Yam growing and handling involves many operations, some of which follow gender lines/stereotyping in some regions. In the south-eastern part of Nigeria, for instance, men and women combine efforts to do the planting; the women carry out weeding which is usually done 2-3 times before harvest; and men and women combine efforts again at crop maturity to do the harvest.

In three locations of Nigeria in the South Region (Ibibio (Akwa Ibom State); Efik (Cross River State); Igbo (Anambra State), gender aspects are similar: Yam is predominantly a “male” crop and farming tasks are common for men to undertake bush clearing, ground preparation, rituals, seed selection and deposition, staking, trailing, harvesting, barn preparation and storage; and for women, covering yam seedlings, weeding, conveying tubers for storage, and cooking. These are the traditional division of labor between the sexes. In Ibibio farming is mainly subsistence, where as in Efik it was more commercial and subsistence farming. But generally, in all locations farming is small-scale and family-centered .Large-scale cultivation creates the need for polygamous relationship as a means to support labor. Men enjoy absolute access and ownership rights, whereas women’s rights of access are at the will of their husbands. In all three locations, yam was seen to enhance the social status of men and symbolize wealth. Yam also has important cultural role in ceremonies and rituals.

There are different varieties preferred by men and women, but literature did not explain reasons behind these different preferences. Greater evidence to support gender roles and activities is required, as a significant amount of the literature provides broad generalizations. As yam is traditionally seen as a man’s crop, it can overlook the important women play in yam value chains (e.g. trading) and undermine the importance of consulting women for their unique preferences.

Demand (NRCRI)

Nigeria is the largest yam producer in the world, contributing two-thirds of global yam production each year. In 2016 Nigeria’s yam production was 44.1 million tones, which represented 67% of the global production. Several observations stand out in a report by Nweke et al (2013): there is direct association between the frequency of yam consumption and consumer’s income group and there is inverse association between the frequencies of yam consumption and retail market price of yam relative to the prices of its substitutes. The two observations underscore the argument that an increase in consumer income in the representative countries (Nigeria, Ghana, Burkina Faso, Mali as covered in the study) or improvement in road network within and among yam producing and consuming countries impact positively on the frequencies of yam consumption. From 2005 to 2009, average annual per capita yam consumption was Nigeria, 84.4 kg; Ghana, 127.4; Mali, 5.2; and Burkina Faso, 2.2 kg (Nweke et al, 2013). Growth in yam consumption was higher than growth in population in Nigeria and Ghana, kept pace with population in Mali and was lower than population growth in Burkina Faso.

As part of the YIIFSWA project, Mignouna et al (2014) conducted a baseline study which established the link between preferred varieties related to criteria such as agronomic performance (e.g. tuber yield, drought tolerance, disease tolerance), marketability, and cooking and utilization. The study was conducted in three Agro-Ecological Zones (AEZ) of Nigeria, and the results show that, overall, Hembamkwase is the preferred yam variety in the Southern Guinea Savanna, Amula in the Derived Savanna, and Obiaturugo in the Humid Forest.

4.1.3 Overview of SoK findings on important product characteristics

An overview of the important product characteristics in the SoKs is summarized in the table below.

Table 1 Summary table of important product characteristics from food science reports

	Quality characteristics of product		
Product/country	***Raw***	***During processing***	***Final***
Boiled cassava / Uganda Nb. In the case of cassava roots, characteristics are in order of importance for the first five characteristics	• Sweet taste when bitten; • Roots should not be watery when chewed fresh; • Easy to chew; • Low fibre content; • Long and slender root shape; • A root of 12 to 18 months maturity; • Soft to break; • Disease free; • Pink cortex (associated with sweet taste).	• Self-retracting peel or easy to peel; • Roots glitter after washing; • Easy to cut without uneven breaks; • Quick cooking (30 minutes), • Nice aroma; • Soft to pound (without fibers or cut into fibre).	• Soft to bite and easy to chew; • Sweet taste; • Feeling energetic after eating; • Nice aroma or mild aroma; • White or not so brown after pounding; • Less fibre- middle fibre only; • Mealy; • Friable - fluffy texture when pressed in the hand; • Doesn't stick in the hand - easily makes a depression when a finger is pushed in pounded cassava; • Less starch.
Granulated cassava / Eba Nigeria	• Low starch cassava varieties may affect a gari that is traditionally cooked for a short time (South West), as after preparation there will not be enough rehydration of the starch to make the Eba hold together; • Also, high starch and dry matter provide more gari yield;	• Drawability and hardness of the Eba influenced by the way Eba is made: longer cooking means more rehydration and complete gelatinization and a harder more drawing eba. • Low dry matter /starch content and variety specific mash color after pressing can contribute to a lower quality product; • Swelling of gari is important (the higher the density the greater the expansion from gari to eba);	• South West consumers prefer soft, low elasticity Eba and a sour and an off-white, ivory, butter-like color for gari. • South South and South East consumers prefer hard, elastic Eba and non-sour, white or yellow gari, the latter achieved with palm oil, which may reduce storability. • Attractiveness, particularly color, is highly valued, and is affected by fermentation, variety and sanitation during processing. • Gari granules that are fine but not too fine are most liked.

	Quality characteristics of product		
Product/country	***Raw***	***During processing***	***Final***
		• Swelling of gari in cold water is significantly higher for fermented gari - this is a preferred trait for people that drink gari; • Granule size is important, and it is influenced by the equipment used, and contact temperature between the mash and the roasting board/pan.	
Gari / Cameroon	• Local cassava varieties are generally preferred because of their availability, their high dry matter content, their liked sweet taste and their ability to be kept in soil for long time after their maturity. • In North-West region ~85% of processors use improved cassava varieties such as "six months" (it is mature after 6 months); • Gari made from improved varieties harvested after 8 – 10 and 14 months, and local varieties harvested after 14 months were the most liked.	• Factors influencing the acceptability of gari include the frying time (10 minutes + reduces the quality), frying temperature, quantity of palm oil, and the storage conditions of roots.	• Fermentation level resulting in acidic or sweet taste, color (white or yellow, depending on the use or not of palm oil during roasting), and grain size are important when buying. • Characteristics are different by region and culture. Anglophones seem to have a preference for sour gari, while Francophones should prefer sweet gari. Gari from the North-West Region seems to have higher demand. • Consumers' most preferred gari was the one from Muyuka, regarding the fineness and uniformity of particles, cleanliness, bright color, good swelling capacity and low sour taste.
Attiéké / Côte d'Ivoire	• The desired characteristics of cassava roots for making a good Attiéké are a high dry matter content, freshness (≤ 1 day after harvest), a good		• A good Attiéké has a yellow chick color, absence of fibers and impurities, visible and well-rounded granules moldable in the hand, a hard texture, a pleasant and salty-sweet taste,

	Quality characteristics of product		
Product/country	***Raw***	***During processing***	***Final***
	sanitary quality, an ease of peeling and absence of fibers. • Varieties used for Attiéké making include: Improved Africa Cassava (IAC), and regional varieties such as Ahoussakplin, Ghana, Bocou 1.		and an odor of freshly cooked fermented cassava product.
Boiled plantain / Cameroon	• In Cameroon, fruit physicochemical characteristics such as fruit girth, fruit length and peel thickness are important criteria for consumers in the choice of plantain cultivars used for specific uses (it is assumed that plantains with high peel thickness are easier to peel). • Other parameters include pulp to peel ratio, pulp firmness, total soluble solids, pH, total titratable acidity and dry matter content which are evaluated during ripening are also of great importance.		• Apart from the consumers' physical traits preferences in Cameroon, few or no information is given regarding the organoleptic characteristics and the quality of boiled plantain at each steps of processing.
matooke / Uganda	• Traits/characteristics of varieties that make good matooke are smooth peeling skin, soft peel/easy to peel and straight and big fingers which are easy to peel (e.g. Muvubo, Musakala and Nakitembe) in Luwero. • In Mbarara it is: yellowish when		• matooke should be served hot. Good quality matooke has the following attributes: golden yellow color, good aroma (some believe it is brought about by the leaves), good taste (e.g. no feeling of sap), soft texture (e.g. like chewing gum), smooth on the tongue (e.g. like a sponge). More characteristics were identified in the main SoK

	Quality characteristics of product		
Product/country	***Raw***	***During processing***	***Final***
	peeled, straight and big fingers hence easy to peel e.g. Butobe, Embururu, Entaragaza and Enjagata, easy to cook, yellow when cooked, mature fast e.g. Entaragaza, big and fat fingers, attractive and appealing to the eye, makes good matooke even if not ripened (Embururu, Butobe and Enjagata can make nice matooke even when not fully mature unlike Kibuzi that can only make nice matooke when fully grown).		report.
Boiled sweetpotato / Uganda	• The characteristics of the desired raw materials are relatively well known: high dry matter content, optimal root shape, and color. Other studies have also identified different organoleptic criteria expected for each of these products. Nevertheless, they need to be consolidated over a larger number of varieties and consumers (Activity 5).	• At household level, sweetpotatoes are mainly prepared in two ways; steaming in banana leaf wrapping and boiling in water till soft. Fried sweetpotato is the third most popular form of consumption.	• Differences in product preferences exist between adult and child consumers. Disaggregating this element, along with by gender and other factors of social difference may constitute a GAP to be achieved during the project.
Boiled yam / Benin	• The main quality characteristics looked for in raw yam are maturity of tuber, variety types, color, tuber size.	• The processing steps to make a high-quality boiled yam are that there is no oxidation or browning, an acceptable cooking duration, and there is a white to milky boiling water.	• Boiled yam piece characteristics that are important include: color, texture, taste. The confidence in the information is still medium for other attributes.

	Quality characteristics of product		
Product/country	***Raw***	***During processing***	***Final***
Pounded yam / Nigeria	• Quality and acceptability of pounded yam depend on the type of variety used to obtain it. • Yam storage duration impact positively the quality of the pounded yam.		• Various works have identified the textural criteria of boiled yam (mealiness, waxiness, sogginess, stickiness and hardness) and pounded yam (stretchability, smoothness, cohesiveness, moderately adhesive and moderately soft).

4.1.4 Gaps in knowledge identified in the SoKs

The gaps in knowledge identified in the SoKs are summarized in the table below.

Table 2 Gaps in Knowledge identified in the SoKs and proposed action

Product	***Food Science***	***Gender***	***Demand***
Boiled Cassava - Uganda	Disaggregation by sex and other factors of social difference. *This is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Systematic and robust evidence on gender roles and control over cassava processing income to avoid over-generalizations. *This will not be addressed by RTBfoods.* Knowledge regarding gender differences in adoption and varietal preferences. *Investigating product preferences using gender and social difference lens is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Market and demand segments linked to preferences for characteristics. *This is expected to be addressed by RTBfoods with the market interviews proposed in Activity 3, 4 and 5.*
Gari/Eba-Nigeria	Priority and range of the characteristics; consumer preferences on granule size, color/attractiveness and swelling of the gari and their relative importance in different regions and how they relate to varietal differences. Methodology for previous studies unclear, particularly by gender and other factors of social difference. Quality characteristics collected through a larger sampling and several	Influence of commercialization over the means of production and income change. *This will not be addressed by RTBfoods.* Knowledge regarding gender differences in trait preferences and how they relate to varietal preferences and adoption. *Investigating product preferences using gender and social difference lens is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Size of gari markets by their variation. How and what kind of *gari* from the rural areas is assembled in hubs in towns or suburbs of cities before it is bulked and sold as wholesale in cities. Specific quantities of each type of *gari,* and how they relate to different cultural traditions and their notions on food product quality and how they relate to varietal differences. *This is expected to be addressed*

Product	Food Science	Gender	Demand
	precise consumer tests. These gaps are *expected to be addressed by RTBfoods Activity 3, 4 and 5.* The relation between fermentation time, preparation method and the "starchiness" and texture of the food (hard or soft eba). Consumer preferences for granule size requires clarification. *These are expected to be addressed by RTBfoods Activity 4.*		*by RTBfoods with the market interviews proposed in Activity 3, 4 and 5.*
Gari, Cameroon	Greater specification of important characteristics for Gari in Cameroon. *This is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	*Not conducted.	Evidence on the size of different demand segments and how the regional dynamics play out in urban centers. *This will not be addressed by RTBfoods Cameroon team.*
Côte d'Ivoire, Attiéké	Information provided on the effect of processing, mainly fermentation step, on physicochemical characteristics of Attiéké. Some papers reported on sensory quality of Attiéké, with a detailed methodology. Hedonic tests were conducted with no more than 50-60 consumers (with no details on gender, education, age, occupation) and sensory scoring by a panel were carried out on only global descriptors (appearance, taste, texture). More precise information on quality characteristics *is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Information on gender roles in Attiéké value chains, supported by evidence is lacking, and how it links to preferences. *Investigating product preferences using gender and social difference lens is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Trends in demand for the three Attiéké products along gender and age groups can be analyzed in more detail; also, how this is related to the characteristics of cassava roots. Knowledgeable traders, who can provide the information, need to be sought at different levels in the value chain. *This is expected to be addressed by RTBfoods with the market interviews proposed in Activity 3, 4 and 5.*
Plantain, Cameroon	Quality characteristics at each processing steps and the quality characteristics of the final product (including some nutritional facts and sensory characteristics) in Cameroon. *This is expected to be*	** Not extensively covered and will not be addressed by RTBfoods.*	** Not extensively covered and will not be addressed by RTBfoods.*

Product	Food Science	Gender	Demand
	addressed by RTBfoods.		
Matooke - Uganda	Gender and socially segmented evidence. *This is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Social aspects of matooke preparation and preferences. Gender and socially segmented evidence. *Investigating product preferences using gender and social difference lens is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Comprehensive study on demand and consumption trends for cooking banana in Uganda. It is suggested that the study should bring out the seasonal differences in the supply and demand of the crop and provide nationally representative and robust statistics. *This is not expected to be covered by RTBfoods.*
Sweet Potato - Uganda	Preferences by gender and other factors of social difference. The processes for obtaining the products, although described, need to be specified. *This is expected to be addressed by RTBfoods Activity 4, 5 and 6.*	Preferences by gender. Regional differences, more nuanced data on decision making, more quantitative data attached to gender roles - need to be linked to preferences and activities. *Investigating product preferences using gender and social difference lens is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Overview of demand trends and consumer segments by product. There was a paucity of data specifically on fried sweetpotato. *This is expected to be addressed by RTBfoods with the market interviews proposed in Activity 3, 4 and 5.*
Boiled yam - Benin	Urban/rural differences in preferences. Disaggregated data by gender and other factors of social difference such as ethnicity, wealth, age, marital status etc. Mean ranges for the quality characteristics. Specific characteristics identified where more information is required. *This is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	There is a lack of information on gender roles for the yam products and at each production and processing step. Reasons for differences in gender norms in relation to product/preference variations. *Investigating product preferences using gender and social difference lens is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Future trends of products, and the link between varieties of yam tubers and the quality of the end-product. Identification of specific demand segments with up-to-date information, along gender and age groups, and for rural areas, secondary centers, and big cities. *This is expected to be addressed by RTBfoods with the market interviews proposed in Activity 3, 4 and 5.*
Boiled yam – NRCRI / Bowen	Perceptions among farmers, processors and consumers on food quality characteristics, along with differences by gender or ethnicity. *This is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Reasons behind gender differences in varietal preferences. Evidence to support gender roles and activities is required to unpack generalizations. *Investigating product preferences using gender and social difference lens is expected to be addressed by RTBfoods Activity 3, 4 and 5.*	Demand segments, quantities traded and consumed, and where, and how this links to preferences. *This is expected to be addressed by RTBfoods with the market interviews proposed in Activity 3, 4 and 5.*

4.1.5 Methodology development

Please, refer & cite the deliverables produced using the codes mentioned in the table above when relevant.

- ➢ *Which methods developed for WP1 framework (Activity 3 to 5)? For which reasons were these methods developed? What for? Which Originality?*

The WP1 4-part Guidance manual showcases the methods developed to guide partners in fieldwork for Activities 1, 3, 4 and 5, and are available on the RTBfoods platform (Del. A.2.1 to A.2.10). They are living documents that will be continually updated. The methodology documented in the manuals is an interdisciplinary and multi-staged, aimed to identify, triangulate and prioritize user preferences to inform breeding priorities. The method is described below.

SoK (Activity 1) is a method developed to systematically guide partners through a literature review, expert interviews and critical self-reflection relating to existing knowledge on quality characteristics, gender and socio-economic context, and demand for the crop and product. This method also determined the gaps in knowledge to be the focus for RTBfoods WP1 activities and beyond.

Gendered Product Mapping (Activity 3) involves consultation in rural communities with people who grow, process and consume the crop in major production and consumption areas in the country, considering geographic and cultural diversity. The methods developed as part of Activity 3 include: Key informant interviews with community leadership, focus groups discussions and individual interviews with community members. Market interviews at the community level also take place as part of Activity 3 fieldwork. Importantly, the method involves consultation for different actors involved in the value chain at a rural level. The aim is to identify the quality characteristics along the food chain (production, post-harvest and market) by different types of stakeholders, the multiple uses and trade-offs between uses, which may reflect different interests of men and women. This will provide a robust evidence base for understanding preferences among different user groups to inform breeding programs of the range of consistency to diversity of preferences. As the SoKs demonstrate that obtain information on these areas will address a significant gap in current knowledge. Priority data for WP2 will be extracted from the dataset as the first stage of analysis.

The method for **Participatory processing diagnosis and quality characteristics (Activity 4)** is to conduct participatory processing demonstrations in processing hubs/ medium size towns. This combines two complementary tools: 1) the diagnosis of the processes by measuring technological parameters at each step of the process, while processors make products from varieties with different quality characteristics, 2) collecting processors' opinions through a semi-structured discussion guide before, during and after processing, on the different quality characteristics of varieties which could influence the final quality of the products, and also on the most liked and least liked characteristics of the final products. Market Interviews are also conducted at this level. Given the large number of product profiles and contexts that are subject to this work, it should be noted that the tools, especially for the conduct of the diagnosis, must be adapted on a case-by-case basis using results from Activities 1 & 3, and the needs of Activity 5, in mind. Activity 4 experiments must be carried out in connection with the WP2 to collect information and samples of the raw materials and the final products for characterization and physico-chemical analysis.

Consumer testing in rural and urban user segments (Activity 5) involves urban and rural consumer testing of products of different sensory properties made by processors in Activity 4, to understand what local consumers, from different demand segments, consider the characteristics of a high-quality product to be. Consumer testing in rural areas is particular is innovative as it is normally conducted in urban centers. But as these products are important food security products, WP1 feels it is important to test these products in rural locations as well. The method involved in this activities include an "all-in-one" method with two small questionnaires and three successive tests while consumers are invited to taste each product, one after the other: a small questionnaire on demographic information and consumption habits, a nine-point scale hedonic test to score the liking of each product, a 3-point scale JAR "Just About Right" test on 2-4 specific descriptors identified as important in Activity 3 & 4 to know if each descriptor is as the consumer likes or not, a CATA "Check-All-That-Apply" test including a table with sensory and perceptions descriptors collected during Activities 3 & 4 to better describe each product. Finally, a small questionnaire on consumer's views

and opinions about each product. Market Interviews are also conducted at this level.

The final method is for **the WP1 – food product profile – first iteration**. This is method involves the extraction of key data (characteristics, user group, and characteristic prioritization) from each of the previous activities to develop and build on a product profile. The product profile is a set of quality characteristics of a product that are required to meet user demand and be successfully released onto a demand segment. The quality characteristics of the product are linked to the bio-physical characteristics of the crop variety and the processing parameters used to make a good quality product. It is envisioned that WP1 will provide the first iteration of product profile to WP2 for bio-physical analysis and work package 5, to help established breeding priorities.

- ➢ *Function/ Objective of each manual from the Capacity strengthening kit (Del. A.2.1 to A.2.10)? (NB: you can provide here manual abstracts). How have they been tested on the field?*

Gendered product mapping - Activity 3: The objectives of the Activity 3 manual is to understand who is producing, processing, selling and consuming the crop and product, from a gendered perspective; understand the multiple uses and products of the crop and possible trade-offs between uses; identify the quality characteristics and descriptors by stakeholder group (e.g. producers, processors) and demand segment (e.g. rural consumers), and to understand how gender influences preferences and prioritization for characteristics. Each partner has tested these tools in the field, except for Cameroon gari team who has not started fieldwork.

Participatory processing diagnosis and quality characteristics - Activity 4: The objective of the Activity 4 manual is to conduct participatory processing/preparation demonstrations for the product under study to understand processors' demand for quality characteristics of the crop, while processing different RTB varieties with various technological properties. The methods will not be tested in the field until year 2.

Consumer testing in rural and urban user segments - Activity 5: The objective of the Activity 5 Manual is to provide a research approach and tools that enable researchers to understand the consumers' demand for quality characteristics of the product under study, i.e. to understand what a high-quality product is for local consumers. The sensory and perception descriptors of several products that have very different sensory properties, will be related to the overall liking with a large number of consumers. The products will be made from local varieties and/or genotypes that were selected by processors and research team because of their different quality characteristics (in Activity 4). Consumer testing will be conducted in rural and urban user segments in year 2.

- ➢ *How first feedback from partners have been integrated to adapt/improve the methodology (learning dimension)?*

Feedback from partners on the WP1 methodology was received at multiple points in time during Year 1, as the manuals are considered 'living documents' and will continue to evolve over the project lifespan with learning from partners. To date, feedback has been integrated into the methodology in the following ways:

- Drafts of the manuals were circulated to PMU, work package leaders and other key resource people, particularly breeders, for their input and suggestions prior to the March 2018 Capacity Strengthening and Sharing Workshop. The manuals on the portal reflect additional input from collaborators following the workshop and will be updated on an ongoing basis.
- The Capacity Strengthening and Sharing Workshop (April, 2018) provided an opportunity for the team to present and receive feedback on the tools and approach which were integrated into the manuals and are reflected in the current versions on the portal.
- Feedback on the approach and tools for Activity 3 was received from partners during preparation, piloting and implementation Activity 3 fieldwork. In most cases, this feedback has focused on tailoring the tools to the country and product context, and the overall approach has not significantly changed.
- The WP1 Coordination team and collaborators undertook learning visits during Gender Food Mapping - Activity 3 pilots in Benin, Nigeria, Uganda, and Côte d'Ivoire. Lessons from the pilots were documented for Benin (June, 2018), Nigeria (August, 2018) and Uganda (September, 2018). See box 1 below for lessons from Nigeria and Uganda experience and

box 2 from Côte d'Ivoire.

Box 1: Summary of lessons from learning visits for Activity 3 facilitated by Lora Forsythe for Nigeria (August, 2018) and Uganda pilots (September, 2018)

General

- Input from breeders on the first day was EXTREMELY valuable. Ask breeders to review/comment on the questionnaires. If they do not have time, ask what they think is the priority data they need. Breeders should have also be interviewed as part of the SoK.
- Link the preferred characteristics back to the varieties. This will help breeders.
- Questionnaire should identify difference characteristics for processing and product variations.
- If all parts of the crop are used, vines, roots, seeds, for animal feed etc., it should be included in the questionnaire as prompts.
- Storage (pre and post-harvest) is something not specifically prompted in the questionnaires. Consider if it is important for the product to probe on this specifically.
- Need to understand how trends and popularity for products is changing.

Questionnaires/tools and preparation – before fieldwork

- Pilot the tools and immediately follow with a debrief with the whole research team to discuss and agree how questions should be asked, challenges and modifications.
- Roles for facilitation and notetaking should be defined clearly. While there should be interaction and support by all team members, we should be empowering one another. Showing organization and a friendly disposition – along with continual engagement with the respondents is necessary.
- Scheduling is very important. Especially for women. Discuss expectations with the mobiliser and clarifying expectations at start of the interview.
- Piloting the tools is vital and each team members needs to have the same interpretation of the questions.
- Adapt the market interview questions to the level of interview that is being conducted. For Activity three it is only village level.

Conducting interviews/focus group – during fieldwork

- "Active" note taking: identifying when to 'skip' questions to avoid repetition, manage time etc.
- Importance of verbatim notes, quotes etc. Using words as the community expresses.
- The interview will need to go beyond statements such as "sour" or "easy to peel" for important characteristics– add value by asking for detail on the type of sour, indicators of sourness or peel ability. Use pictures in the sand, bottles, to compare sizing, shape etc.
- Ask the question open-ended first. If the person is having trouble use prompts as an example. It is not necessary to ask about gender, ethnicity, age, wealth for every question. Remind the interviewer to ask if the responses is true for everyone in the community.
- For pairwise/simple ranking. After piloting and the team has a better understanding of how the time needs to be managed, decide if simple ranking or pairwise ranking will be used. The approach will need to be consistent. Pairwise is more reliable in terms of understanding priorities compared with ranking but is still not perfect.
- Be specific with the questions.
- Some respondents are less responsive and have more trouble with the questions. The interview may need to ask a series of "step by step" questions that can be worked out in the pilots, which would help the respondent along.
- Sometimes you will need to end the interview or wrap up quickly if the person is not responsive – that is OK. If the person says they don't know, that is also an answer!

Time management is essential. Here are some tips we learned:

- Note taker can manage time and guide the facilitator on the speed. Divide your target time for completion (FGD=2hrs, Interviews=1-1.5hrs) by the number of sections in the questionnaire. Give more time to priority questions and areas important for WP2 and breeders (preferences, characteristics, descriptors).
- If you lack time, focus on questions with a *. Critical questions with an asterisk (*) to ensure they are not missed and we can make comparisons across products.
- Skip the question if it has been answered already – but be careful that the question has been well understood (e.g. there are similar questions regarding on the crop and the product, but they are different and both need to be asked).
- If a respondent provides an answer to a question that is later in the questionnaire that is OK. Take the notes and include the appropriate question number. Notetaker to guide the facilitator and let them know when they already have an answer to the question so there is no repetition.

Box 2: Summary of lessons from learning visits for Activity 3 facilitated by Geneviève Fliedel for Côte d'Ivoire (September, 2018)

- First experience by a research team in a first village. Misunderstanding of some questions in the English version of the questionnaire, even in the translated version
- Discussion by skype (several sessions) with the team, then during the field visit, to precise the objective of some questions (food science, gender and market study).
- Research team will need to revise and better translate all the questionnaires and adapt them to their product, region and country
- The team will need to better precise the objective of the project to the village chief and other village notables or officials, to avoid questions and loss of time before starting key informant interviews
- Research team will record the FGD or KII if taking many notes is difficult for some members
- Five days were necessary in one village to conduct Activity 3, so 4 weeks for one region.

The team consisted of 5 persons: 2 scientists (gender and economist) and 3 students (1 PhD in Food science, 1 master student in socio-economy and 1 master student in food science) with a food scientist as a supervisor. The team was very complementary and did a very good job.

4.1.6 Training in Benin

➢ *Provide a Summary of the training organized in Benin including: Dates, Trainers Curricula, Training Objectives, Nb of participants, Institutes, any other useful information (NB : you can provide the abstract of the training reports or a summary table).*

The Capacity Strengthening and Sharing workshop was held between the 16th and 24th of April, 2018 in Cotonou, Benin. The workshop provided the coordination team with the opportunity to present a 'core' methodology for identifying user preferences, and to receive feedback and input from project partners on best practices for the methodology based on their experience and expertise. The methods are nonetheless envisioned to be adapted with the results from fieldwork to ensure success into the future of project implementation. The objectives of the WP1 workshop were twofold:

1. Design robust interdisciplinary methodology bridging economics, food science and gender, employing participatory approaches to identify quality characteristics in RTBfoods products.
2. Foster a co-creative environment to ensure the diverse group of researchers input into,

understand and own the methodology.

The workshop was facilitated by Lora Forsythe (NRI), Genevieve Fliedel (CIRAD), Ulrich Kleih (NRI) and Alexandre Bouniol (CIRAD). Logistical and organization support was provided by Noel Akissoe and Laurent Adinsi (UAC-FSA), Alexandre Bouniol (CIRAD), and Caroline Troy (NRI).

There were 31 participants at the workshop from six countries. Out of 31 participants, 15 were women (48%), which demonstrates good representation of women at the event. Out of the 29 technical participants, food science was the most highly represented (16 participants), followed by socio-economics (8) and gender (5). Participants represented the following institutions: Bowen, CARBAP, CIP, CIRAD, CNRA, ENSAI, FSA-UAC, IITA, NaCRRI, NARL, NRCRI and NRI.

The output from the workshop was revised WP1 manual and Capacity Strengthening and Sharing Kit. Initial feedback was provided to teams who provided draft SoKs prior to the workshop. Partners also provided work plans and their sampling frame following the workshop.

- *Beyond training objectives, what did the training « bring in » for the WP1 framework? Lessons learnt? (e.g. knowledge, experience share, whatever being all together brought to the team).*

The WP1 being multidisciplinary by nature, the Capacity Building and Strengthening Workshop provided a way to understand the expertise and experience of each partner. This has resulted in an effort to draft guides so that they are accessible and usable by all partners, reflecting both existing knowledge and new ideas. It also provided an opportunity to integrate partner feedback into the framework. It was also an opportunity to propose support to partners in carrying out activities.

A point of reflection for the Workshop facilitators, based on comments from the workshop evaluation, is how the workshop could have been more participatory and make better use of the knowledge and experience of the participants.

Output 1.5.1: *Gendered socio-economic databases on consumer/user preferences for 11 RTBfoods/processed products in 5 African countries*

Activities conducted	***Deliverables***
Uploading Raw data + Coded Data + Processed/Analyzed Data on secured repositories	I.1- Raw data from surveys on RTB consumption habits and preferences secured on RTBfoods platform (Questionnaires + Consent forms): I.1.1- Boiled and pounded yam at Bowen I.1.2- Boiled and pounded yam at NRCRI I.1.3- Gari/Eba at IITA I.1.4- Boiled cassava at NaCRRI I.1.5- matooke at NARL I.1.6- Boiled yam at UAC-FSA I.1.7- Attiéké at CNRA I.1.8- Boiled Plantain at CARBAP I.1.9- Boiled Sweetpotato at CIP I.1.10- Gari/Eba & Fufu at NRCRI

Output Indicators 1.5.1	*Targets / Milestones*		
	Planned for Period 1	***Achieved***	***Variance & Brief Explanation***
Nb of food product profiles for which Raw Data + Coded Data + Processed Data (Analysis) is secured on repositories (CIRAD dataverse &/or BTI repositories)	Raw + Coded data from surveys secured on RTBfoods platform for 9 teams (covering 6 food products)	9 out of 9 teams conducting surveys on 8 food products in Period 1 have uploaded their raw data attached with consent forms signed by each respondent. * To date, 6 datasets (coded data) have been uploaded from 9 teams.	*1 team (Attiéké) had not completed fieldwork due to University strikes in the country. Remaining databases, and cleaned databases, are planned to be received by the coordination team by the Annual Meeting in March 2019.

4.1.7 Field Activities

- *Activities conducted by WP1 partner teams: Fill-in the table hereunder to synthetize activities conducted on the field by the different teams. (Please, treat each food product separately = even if the surveys have been conducted during the same interviews & by the same team – Keep the food product as an entry point)*

Activities for the Gendered Food Mapping - Activity 3 fieldwork started for 9 teams at staggered times (appropriate to season, staff availability etc.) starting from May 2018. To date, all teams have completed their fieldwork except for Côte d'Ivoire – Attiéké, who will need to complete one region which was delayed due to country-wide strikes, and Cameroon – Gari, due to funding delays.

The table below displays the details on Activity 3 fieldwork by product and country.

11 RTBfoods Products	Countries covered in Period 1		Dates of Field Surveys		Regions surveyed	List of Localities: Big cities Small cities Villages	Nb of Individual Interviews conducted		Nb of Focus groups organized	Questionnaires uploaded on RTBfoods platform	
			start	end			M	F		Yes	No
Boiled cassava	Primary country	Uganda	26 September 2018	6 October 2018	APAC (Northern Uganda)	ATANA	6	5	2	Y	
						AKERE	4	5	2	Y	
						CHEGERE	4	5	2	Y	
						ATIGOLWOK	6	4	2	Y	
			08 October 2018	18 October 2018	LUWEERO (Central Uganda)	BUKAMBAGA	2	5	2	Y	
						BWAZIBA	5	5	2	Y	
						KABAKEDI	5	8	2	Y	
						KAKINZI	5	5	2	Y	
Gari/Eba	Primary country	Nigeria - NRCRI	10/8/18	30/8/18	South-East (Imo State)	Uzoagba Ikeduru, Imo State	4	6	2	Y	
						Akwakuma, Owerri North, Imo state	2	8	2	Y	
						Amandugba, Isu LGA Imo state.	3	7	2	Y	
						Isinweke Ihitte Uboma, Imo State	2	8	2	Y	
		Nigeria - IITA	5/08/2018	28/10/2018	Benue state	Al' Okete (Okpokwu LGA)	7	2	2	Y	
						Tyomu (Makurdi LGA)	4	6	2	Y	
						Nyam II (Gwer East LGA)	3	7	2	Y	
						Shangev (Kwande LGA)	3	7	2	Y	
					Osun state	Oyan (odo-otin, LGA)	0	10	2	Y	
						Ago-Owu farm settlement (Isokan LCDA)	2	7	2	Y	
						Wasinmi (Irewole LGA)	0	9	2	Y	
						Elefon (Ife Central LGA)	2	7	2	Y	
	Spillover Country	Côte d'Ivoire (Attiéké)	10 September 2018	29 September 2018	South	ABIDJAN					
						Bingerville					
						• Bregbo	0	10	2	Y	
			18October 2018	27 October 2018		• Eloka-Te	0	10	2	Y	
						• Achokoi	0	10	2	Y	
						Dabou				Y	

11 RTBfoods Products	Countries covered in Period 1		Dates of Field Surveys		Regions surveyed	List of Localities: Big cities Small cities Villages	Nb of Individual Interviews conducted		Nb of Focus groups organized	Questionnaires uploaded on RTBfoods platform	
			start	end			M	F		Yes	No
						• Akradio	0	10	2	Y	
						• Opoyounem (Okpoyou)	0	10	2	Y	
					Centre	BOUAKE – in 2019					
Fufu	**Primary Country**	**Nigeria**	10/8/18	30/8/18	South-East (Imo State)	Uzoagba Ikeduru, Imo State	4	6	2	Y	
						Akwakuma, Owerri North, Imo state	2	8	2	Y	
						Amandugba, Isu LGA Imo state.	3	7	2	Y	
						Isinweke Ihitte Uboma, Imo State	2	8	2	Y	
Boiled Plantain	**Primary Country**	**Cameroon**	05-September 2018	20-September 2018	West region	Balessing	8	2	2	Y	
						Bafounda	4	5	2	Y	
						Penka Michel	5	5	2	Y	
						Bamendjing	5	5	2	Y	
					Littoral region	Bouba	4	5	2	Y	
						Kombe	5	5	2	Y	
						Sokelle	3	7	2	Y	
						Song-mayo	4	6	2	Y	
matooke	**Primary Country**	**Uganda**			Mbarara	Nyindo	10	3	2	Y	
						Kacuucu	11	7	2	Y	
						Mutuumo	9	7	2	Y	
						Keiba	9	6	2	Y	
					Luwero	Kabala	6	10	2	Y	
						Kabila	7	8	2	Y	
						Kalagala	8	8	2	Y	
						Nakaseeta	5	10	1	Y	
Boiled /FRIED Sweet	**Primary Country**	**Uganda**	15th October 2018	19th October 2018	Lira	Barkwoyo	12	12	2	Y	
						Obato	2	2	2	Y	
						Abalalai	12	12	2	Y	

11 RTBfoods Products	Countries covered in Period 1		Dates of Field Surveys		Regions surveyed	List of Localities: Big cities Small cities Villages		Nb of Individual Interviews conducted		Nb of Focus groups organized	Questionnaires uploaded on RTBfoods platform	
			start	end				M	F		Yes	No
potato			12th November 2018	16th November 2018		Aweo		2	2	2	Y	
					Kamwenge	Byabasambu		14	14	4	Y	
						Kyakanyemera		10	9	4	Y	
Boiled Yam	Primary Country	Benin			Dassa	DASSA II	KPEKOUTE	5	5	2	Y	
						KERE	IGOHO	5	5	2	Y	
						KPINGNI	ADIHINLIDJI	4	6	2	Y	
						LEMA	LEMA	4	6	2	Y	
					Djidja Centre	DAN CENTRE	HANNANGBO	1	9	2	Y	
							LALO	2	8	2	Y	
						DJIDJA CENTRE	MANDJAVI	3	7	2	Y	
							ZINKAMIN	5	5	Y	Y	
	Spillover Country	Nigeria	6/9/18	15/9/18	South-East(Ebonyi State)	Onueke, Ezza, Ebonyi State		7	3	2	Y	
						Amagu Izzi, Abakiliki Ebonyi state		6	4	2	Y	
						Umuebe, Ezza Ohaukwu Ebonyi state		6	4	2	Y	
						Obinagu Ishiagu, Ebonyi State		7	3	2	y	
Pounded Yam	Primary Country	Nigeria	31/10/18 30/11/18 5/12/18 Next week	31/10/18 30/11/18 5/12/18 Next week	Osun	Ife-Odan		4	7		Y	
						Iwo		4	5		Y	
						Gbongan		2	6		Y	
						Ilesa						Not yet

4.1.8 Team coordination

➢ *Successful collaborations on some activities and/or for some food products among WP1 partners? (e.g. collaboration between Bowen/NRCRI/IITA in Nigeria on 4 food products i.e. Gari/Eba, Boiled & Pounded Yam, Fufu).*

Collaboration between teams

There have been a number of examples in year one that demonstrate innovative collaboration between partners. For example:

- In Nigeria, IITA, Bowen and NRCRI have undertaken the fieldwork (each focusing on specific regions), piloting and demonstrations together to ensure the field teams have a consistent approach and make the best use of resources.
- Similarly, in Uganda, Bioversity/NARO/NARL, CIP, and NaCRRI undertook the fieldwork together for the three products, shared a piloting workshop and field testing, to ensure field teams have a consistent approach and make the best use of resources.
- IITA Cameroon (Noël Takam, socio-economist, new PhD student) and ENSAI (Franklin Ngoualem Kégah, post-doctoral fellow in Food Science and Robert Ndjouenkeu Professor in Food Science) on Activity 1 SoK on gari and on Activity 3 sampling and work plan with a prospection in the regions of study, before receiving project funding.

Support visits to ensure a successful WP1 coordination

Lora Forsythe travelled to Umudike in Southeast Nigeria August, 2018 to support local partners – the International Institute for Tropical Agriculture (IITA) and National Root Crops Institute (NRCRI) – in piloting survey tools for Activity 3 *Gendered Product Mapping*. Lora and Ulrich Klieh also traveled to Uganda to support the matooke, boiled cassava and sweetpotato teams in their pilots in September, 2018. Learning from both pilots were documented in lesson learning reports. In addition, while Lora visited Benin for the Global Cassava Partnership – GCP 21 Conference in June, 2018, meetings were held with UAC and IITA to provide support as it was required.

In October, Lora and Genevieve Fliedel conducted a visit to Cotonou, Benin to work with IITA and UAC Activity 3 datasets and to develop a data analysis plan to support other partners to 1) extract priority data for WP2, and 2) suggestions on how to analyze and report data for Activity objectives. This Activity has resulted two separate documents that are currently being finalized and will be circulated in January, 2019.

Genevieve Fliedel visited Cameroon to support funding arrangements and management issues and provide guidance on the SoK and Activity 3 fieldwork. Visit in Cameroon was focused on SoK, on Activity 3 new sampling with a choice of other regions (difficult politic situation in Anglophone regions, those that mainly produce gari), their work plan, and clarification on IITA and CIRAD funding, and Takam PhD (inscription and supervision).

Other activities

To spread awareness and highlight the importance of this project, and specifically the innovative approach of WP1, a news article piece on the RTBfoods project was published on CIRAD and NRI's website. Additionally, information and photos were posted on NRI's Facebook group after the workshop, and support visits to countries. Documents are regularly uploaded onto the CIRAD collaborative platform to allow all project partners to access information and tools, as well as track progress in meeting project goals and projected outcomes.

Online email and skype support was available to partners throughout the year. In some countries, Whatsapp groups were started among field teams, and Coordinators. (Nigeria and Uganda)

➢ *Challenges faced in coordination of WP1 partner teams & Strategies to be*

reinforced/developed by WP1 coordination team for Risk mitigation?

The RTBfoods project is unique in its approach to design and delivery of research activities for WP1. The collaborative nature of the project then creates the space for each country team to take the tools and adapt them to reflect their interests, with the exception for core questions that remain standard across all sites.

There are advantages in obtaining different types of information on an issue by using a range of survey methods (e.g. focus group interviews, individual interviews, consumer testing, measurements of processing parameters). At the same time, the coordination of different professional disciplines, which complement each other, leads to more in-depth information.

This structure however does also run the risk of leading to variability in data quality or depth, and completeness, in addition to creating potential for spill-over activities that are beyond the scope of WP1. The challenge to WP1 leadership has been to balance delivering high quality results for outputs defined at the project inception, with supporting teams to carry out additional work.

We have also encountered issues with funding. The country/crop budgets are variable and in some cases are not large enough to cover all WP1 activities – to address this, the scope of activities had to be cut from the original proposal (e.g. specific fieldwork on gender and demand). This could especially prove problematic if issues around data quality arise, necessitating more research. From the inception of the project there has been a tension around collecting enough information for good data quality and budgets.

Activity specific challenges

Workshop: It is broadly felt by the facilitators that the objectives of the workshop were met and the participants were highly engaged with the material. However, there were naturally some challenges. The mix of experience in qualitative research within the combination of fields represented by the attendants made it challenging to address everything comprehensively given the length of the training (10 days). Also, given that there were different levels of capacity, it was difficult to satisfy the needs all participants. For example, some gender specialists are advanced and would like to learn more advanced techniques for qualitative data analysis such as using software like Atlas ti. Other gender specialists, however, lack basic skills in qualitative research methods**.** It was felt that the workshop could be more participatory, such as greater time for the participants to use and comment on the tools. The Coordination team decided it would develop the tools in advance due to the time constraints, size of time, and the need for coordination and consistency in data and approach between the teams. How to manage the balance these constraints while at the same time creating ownership among the team, was a challenge. Given that there were different levels of capacity, it was difficult to satisfy the needs all participants. Another challenge was the lack of preparation time for developing the methodology and content for the workshop, in addition for securing a budget for the workshop. From the inception meeting there were two months to make the preparations. Budgetary issues were a significant constraint on the workshop and the participants.

SoKs: SoK guidance was developed to achieve standardization of the knowledge base collected on each product. There are gaps in partner capacity in terms of finance and staff expertise (we recommend a gender specialist, economist and food scientist to fully execute the planned work package), which limit the implementation of WP1 as outlined in the RTBfoods proposal submitted to BMGF. It is difficult to backstop on these capacity gaps, so different types of outputs proposed (see extensive and abbreviated outputs as described further in this report) that reflect the gaps and lay out realistic and achievable plans for each country/product. As far as possible, the outputs are be modular, and therefore parts can be included in the future with increasing capacity or complementary funding in the future.

In terms of outputs, there are varying levels of depth to the reports. This is for a number of reasons: literature was sparse for some products, particularly specific to geographical contexts. Partner

budgets were also prioritized for WP1 fieldwork, and therefore partners had less time to conduct thorough research. This approach was supported by the coordination team. With regards to food science, some reports required greater specification of the important characteristics that have already been identified in peer-reviewed or grey literature. In addition, some reports lacked critical review of the methodology existing literature e.g. assessing if sample size was represented, if gender desegregation was conducted, which would have added nuance to what were identified as the gaps in knowledge. Regarding the gender and demand SoK modules, greater nuance in information and analysis would be helpful in providing better quality and depth of information for some of the SoKs, this would require more time and support in research and report development.

Activity 3: stratifying Activity 3 data analysis to prioritize WP2 relevant outputs was necessary but carries with it a risk of the remaining Activity 3 data being left by the wayside. It will be a challenge to motivate teams to complete full analysis of Activity 3 data after the partial analysis. Other challenges with Activity 3 data are variability in the depth of demand and gender-related data between the teams. Furthermore, as the individual interviews are focused on processors to obtain a critical mass of knowledgeable individuals to discuss product-specific characteristics, it has the de facto result of a sample including mainly women, and therefore characteristics cannot be disaggregated by gender – however, this was a trade-off acknowledged by the Coordination team.

4.1.9 Cross-WP Coordination & Collaboration

➢ *Fill-in the table below with a brief description or bullet-point lists of interactions with other WPs (successful ones & gaps) and propositions for risk mitigation.*

	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed from other WPs ? (NR = not relevant)***	***Risk mitigation : How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP2	• WP1 roadmap circulated just after kick-off meeting to inform all the WPs and management • Guidance document and Activity 3 data analysis circulated • Two calls with WP2 leadership to define type of data necessary from WP1 to inform WP2. • Planning WP1 Activity 3 analysis to deliver list of characteristics to WP2 as a priority	• Greater responsiveness to documents circulated	• Regular calls (quarterly) • Sharing research tools and plans • Phased data analysis to prioritize WP2 relevant data.
WP3	• Guidance document and Activity 3 data analysis circulated	None	• Not directly relevant to WP1
WP4	• Guidance document and Activity 3 data analysis circulated • Call with WP1 Coordinator on WP1 process	**None**	• Not directly relevant to WP1

	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed from other WPs ? (NR = not relevant)***	***Risk mitigation : How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP5	• Guidance document and Activity 3 data analysis circulated • Nextgen evaluation of mother-baby populations in the field were used as a model for WP5 population processing protocol	• Need greater coordination with WP5 to identify populations that will be evaluated and informing the protocols to do so • Greater links between Activity 4 and WP5 evaluation. Not clear how these protocols align	• Regular calls (quarterly) • Comparing work plans to harmonize activities
WP6	• Continual communication with the Project manager for Monitoring and Evaluation	**None**	• Regular calls (1-2 per month)

4.1.10 Collaboration with other projects:

- Extensive collaboration with NextGen project, through use of overlapping respondents and field sites for WP1 and WP5 activities. The NextGen mother trials have been maintained in Nigeria for WP1 Activity 5 in 2019.
- Ongoing discussions with Excellence in Breeding (EiB) Platform to harmonize RTBfoods and EiB definitions of “product profiles”.
- Participation of WP1 coordinators in CGIAR Gender Breeding Initiative (GBI) Workshops November 2018 to:
    - Broadly discuss product profiles and mainstreaming gender in breeding activities
    - Input into a prototype tool specifically on gender responsive product profiles, drawing on RTBfoods experience in WP1
    - Lora Forsythe presented on WP1 during workshop, which was very well received

4.1.11 Conclusion on Progress & Key Achievements

➢ *Synthesis on what worked well in Period 1 - Successful achievements – Strengths & Complementarities of WP1 teams in the different countries.*

Good Practice:

- Communications: at least two face to face meetings per year, and at least monthly calls within the work package
- Research coordination: provision of clear and concise instructions for data collection, analysis and reporting.
- Training: teams responsive and highly motivate to contribute to the improvement and refinement of the approach

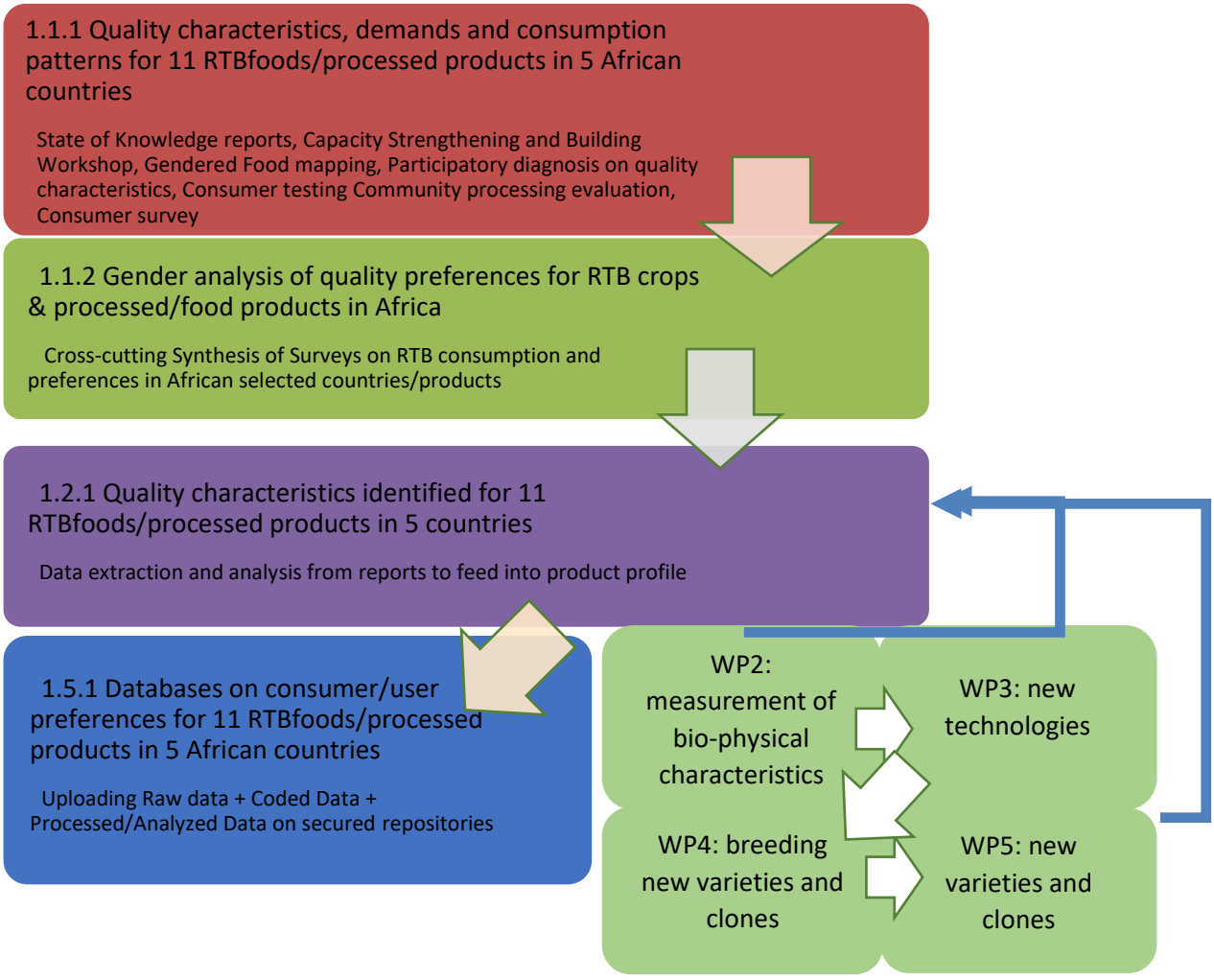
- Transparent, collaborative and participatory method development, allowing for flexibility and adaptation to country contexts
- Institutional collaboration between partners in the same country (e.g. Uganda, Nigeria, Benin)
- Independent initiative of partners in French translation and resource sharing between Francophone countries
- Significant commitment of teams to the project (e.g. obtaining complimentary funding and resources to execute activities)

Challenges:

- Adherence to deadlines and follow through on some activities
- Variable team composition and available expertise
- Competing priorities vying for research teams' time
- Funding limitations for WP1 activities in some countries

➢ *Please, Modify / Annotate the WP1 flow chart hereunder (from project narrative).*

➢ *Indicate the Steps achieved or being completed in Period 1.*



4.1.12 Perspectives for Period 2:

Data analysis, Surveys on other Food products, Interactions with WP2 (results sharing for product profiles), Publications, etc.

For period 2, the following activities are planned:

Activity 3 - Gendered Food Mapping, data analysis:

- Virtual support to partners from the WP1 Coordination team and collaborators
- Extraction of Activity 3 relevant data for WP2
- Full reporting Activity 3 data
- Preparation and presentation of initial findings on 1-2 selected products at the Second Annual RTBfoods Meeting
- Capacity strengthening for Gendered Food Mapping, Activity 3, data analysis at the Second Annual RTBfoods Meeting

Activity 4- Participatory processing diagnosis and quality characteristics:

- Planning and commencement of participatory demonstrations, Activity 4, while integrating the needs and constraints necessary for the implementation of the Activity 5.
- The various partners who have been able to follow during the first period the training on sensory analysis and the acceptability of products (Activity 5) will have to pay particular attention to the implementation of Activity 4 so that it reaches all of its objectives.
- In the same way and from the planning of the implementation of the experiments of the Activity 4, a coordination with the WP2 must be assured in order to collect the useful information to the development of the methods of characterization of the products.

Activity 5 - Consumer testing in rural and urban user segments:

- Planning and commencement of Consumer testing, Activity 5, most often just after implementation of Activity 4 and processing of the 4-5 products from very different varieties in quality characteristics. If the products are dry (such as gari), the implementation of Activity 5 consumer testing may be delayed and the products stored.
- A list of quality characteristics collected during Activity 3 & 4 will be required to prepare the questionnaire (JAR & CATA tests).
- A well knowledge on consumption habits and the most frequent consumption pattern will be necessary to be able to plan this Activity 5.
- Locations with different ethnicity, education or occupation will be selected before conducting this Activity 5.

4.2 Annex 2: WP2 Extensive Activity Report

Activities Conducted, Key Research Findings & Perspectives

Main Author(s): MUZHINGI, Tawanda, CIP, Kenya

Contributor(s):

- MESTRES, Christian, CIRAD, France
- TRAN, Thierry, CIAT/CIRAD, France

This synthesis refers to the following teams

	Partner Institution(s)	***Country***	***RTB crop(s) of interest for RTBfoods***	***Processed/Food Product(s) of interest for RTBfoods***	***Names of people involved in the team for this WP***
Team 1	FSA-UAC- / CIRAD / INRA	Benin	Yam, Cassava	Boiled yam, Boiled cassava	Noel Akissoé, Laurent Adinsi, Christian Mestres Agnès Rolland-Sabaté
Team 2	ENSAI / IITA / (CIRAD / CIAT)	Cameroon	Cassava	Gari	Robert Ndjouenkeu Apollin Fotso, (Didier Mbeguié Thierry Tran)
Team 3	CARBAP / INRA / CIRAD	Cameroon	Plantain	Boiled plantain	Gérard Ngoh Agnès Rolland-Sabaté Christophe Bugaud
Team 4	CNRA / INRA / CIRAD (CIAT)	Côte d'Ivoire	Cassava	Attiéké, Pounded Yam	Catherine Ebah, Sylvie N'Nan Diby Lucienne Desfontaines Gemma Arnau (Thierry Tran)
Team 5	NaCRRI	Uganda	Cassava	Boiled cassava	Robert Kawuki, Ephraim Nuwamanya, Enock Wembabazi, Ann-Ritah Nanyonjo, William Esuma
Team 6	Bioversity/ NARL / CIRAD	Uganda	Banana	matooke	Kephas Nowakunda, Didier Mbeguié
Team 7	CIP, CNRA JHI	Uganda, Côte d'Ivoire	Sweet potato	Boiled sweetpotato, fried sweetpotato	Tawanda Muzhingi Catherine Ebah Mark Taylor
Team 8	NRCRI	Nigeria	Cassava, yam	Eba, boiled yam, fufu	Ugo Chijioke
Team 9	IITA-Nigeria	Nigeria	Cassava	Eba	Busie Maziya-Dixon, Michael Adesokan, Wasiu Awoyale, Adebowale Osunbade
Team 10	Bowen University / INRA / CIRAD	Nigeria	Pounded Yam	Pounded Yam	Bolanle Otegbayo Lucienne Desfontaines Gemma Arnau
Team 11	CIP	Uganda	potato	Boiled potato	Tawanda Muzhingi Gabriela Burgos
Team 12	CIAT	Colombia	Cassava	Boiled cassava	Thierry Tran, John Belalcazar, Larry Moreno, Maria Alejandra Ospina, Andrés Escobar, William Trivino

4.2.1 Abstract

of the full document summarizing each section *(NB: This section will be copied & pasted in the Annual Report delivered to BMGF). (2 pages)*

The main objective of WP2 is to translate the user traits already known and those captured in the food Product Profiles from WP1 into laboratory based quantitative assessments of biophysical and functional properties that can be used as reference values for developing high-throughput product profiling (HTPP) in WP3. Root, Tubers and Banana (RTB) crops are nutritious but their sensory properties and the drivers of sensorial preference/desirability which affects their adoption are not clearly established. Therefore, the development of a sensory lexicon for RTB crops will assist with characterization of their sensory properties and assist in the understanding of key consumer liking attributes. These consumer insights will help breeders in understanding the impact of color, flavor and texture of RTB-based products on consumers preference and acceptance. The textural and food quality of the RTB end-products depends on the initial characteristics of raw material and on processing techniques. This multi-dimensional aspect requires assessing the relationship of raw RTB crops and processed/cooked products for their dry matter content, starch and fiber content, pectins and cell wall components, post-harvest deterioration among others. Existing information was used as a starting point for research conducted within this work package in year one while waiting for feedback from WP1.

Texture issues are not adequately addressed in RTB crops (Banana, Cassava, Potato, Sweetpotato and Yam) in Africa. It is important to note that texture measurement must be performed on freshly cooked product in parallel to sensory analyses and/or results of WP1; the same products (same cultivar and same processing/preparation conditions) must be analyzed by instrumental (texture measurement) and by human in order to clearly identify the correlations between sensory and instrumental characterizations, and establish instrumental methods that accurately reflect the human perceptions of the products. It was acknowledged that users traits can be grouped in different categories: Traits relating to raw products, traits relating to cooked/processed products, and also traits relating to handling RTB crops after harvest: shelf-life & deterioration, logistical issues, storage conditions, size and shape of RTB for optimum packing and processing (e.g. peeling), etc. Agronomic traits are also of importance, albeit less in focus for WP2 activities. An initial list of priority traits to characterize was generated: Dry matter (DM), removal of fibers, cell wall structures and composition, starch content, cooking ability, fermentation ability, cyanogens (in the case of cassava). Texture is potentially determined by a combination of several factors including cell walls, starch content, starch granules structure, amylose content (due to its retrogradation properties). Categories of traits will be classified and developed by agronomic, sensorial and processing ability. Aside from texture, taste is a major driver for adoption for RTB crops and product. Health and Nutrition traits are important but are not the major focus of our activities within RTBfoods. From a logistical point of view for WP2 activities, reliable protocols need to be developed and shared among partners for sampling and transport & handling of samples for analysis of raw and cooked products. This inventory of protocols, methodologies and capacities by partners were successfully conducted.

Texture is a key criterion for the sensory quality of boiled cassava, including traits such as hardness (or softness after cooking), cooking time, mealiness, friability, etc. Varieties that do not cook well remain hard even after a prolonged period of cooking therefore affecting the acceptability of the product. Peeled cassava roots can be fried either as large chunks or as medium-size or as smaller-size slices such as fried chips. Studies showed that crispness and friability were quality criteria for fried cassava. In addition, studies report that crisp quality was depending on oil content, color and texture for the same dehydration level. The aspect and color analysis of potato chips is used to evaluate for various color and textural features to characterize and classify the appearance and to model the quality preferences of a group of consumers. Features derived from the image texture analysis contain better information than color features to discriminate both the quality categories of

chips and consumers' preferences. The sweetness and texture of boiled sweetpotato are a factor regarding their eating quality and is linked to their starch content and beta-amylase activity. Although cooked potato tuber texture is an important trait that influences consumer preference, a detailed understanding of tuber textural properties has identified tuber pectin methyl esterase activity (PME) as a potential factor impacting on textural properties in potato but not in sweetpotato, cassava, yam and banana. Another point that appears important to understand the texture of a product is its structure; the residual cellular structure of pounded yam has thus been tentatively related to its texture. Frying imparts desirable taste and textural properties to RTB crop product. Frying is reviewed as a structuring process, and methodologies to determine texture in fried potato products need better understanding in RTB crop products. Moisture uptake during post-frying is critical in the loss of crispness (limpness) of fries and in softening of potato chips. Fermented products (gari, Attiéké) also require characterization of specific traits such as softening during fermentation, processing ability, sour taste, etc.

During the RTBfoods Kickoff meeting (Buea, January 2018), side meetings were held with all members of WP2 to define in more detail the who, what, where, when and how of WP2. Also discussed were the proposed interactions between partners working in WP2 and how information and feedback from other Work Packages (WP) will be received and integrated into WP2 work-plans. It was noted that interactions with WP1, WP3 and WP4 were crucial for WP2 activities. The WP leaders also highlighted communication, reporting and information sharing as important as activities are linked up and are interdependent. For example, WP4 will provide WP2 with the plant materials for sensory panels, biochemical and biophysical analyses. Also a joint training WP2 and WP4 for sensory panels is important and was successfully conducted in Uganda (September 2018). WP1 started working on state of knowledge reviews and field activities and their results also feed into WP2 year 2 activities. WP3 members participated in WP2 coordination meeting in order to start working on HTPP techniques; initial WP2-WP3 research on the feasibility of predicting by NIRS the cooking time and/or texture of boiled cassava was conducted in the second half of 2018. The breeders in WP4 agreed shared their planting calendar with WP2 for planning of WP2 activities.

Approach

- Identified low hanging fruits in work-plan development and execution
- Identified capacities by product profiles, opportunities for capacity building and collaborations
- Assigned responsibilities for leadership and support within the WP2 (clusters based on crop product profiles and geographic locations).
- Community of Practice for knowledge sharing: Standard operating procedures (SOPs), sharing reference samples between partners to calibrate analytical methods across different laboratories.
- Identified common linkages with WP1, 3 and 4
- Established communication protocols with other WP leaders, Product Champions, Advisory Committee members and project PI
- Identified source of genetic material for WP2 activities and coordinate with WP3 and WP4

4.2.2 WP2 Results Tracker: Activities & Milestones achieved

Output 1.3.1: *High quality SOPs to characterize and understand key users' preferred quality traits developed*

Activities conducted for Output 1.3.1.	***Deliverables***
1- Inventory of partner laboratories' facilities, competences, biophysical methods used for characterization of RTB products and capacity building needs	*E.1.1- Synthesis on partner laboratories' facilities, competences, biophysical methods used for characterization of RTB products and capacity building needs*

Indicators for Output 1.3.1	***Target / Milestone***		
	Planned for Period 1	***Achieved***	***Variance & Brief Explanation***
Nb of SOPs developed for RTB crops and products	Inventory of existing methods & protocols	*80% achieved to be completed in Period 2 before standardization of protocols*	*See discrepancies and gaps below*

- *Based on Del. E.1.1, Discrepancies & Gaps identified among partners and Strategy for Risk mitigation in SoPs development and harmonization:*
  - Some of the physico-chemical analyses (dry matter, starch, amylose, sugars etc) have already being used for years by partners with diverse procedures and the obtained results used for NIRS calibration: harmonization of procedures would mean re-calibration and/or measuring the gaps between procedures, and re-calibration of NIRS,
  - Some investments (texture analyzer for example) have not been already acquired that will delay the application of SOP using these investments,
  - Some procedures have to be developed (cell wall and pectin determinations, for example) before dissemination,
  - Partners are largely involved in WP1 and cannot perform WP2 in same time,
  - Results from WP1 (processing habits and consumer demands) and from sensory analysis results (WP2) are necessary for choosing the appropriate biophysical procedures related to quality

Output 1.3.2 : *Standardized ontology established for major quality traits for 11 RTBfoods/processed products with objective goal defined for each attribute*

Activities conducted for Output 1.3.2	***Deliverables***
3- Desk literature review	*F.1- State of knowledge on traits of fresh crops and processed products:* *F.1.1- Boiled & Pounded Cassava* *F.1.2- Gari /Eba* *F.1.3- Attiéké* *F.1.4- Fufu* *F.1.5- Boiled Plantain*

Activities conducted for Output 1.3.2	Deliverables
	F.1.6- matooke *F.1.7- Boiled & Fried Sweetpotato* *F.1.8- Boiled Yam* *F.1.9- Pounded Yam* *F.1.10- Boiled & Fried Potato*
4A- Training Workshops on Sensory Panels (with experts on the subject) 4B- Validation of a Standardized ontology for uniform sensory testing on 11 products and 5 countries	*F.2.1- Training of trainers for conducting sensory testing (training report)* *F.2.2- Standardized methods for conducting sensory testing (and generate lexicon) (in English)* *F.2.2bis- Standardized methods for conducting sensory testing (and generate lexicon) (in French)* *F.2.3 - Sensory Analysis Presentation (in English)* *F.2.3bis- Sensory Analysis Presentation (in French)*

Indicators for Output 1.3.2	Target / Milestone		
	Planned for Period 1	Achieved	Variance & Brief Explanation
Nb of quality traits for RTB food/processed products (i.e. functional traits) defined with lexicon and objective attribute goals	State of knowledge	*The State of knowledge (SoK) reports have established inventories of sensory quality traits for the various RTB products of the project.*	*The sensory quality traits inventoried in the SoKs need to be consolidated into one synthetic document. Additional inputs from WP1 are expected in Period 2 to complete the inventory.*

- *Key findings from the SoKs (Del. F.1.1 to F.1.10): gaps identified and lessons learnt disaggregated by food product for the 11 food products (NB: Please, refer & cite the deliverables produced using the codes mentioned in the table above - Please, treat each food product separately -even if the SoKs have been done simultaneously ; Keep the food product as an entry point).*

- *Boiled & Pounded Cassava (Del. F.1.1):*

Cassava cyanogenic potential and mealiness of boiled root are two of the most important traits that influence the consumption of boiled cassava. Mealiness is related to the feel in the mouth of boiled cassava (and other RTB crops), and is associated with friability (disintegration in the mouth or under pressure from e.g. a spoon or fork). No clear definition of mealiness was found in the literature, hence during training of sensory panels, members need to agree on a common definition and protocol to assess mealiness during tasting of samples.

Gaps include further work on the effect of boiling on the texture and sensory characteristics of the end product, including the molecular mechanisms involved in the texture changes during boiling. This is important for the release of cassava varieties that meet the acceptance criteria of consumers, to improve the adoption rates of some of the varieties being developed by breeding programs. Traits related to processing ability also need further studies to match improved varieties with the constraints of local processing techniques.

- *Granulated Cassava (Gari /Eba & Attiéké) (Del. F.1.2 & F.1.3):*

Extensive literature exist on the composition of raw cassava roots, methods of preservation, composition of gari with or without nutritional fortification, and sensory evaluation of roasted gari and gari reconstituted into eba.

Information on the effect of traditional processing on the quality of Attiéké is also available, in particular composition and optimum quantity starter inoculum, optimum fermentation time, effect of water content on the granulation of Attiéké.

On the other hand information is lacking on the relationship between the characteristics of the raw roots (genotype, composition) and the quality of the end product (instrumental and sensory quality).

Gaps were also identified in the effect of mechanization of the quality of gari and Attiéké, compared to the traditional process, in terms of physicochemical and functional properties, sensory properties and consumer acceptability. Similarly, little data is available on the effect of pre-harvest treatments to extend shelf-life (e.g. pruning and ratooning) on the quality of gari, Eba and Attiéké.

Sensory and instrumental characterizations of the quality of Eba were also underrepresented in the literature.

- *Fufu (Del. F.1.4):*

This SoK is still under writing process.

- *Boiled Plantain (Del. F.1.5):*

The physicochemical and nutritional composition of bananas and plantains has been characterized in many studies.

Boiled plantain has not been really investigated in terms of product characterization and relationship with sensory evaluation.

Within the framework of RTBfoods, it will be important to focus on boiled plantain characterization in relation to sensory analysis and consumer preference.

- *matooke (Del. F.1.6):*

Despite being a key livelihood source, the East African Highland cooking banana (matooke bananas) are not well studied, especially the fruit characteristics and composition. There are isolated studies on proximate composition, color, texture and behavior of starch under different processing conditions. However, most of the analyses were done using different methodologies, making the results difficult to compare. Some components such as tannins were analysed indirectly by recording their absorbance values while other studies quantified the tannins in metric units. Moreover, there are no studies that have linked compositional attributes to sensory attributes. As a result, the chemical components that underpin the unique taste, appearance and textural attributes that endear the crop to its consumers remain unknown.

Textural studies were done using either puncture tests or texture analyzers and were not related with sensorial analyzes.

- *Boiled Yam (Del. F.1.8):*

Proximate composition and microstructure of fresh yam is quite well documented using referenced analytical methods. The species/cultivar, tuber part (proximal, middle, distal), growing environment, post-harvest storage duration greatly affects the composition of fresh yam. In short, yam is nutritional RTB crop although various antinutrient factors (such as tannins, phytates alkaloids etc) were reported with different effects on nutritional and organoleptic properties.

The changes in the composition during and after cooking are partially established but much information is still lacking since in most of the available literature the composition of fresh yam and boiled yam were evaluated separately without establishing the link between them.

The structure of fresh yam and its evolution during and after cooking reported in the literature already give some insights about the role of the structure of yam on its quality, but the relationship with cell wall composition still remains to be detailed.

Water absorption and pasting characteristics of fresh yam were used as indicator of cooking yam quality. A good relationship was established between the instrumental measurement (composition

and texture) and sensory perception (sweet/sugared, easy to swallow, adhesiveness, wetness and hardness) of boiled yam, but some key sensory attributes (mealiness and colour) still remains to be related with instrumental parameters.

- *Pounded Yam (Del. F.1.9):*

Chemical composition of yam has been reported by many authors. In terms of the morphological characteristics of yam starch, from the reports only the granule size can influence the physicochemical and functional properties of the starch which can subsequently affect the textural quality of the final product.

The cell integrity of the yam before and after cooking and pounding can be an indicator of textural quality of pounded yam but it is not a rapid or high throughput method.

It has been established that dry matter, starch and amylose contents plays a great role in the final texture of yam food products.

Non- starchy carbohydrates may also influence the textural quality of pounded yam, pectin was reported to influence smoothness in pounded yam. The role of non-starchy carbohydrates and their effect on food quality of pounded yam needs to be further investigated

Various instrumental methods have been used to evaluate textural quality of pounded yam as reported by different authors. But we may need to find out which method correlates with the textural quality that the consumers preferred.

- *Boiled Sweetpotato (Del. F.1.7) & Fried Sweetpotato (Del. F.1.7):*

Sweet potato is an important root crop consumed in much of Sub Saharan Africa (SSA) for nutrition and food security.

The sweetpotato starch is made up of 20 – 30% amylose to 70 – 80% amylopectin, although up to 38% amylose, the amylose content and amylopectin molecular structure (branch chain length and pattern) predominantly contributes to the structural and functional properties of both potato and sweetpotato starch.

The amylose content has also been reported to vary depending on the flesh color, with orange fleshed varieties exhibiting higher values than purple and pale fleshed varieties

The common processing methods are boiling, steaming, frying, roasting and baking, each cooking method leads to different changes in the quality attributes of sweetpotato.

Orange fleshed sweetpotato varieties have been widely promoted in SSA are not preferred in some because of the moistness/softness or tendency to become soggy after boiling.

Sensory evaluations of sweetpotato in East Africa suggest that profiles for traditional cream-fleshed and new OFSP cultivars differ substantially over the sensory spectrum, consequently, eating quality, predominantly flavor and texture, must be taken into account, alongside nutritional quality for the development of successful cultivars.

Texture is an important sensory attribute that determines consumer acceptance. Structural changes in sweetpotato processing are mostly due to changes in starch, since it is the major dry matter component. Varieties with high DM content are known to develop a firm and mealy texture after cooking, although those with low DM content have a soggy texture after cooking

Microscopy studies conducted immediately after boiling and cooling sweetpotato roots revealed that in parenchyma cells, all starch granules lost their shape, regardless of the cooking method.

The degree of pectin methylation and the activity of pectin methyl esterase can thus be used for prediction of cooked texture of sweetpotato. Structural modifications of the cell wall depend greatly on the method of cooking.

- *Boiled & Fried Potato (Del. F.1.10):*

Dry matter content is genetically controlled and great variation exists between cultivars. Some varieties consistently produce high dry matter while others produce low values, however, there is no absolute for any cultivar, as it can be modified by cultural practices and environmental factors.

The precise composition of cell walls varies amongst cultivars and with different developmental

stages. The structure and composition, particularly of the pectic substances greatly influences the texture of cooked potatoes.

The amylopectin accounts for the crystallinity of potato starches (described as 'B' type X ray pattern) while amylose represents the amorphous component.

The organoleptic drivers; appearance, texture and flavor, are increasingly recognized as important drivers of consumer purchase, and can these can be evaluated by a sensory panel, or through instrumental means.

Whilst these studies indicate that convenience is important, all cite taste and or texture as being factors in consumer choice. Further consumer research may add to an understanding of different potato markets and how much traits such as flavor and texture influence purchasing decisions.

Upon processing, there are several changes in the structure and chemical composition of potatoes. In boiled potatoes, softening is the most evident structural change and is mainly due to changes in the cell wall and starch composition.

Frying induces changes in starch and cells similar to those observed in boiling of potatoes.

The microstructure and composition of raw potato tubers play an important role in determining the sensory attributes of the processed potato.

Dry matter and starch have been reported to be the major contributors to textural properties in cooked potato, however, other research findings suggest the composition, structure and modification of cell wall pectins during cooking also have an important role.

Some studies indicate very little correlation between starch content and textural properties.

There is need to study the local cultivars and genotypes within breeding programs in SSA, in a bid to understand the quality determinants. There is also need to develop instrumental techniques to measure quality attributes and ultimately, improve breeding progress towards improved quality and consumer preferred characteristics.

4.2.3 Sensory Panel Training in Uganda

- *Provide a Summary of the training organized in Uganda (Del. F.2.1 to F.2.3bis): Dates, Trainers Curricula, Training Objectives, Nb of participants, Institutes, any other useful information (NB : you can provide the abstract of the training reports or a summary table)*

Sensory panels

After identification and mapping of crop products by partners in WP2, the next activity was to go deeper and understand the nature of work required. One of the key activities in WP2 are training sensory panels (descriptive analysis panel). It was recommended that trained sensory panels be set up clusters around W4 platforms. It was acknowledged that not every partner needs to have a sensory panel for a particular product profile they are working. In order to maximize limited funding resources and encourage institutional and inter-discipline collaboration it agreed that a sensory panel will be set-up in Uganda to focus on banana, cassava, potato, sweetpotato and associated product profiles. It was noted that CIRAD will coordinate the establishment and training of sensory panels in west African francophone countries (Cameroon, Côte d'Ivoire and Benin) on plantain (banana), cassava, yam, sweetpotato and their associated product profiles. IITA was designated to lead the sensory panel establishment and training for Nigeria on cassava and yam and their associated product profiles.

Sensory testing provides discrimination, descriptive and affective tests which are recognized as analytical tests to detect product differences or characteristics as opposed to affective analysis or hedonic test that explore consumer likings of the products. A sensory panel is made up of a group of people of testers who can describe products on the basis of taste, smell and texture. Sensory panels are trained to have skills and abilities to describe their sensory attributes with standardized words. These words are more detailed than those used by consumers, and more useful for R&D departments. In WP2 statistically linking data from a sensory panel and affective analysis data from WP1 will be a very powerful development which will assist in mapping expert descriptions and consumer liking to determine the key elements that actually drive RTB preference can be optimized

to meet end user needs.

The output of the sensory panels is the development of sensory lexicon of RTB products. The lexicon will contain information on the attributes such as flavor, aroma, and texture attributes present in RTB crop product profiles and providing references for measuring their intensity. The next step is to link information from the sensory lexicon to particular biochemical and biophysical parameters of RTBfoods crop profiles. WP2 members brainstormed and identified key components that affect texture, taste, aroma, storability and processing ability of respective RTB crops. A group exercise by WP2 members identified key traits for the RTB crops such as texture, aroma, appearance, taste and defined their respective components, the key driver and analytical tools available to study them.

RTBfoods Sensory Panel Training – Sensory Profiles Workshop 17th-21st September 2018, Kabira country Club and NARL Food Science and Post-Harvest Laboratories, Kawanda, Uganda.

The aim of this training to equip scientists in RTBfoods foods especially those in WP2 with an understanding of the principles of good sensory practice, the importance of being objective, selection and training of test panelists, sensory methodologies and practical application of the sensory techniques to RTBfoods product profiles. This training workshop is relevant to those new to sensory science who will learn how to describe and measure the sensory attributes of products. The serves to provide both beginners and experienced food scientist with an understanding and practical and rigorous application of sensory methods to our RTBfoods breeding for end user preference objectives.

The workshop was divided into 4 sections.

- Section 1: An introduction to how we perceive foods through the five human senses and an exploration of key physiological and psychological factors involved in perception.
- Section 2: An introduction to the methodology in sensory science and their application. An introduction to the taste panel, including recruitment and training of assessors and practical considerations for sensory testing including the importance of best practice and design of facilities.
    - Test methods – Discrimination, Descriptive and Acceptance: what methods exist and when and what can I use them for?
    - Sensory Panel: who should be assessing your products
    - Controlling sensory investigations – the room, the samples and the panel
- Section 3: Practical applications. Test some of our own RTB product profiles
- Section 4: Theoretical and practical data processing of sensory panel results (using XL-stat software)

➢ *Beyond training objectives, what did the training « bring in » for the WP2 framework? Lessons learnt? (e.g. knowledge, experience share, whatever being all together brought to the team)*

- The sensory evaluation workshop achieved one important task for the WP, it was team building exercise. It was the first opportunity to have almost all WP members represented and meeting in person for the first time.
- The sensory evaluation workshop also brought together different members of RTBfoods WPs, it was a great collaborative and joint learning for social scientists in WP1, food scientists in WP2 and breeders in WP3, 4 and 5.
- The sensory evaluation workshop was also an opportunity for not only inter-disciplinary learning but also for cross crop, cross country and cross culturally learning experience. For example, participants working on cassava from Benin, got to learn about cassava and sweetpotato consumption and trait preferences in Uganda. Scientist working on plantains in west Africa also got to learn about Uganda East Highland Bananas (matooke).
- It is important for WP2 teams and RTBfoods members to fully appreciate the power of diversity, at the training, there was great learning and team work from anglophone and francophones. Also, the NCSU team training complimented very well the CIRAD team's expertise. This diversity was well appreciated by the participants.

- There was a big revelation that sensory evaluation is misunderstand. Many people are exposed to hedonic or acceptance studies for sensory evaluation which are based on subjective rankings of liking or not liking a product (food). At this training the focus was on sensory panels to gather objective analysis.
- The sensory evaluation workshop re-enforced our strategy for WP2 which was based on establishing three sensory panel clusters 1) the Uganda lead east African cluster focusing on potato, sweetpotato and matooke, 2) the Nigerian lead cluster focusing on cassava and yam and 3) Benin lead cluster focusing on plantains and cassava. In east African, CIP and NARO centers will lead the data collection, in Nigeria IITA and CIAT will lead the coordination and in CIRAD and University of Benin will coordinate the data collection.

4.2.4 Methodology development

- *Methodology of sensory panels for profiling: What is the role / use of sensory panels within WP2 framework? Why are sensory panels essential for RTBfoods project?*

RTB crops are important commercially, economically and health wise to millions of people worldwide. They are some of the most versatile food crops, used worldwide for human and animal consumption, and as raw material for food processing. As learnt from potato in developed countries, one of the most important aspects of RTB crops production is quality, that includes traits such as proteins, carbohydrates, and minerals; sensorial traits (e.g. flavor, texture); and industrial traits (e.g. tuber shape and starch quality). Through genetic manipulation, therefore, breeding work can successfully to meet the needs of a changing and demanding world. Sensory evaluation can therefore be used successfully for screening breeding selections to provide more reliable data than the opinions of only one or two people. For example, descriptive statistics from sensory panel data can reveal background flavors and textures, as well as intensities that explain consumer choices. Combined analysis of consumer and descriptive data reveals key drivers of consumer liking and how to make a product that meets acceptance standards.

- *Function/Objective of the manual produced on Standardized Methods for conducting Sensory Testing (Del. F.2.2 & F.2.2bis)? (NB: you can provide here the abstract of the manual)*

The Sensory Panel Training was held at the Kabira Hotel Country Club and NARO in Uganda, from the 17th to the 21st of September 2018. The training was attended by forty-one (41) participants involved in Work Package 2 (WP2) the RTBfoods project and facilitated by trainers from CIRAD (Montpellier) and RTBfoods experts.

The training kicked off at the Country Club with opening remarks and a welcome note by Dr Tawanda Muzhingi (CIP, Kenya), followed by a video presentation by Dr. Chris Findlay (Compusense, Canada), where he discussed aspects of sensory science and how Compusense can help organizations to develop and maintain a sensory program. Participants were given a chance to introduce themselves. Cathy Méjean (CIRAD, France) introduced participants to the RTBfoods collaborative platform sensory analysis fundamental concepts and encouraged everyone to learn how to use it.

During the 5 day period, participants learnt the theoretical aspects of sensory analysis as well as hands on practicals at the National Agricultural Research Organization (NARO) laboratories. Each day, a recap of the previous day activities was given by Dr. Suzanne Johanningsmeier (USDA-ARS, USA). The general aim of the workshop was to introduce the participants to basic principles of sensory analysis, application in roots and tubers and how to analyze sensory panel data. The ultimate goal was to select future leaders who would be trained on how to set up a sensory panel in order to establish the sensory profiles of finished products within the RTBfoods project.

The workshop was divided into 3 sections;

- Sensory methodologies. Nelly Forestier-Chiron (CIRAD, France) covered this section in four parts; basic principles of sensory analysis, different tests available, panel management, identification of basic taste odour and texture using matooke.
- Practical application on boiled sweetpotato.
- Data processing of sensory panel results using XL-stat software, demonstrated by Dr.

Christophe Bugaud (CIRAD, France).

- On the third day, participants had an opportunity to visit the plant breeding site hosted by the International Institute of Tropical Agriculture (IITA), National Crops Resources Research Institute (NaCRRI) and National Agricultural Research Organization (NARO) in Namulonge, Uganda. They were taken through the banana, cassava and sweetpotato breeding trials and some key biochemical analyses that are carried out prior to sensory analysis.

On the 21st of September, Dr. Tawanda Muzhingi thanked workshop participants, trainers, and NARL hosts for participating in the RTBfoods Sensory Profiles Workshop. Dr. Wilberforce Tushemereirwe, Director of NARL, presented certificates to the participants and shared more information about the NARL organization and its role. He thanked everyone involved in the training and announced the conclusion of the RTBfoods Sensory Profiles Workshop.

- *Provide an inventory of partner laboratories which are already equipped to set up sensory panels.*
    1. Uganda NARO sensory laboratories at NARL Kawanda are the most advanced. Sensory panels laboratory evaluation laboratories also exist at Namulonge with NaCRRI.
    2. In Nigeria sensory laboratory exists at IITA and at Bowen University. Researchers at NCRRI Umudike also have capacity for sensory panels.
    3. In Benin and Cameroon CIRAD has over the years built the capacity for sensory panels, with University of Benin having the most advanced facility in the region.
    4. CIP in Kenya has established a taste kitchen and an ISO certified mobile sensory panel laboratory that can be used in the field within east Africa for both potato and sweetpotato.

4.2.5 Team coordination

- *Successful collaborations on some activities and/or for some food products among WP2 partners?*

- There was good collaborations between CIP and JHI scientists working on sweetpotato and potato texture. The CIP shared with JHI sweetpotato genotypes which were used for method development and in year 2, there will be joint activities in the laboratory.
- There was great collaborations among the WP2 teams in Uganda, the Uganda teams in NARO will coordinate their work jointly especially for sensory panels for banana, cassava and sweetpotato in Kawanda working with the breeders in CIP, NARO and IITA.
- CIRAD & INRA teams also coordinate work with members in Benin and Cameroon on yam, banana and cassava, particularly on texture instrumental assessment and on cell wall and polyphenol characterization.
- CIAT teams collaborated with CIRAD to correlate NIRS data with biophysical data on cooking time and texture of boiled cassava, in order to assess the feasibility of predicting cooking quality of cassava with NIRS. CIAT and FSA (Benin) also collaborated to build capacity at FSA on programming the texture analyzer (TAXT-Plus) to measure various samples, and analyzing the resulting texture data.

Challenges faced in coordination of WP2 teams & Strategies to be reinforced/developed by WP2 coordination team for Risk mitigation?

There were a few challenges observed in year one, to coordinate activities distributed between several partners around inventories, protocols development and training. However, the biggest challenges faced was getting people to meet for regular global calls of the WP2 scientists, because of differences in location and time. We propose an annual plan to enable people to plan ahead and set up time for these important planning meetings.

Success Story Box : *If relevant, WP Success Stories you want to make appear in the Annual Report: Narrative on WP framework, or set of activities that illustrate well the dynamism and the innovative framework of RTBfoods research project. List the teams involved (Institution+Country+RTB crop or food product concerned), the type of Activity and the Point(s) of Interest you want to put the lights on (300 words max per Success Story).*

GENOTYPIC DIVERSITY SHEDS LIGHT ON HOW TEXTURE DEVELOPS DURING CASSAVA BOILING

In 2018, 270 genotypes representative of the genotypic diversity of cassava in Latin America were harvested and characterized at CIAT. Texture analysis revealed two distinct stages in the development of texture during boiling:

Firstly hardness dropped quickly within the first 10 minutes, with an average decrease of 77% from the initial hardness (measured at total area under the texture curve). All genotypes, in spite of the diversity of origin and specific hardness, behaved in a remarkably similar way on this aspect, with a coefficient of variation of 7.6% for the loss of hardness, compared to a coefficient of variation of 27.4% for the hardness after 10 minutes boiling. This points to an underlying molecular mechanism nearly identical for all genotypes, most probably starch gelatinization.

Secondly, in spite of this major change in hardness, further boiling until "optimum cooking time" was necessary to achieve the mealy texture preferred by consumers. Whereas the initial drop in hardness was similar among all genotypes, optimum cooking time was highly diversified, ranging from 15 up to 60 minutes with a coefficient of variation of 40%. Some genotypes never actually reached the target mealy texture. These observations confirmed the distinct roles of starch (general drop in hardness) and of other components such as pectins and cell wall materials (CWM) in developing the final texture of boiled cassava. Given the higher variability in cooking time, the key determining factor of cooking ability and quality seems to be the CWM fraction (and its composition and changes during boiling), rather than the starch fraction.

Complementary medium infrared (MIRS) analyses on a sub-group of 30 genotypes tentatively showed a link with cooking time. In Period 2, we will expand these analyses to include the full set of genotypes and texture data, and investigate the potential of MIRS to predict cooking ability and quality.

These results are obtained from work conducted by Team 13 (CIAT) with support from CIRAD (Karima Meghar, Fabrice Davrieux).

4.2.6 Cross-WP Coordination & Collaboration

- *Fill-in the table below with a brief description or bullet-point lists of interactions with other WPs (successful ones & gaps) and propositions for risk mitigation*

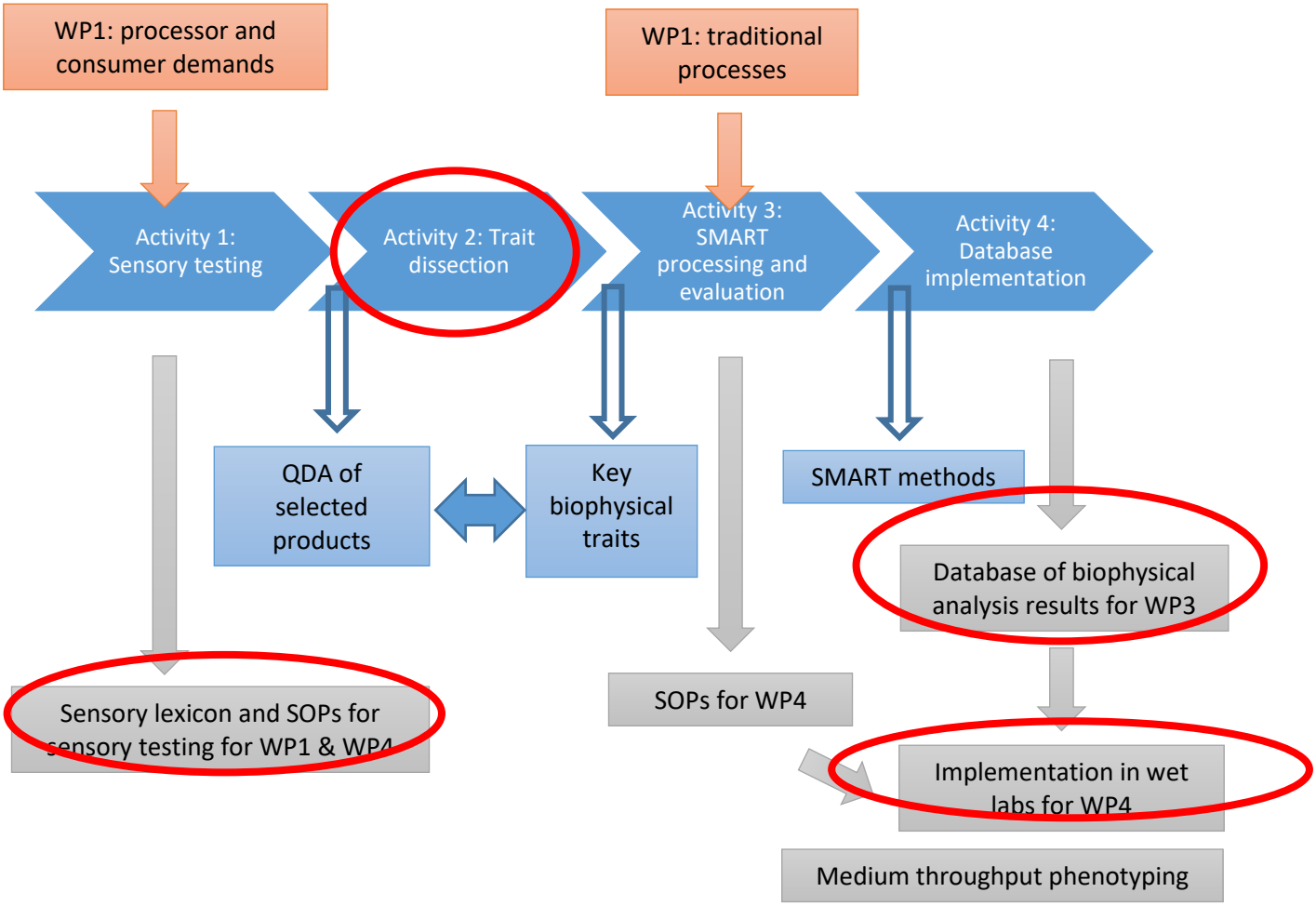
	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed form other WPs ? (NR = not relevant)***	***Risk mitigation: How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP1	WP1 and WP2 leaders met in Uganda in September and discussed the progress on field activities in Uganda and west Africa. We also discussed how information was going to be shared from WP1 activities into WP2 work plans in year two. A sub-committee was established with co-leaders of WP2 and WP1 and they met and agreed on the information sharing plan.	Planning of activities of WP1 should be shared to better plan WP2 activities…	Regular meetings with WP1…
WP3	WP2 and WP3 collaborated at CIAT and CIRAD for the NIRS and MIRS analysis of cell wall materials (CWM) extracts from 30 cassava genotypes representing a wide range of cooking times (15 to more than 60 minutes). The NIRS spectra of the corresponding flours (before CWM extraction) and fresh roots were also recorded. Search for correlations between NIRS/MIRS spectra and biophysical characterizations of the same genotypes is ongoing and will continue into Period 2.	The baseline of NIRS calibrations (availability with which wet lab reference procedure difficulties, figures of wet lab analyses etc) should be shared and discussed with WP2…	Common meeting(s) with WP3
WP4	WP2, WP3 and WP4 leaders had a joint visit in May to RTBfoods partners in Uganda. The team visited NARO cassava breeding program, CIP sweetpotato breeding program and IITA banana breeding program at Namulonge. At Kawanda the team visited NARL and Bioversity International breeding program and food science, post harvest and sensory laboratories. The team was satisfied with the research capacities at these institutions and recommended joint activities and sharing of facilities by all partners.	SoK on breeding for quality should be shared and discussed with WP2 to focus WP2 activities on breeders (WP4) and processor/consumer (WP1) demand…	Common meeting(s) with WP4
WP5	n/a in Period 1	• NR	• NR
WP6	Organization of regular WP2 coordination (WP2 leader & co-leaders & global (all WP2 partners) calls Logistical support to the organization of the Training in Uganda	• NR	• NR

4.2.7 Conclusion on Progress & Key Achievements

- *Synthesis on what worked well in Period 1 - Successful achievements – Strengths & Complementarities of WP2 teams in the different countries.*

In Period one we had successful interactions with the WP. We held monthly coordination meetings between the WP leader and co-leaders to make sure we plan our activities jointly and communicate effectively with partners. We also had quarterly meeting WP2 conference call with all members of the WP2 and also other stakeholders such as focal points from WP1, WP3 and WP4. Through these coordination efforts we successfully established management structures to guide our research. We established the cassava cluster lead by Thierry Tran, the Yam/plantain cluster lead by Christian and the potato/sweetpotato/matooke cluster lead by Tawanda. Through these cluster we organized and coordinated the write up and peer review of the SoKs. The preparations for the sensory evaluation training workshops and laboratory inventories were also management through the clusters. We also see in the Y2 more cluster focused implementation of sensory panels and joint activities within the WP. Going into year two we will make more efforts to work more with other WPs especially WP1 and WP3. We use data from WP2 to feed directly into our activities and also share focused activities with WP3 and WP4 in the WP. Also, we will focus more on capacity building especially on the quality control and assurance on lab-based activities on biochemical and biophysical characterization of selected traits. Our NARS partners may need more support to execute some of these activities in partnership with CGIAR centers, CIRAD and ARI in Europe and USA. These activities will be coordinated and communicated well at the annual meeting in Abuja in March, 2019.

- *Please, Modify / Re-design / Annotate the WP2 flow chart from project proposal narrative hereunder.*
- *Indicate (e.g. circle or underline) the steps achieved or started in Period 1.*



Note: Circled are activities conducted in parallel during Period 1. This does not mean that these activities are completed; they will continue during Period 2 and later for most of them. Also, the reader should not expect a linear progression between activities.

4.2.8 Perspectives for Period 2:

Following the training workshop on sensory analysis in September 2018 (Uganda), we expect several teams to set-up and train sensory panels in Period 2 and carry out initial sensory activities: Generation of descriptors of selected RTB crops and products, descriptive sensory analysis of RTB products made from a range of genotypes representative of the diversity of quality traits of said products.

The inventory of SOPs and laboratory protocols in Period 1 has shown several differences among partners. Consequently we will organize a workshop on Harmonization of laboratory protocols as a side meeting of the RTBfoods annual meeting in March 2019. Following this workshop, trainings on SOPs will be organized as necessary.

We will strengthen interactions with WP1 & WP3 as more results become available on users preference traits (from WP1) and more biophysical data are generated (by WP2) to investigate calibrations with NIRS and other HTPP methods with WP3.

We will also endeavour to communicate results through publications and presentations at international congresses, depending on opportunities.

4.3 Annex 3: WP3 Extensive Activity Report

Activities Conducted, Key Research Findings & Perspectives

Main Author(s):

- DAVRIEUX, Fabrice, CIRAD, France
- ALAMU, Emmanuel, IITA, Zambia
- ZUM FELDE, Thomas, CIP, Peru

Contributor(s):

- Thierry Tran, CIAT/CIRAD, Colombia
- NUWAMANYA, Ephraim, NaCRRI, Uganda
- IKEOGU, Ugochukwu, NRCRI, Nigeria
- UWIMANA, Brigitte, IITA, Uganda

This synthesis refers to the following teams

	Partner Institution(s)	***Country***	***RTB crop(s) of interest for RTBfoods***	***Names of people involved in the team for this WP***
Team 1	INRA/CIRAD	Guadeloupe	Yam	Cornet Denis, Desfontaines Lucienne, Arnau Gemma, Marie-Magdeleine-Cherry Carine
Team 2	CIAT	Colombia	Cassava	Tran Thierry, John Belalcazar
Team 3	CIP	Peru/Uganda/ Ghana/Mozambique	Sweet potato and potato	zum Felde Thomas, Tuffour Thomas, Burgos Gabriela, Porras Eduardo, Mendes Thiago, Swanckaert Julien
Team 4	NACRRI	Uganda	Cassava	Nuwamanya Ephraim, Kawuki Robert
Team 5	IITA	Nigeria	Cassava and yam	Alamu Emmanuel, Maziya-Dixon Bussie
Team 6	NRCRI	Nigeria	Cassava	Ugo Chijioke, Egesi Chiedozie
Team 6	NARL/IITA	Nigeria	Banana	Nowakunda Kephas, Uwimana Brigitte
Team 8	CIRAD	France	All	Davrieux Fabrice, Karima Meghar

4.3.1 Abstract

of the full document summarizing each section *(NB: This section will be copied & pasted in the Annual Report delivered to BMGF). (2 pages)*

The WP3 of RTBfoods project consists of eight teams from different institutes (INRA, CIAT, CIP, IITA, NACRRI, NARL, NRCRI and CIRAD) over seven countries (Uganda, Nigeria, Colombia, Peru, Guadeloupe, Ghana and France). The main activities conducted during this first project year were 1) inventory of high throughput (HTP) facilities of partner laboratories (equipment, human resources), 2) training workshops on NIRS routine analysis and 3) a state of knowledge on HTP methods applied to RTB crops.

Fourteen (14) NIR spectrometers were found for the eight teams. Except NARL in Uganda, each team owns a least one NIR spectrometer available for the project. Instruments come from two brands

(Foss[1] and ASD[2]), ten instruments are benchtop models covering the spectra range from 400 nm to 2500 nm (visible and NIR), two instruments are portable ones (ASD QualitySpec and LabSpec) and two devices are miniatures ones (SCIO[3] spectrometers).

For capacity strengthening of the teams, five training sessions were performed with the following main objective: To improve knowledge on principles of NIR spectroscopy, data management, data treatment, calibrations development and validation procedures; and needed laboratory conditions. The trainings took place in Uganda (2), Nigeria and Peru and 1 to 19 participants were involved in the training sessions depending on the place and purpose.

The SoK report highlights the potential of non-destructive techniques to qualify, sort and/or characterize nutritional quality of root, tuber or banana crops. A large part of the techniques refers to vibrational spectroscopy in the wavelength range from visible to mid infrared light. Other non-invasive techniques, such as nuclear magnetic resonance (NMR), Raman spectroscopy, imaging, ultrasound technology and X-ray, have shown their potential for successful applications in quality monitoring of fruits, vegetables, roots and tubers. Researches using non-destructive techniques have evaluated fresh and processed products qualities. Most of the time, quality control or process monitoring are reached through the quantification of biochemical compounds: carbohydrate composition including different starches and sugars, protein, vitamins, minerals, carotenoids, moisture, phenols, fat among others. Other part of the researches refers to physical properties such as specific gravity, skin color and texture and some researches focus on contaminant quantification such as acrylamide in processed products or concern different quality aspects and potential use: external or internal defects, greening, bruises, enzymatic browning, non-enzymatic browning, and physiological disorders. The products were analyzed in different conditions and presentations or forms (intact, peeled, sun-dried, freeze-dried, mashed, crushed, sliced, cooked, deep frying, chips, crisp, etc.). The quality characterization of RTB crops and products using HTP techniques is well documented, the challenges for RTBfoods project is translation of the quality traits of interest into measurable variables or indirect correlated variables in order to choose the right techniques and to develop a strategy for relevant calibrations to meet end-user preferred traits.

Different calibrations are already applied in routine analysis. The calibrations were developed in the frame work of different projects linked to RTBfoods project. For fresh cassava, two calibrations (dry matter (DM) and total carotenoids) are used, in Colombia at CIAT and in Nigeria at IITA and NRCRI and another one is ongoing in Uganda (NACRRI). For yam flour, a calibration (DM, starch, protein…) is developed by IITA in Nigeria and another one in Guadeloupe by INRA-CIRAD for quantification of DM, sugars, starch, amylose and protein. CIP has a calibration for sweetpotato flour (freeze dried and milled samples). The calibration aimed at quantifying protein, starch, glucose, fructose, sucrose, maltose, beta-carotene, iron and zinc contents. CIP did also a calibration for cooked dried ground sweetpotato. The calibration will be applied to quantify starch and individual sugars contents. Another calibration is in development at CIP for raw sweetpotato (Fresh, cut/blended roots). This calibration is applied to quantification of DM, total carotenoid and beta-carotene contents.

These calibrations were established from existing or ongoing databases of spectral data and metadata. Databases for fresh cassava are developed by CIAT, IITA and NRCRI. INRA develops a data base for yam flour while IITA develops a date base for both dried and fresh yam. CIP has been developing a database for freeze dried milled sweetpotato for many years. CIP recently started working on fresh material, fresh raw sweetpotato for dry matter and carotenoids in particular but this is still at the stage of feasibility study. The number of samples associated with chemistry data is indeed too small to be considered as a database at this stage. It can also be mentioned here that CIP has been developing calibrations for cooked dried ground sweetpotato in Ghana. However,

[1] https://www.fossanalytics.com
[2] https://portableas.com/analytical-spectral-devices-asd-nir/
[3] https://www.consumerphysics.com/

these calibrations need improvements and updates through an application to much more local samples from other countries than the current limited testing set from Ghana and Uganda. A database for dried milled potato is also available from CIP. NARL in collaboration with IITA and NACRRI started to develop a database for plantain, this collaboration is one of the success story of the first year for WP3.

The main challenge faced in coordination of WP3 was to overtake the diversity of the teams: Eight different teams of more than 5 countries. These teams are diverse in terms of background knowledge on HTP methods and especially NIRS, in terms of human resources ready to be mobilized in the project and in terms of capacities (different equipment or no equipment). This first challenge was for a part resolved by having inventory of capacities and facilities of all partner countries and institutions and visits of the three WP3 leaders to the teams. An effort has been done on capacity development by carried out series of trainings. However, this current support through visiting of the teams and training sessions should be reinforced and strengthened for the second year, especially during the measurement joint campaigns with WP2. The second challenge was to know exactly what was already done on HTP and RTB crops by the different teams. This was also addressed by compiling a complete description of the existing database and existing calibrations applied to RTB realized by each partner. This work will be a solid base to adapt protocols for relevant quality traits. The third challenge is inherent to the project and consisted in starting an analytical activity, with the implementation of sampling designs and measurement protocols, even though the criteria to be measured were not defined. The existing knowhow and the knowledge of the work done on RTB crops and HTP methods by the teams will help to define the strategy and the choice of the methods. But, to be efficient, this should be done as soon as the relevant quality traits are known in collaboration with WPs 1 and 2. To do the best, the WP3 leaders and team leaders will have a meeting in order to define the priorities and organize the work in year two.

This first year, the interaction with other WPs were limited and concern mainly WP2, for capacities and facilities inventory and for sharing protocols, work plans, tools and materials. The main gap in interaction with WP2 was probably that there were not enough meetings between team leaders due to time concerns and limited resources. Regarding WP4, we need for next year a common calendar of availability of plant materials. The interactions were regular with WP6 through face to face meeting or mails or Visio conferences.

In conclusion, the main objective of period 1 was successfully achieved through an exhaustive inventory of the facilities with a description of human resources and their background knowledge. This inventory was completed by five trainings adapted to needs of the teams. WP3 took advantage of the background knowledge of researchers to share experience and to boost team through these training sessions. Finally, this approach was completed by a description of the existing and ongoing development of calibrations and databases on RTB products. At the end of this first period, the joint analysis of the state of the art on HTP phenotyping tools applied to RTB products and the description of the teams is a decision aid for the choice of equipment and their sharing. Indeed, sharing an instrument between NaCRII and IITA and NARL, was decided for banana in Uganda. The decision regarding new instruments is postponed to second period annual meeting in March 2019 in Abuja in Nigeria. The reason is that we need more information about consumer's preferences related quality traits which influences the choice of new HTP technologies not yet available in the RTBfoods community.

The perspectives for period 2 are to go ahead with the training sessions with more intensive trainings for the development of calibrations, to continue to upgrade the existing and ongoing databases, to set up and implement measurements protocols as soon as the preference traits will be known for each product and to start calibration in close collaboration with WP2 for the relevant parameters.

During this second period we will have to choose, buy and start the needed complementary HTP techniques.

4.3.2 WP3 Results Tracker: Activities & Milestones achieved

Output 1.4.1: *Screening capacity for users' preferred quality traits developed in key countries*

Activities conducted	***Deliverables***
Capacity inventory of HTP facilities of partner laboratories (equipment, human resources)	G.1- Capacity inventory of HTPP (equipment, human resources): G.1.1- IITA Nigeria G.1.2- INRA/CIRAD Guadeloupe G.1.3- NaCRRI Uganda G.1.4- CIAT Colombia G.1.5- NRCRI Nigeria G.1.6- CIP Mozambique G.1.7- CIP Peru G.1.8- CIP Ghana G.1.9- CIP Uganda
Training workshops on NIRS routine analysis	G.2- Training reports: G.2.1- IITA Nigeria G.2.2- CIP Uganda G.2.3- CIP Peru G.2.4- NaCRRI, NARL & CIP Uganda

Output 1.4.1 Indicators	***Targets / Milestones***		
	Planned for Period 1	***Achieved***	***Variance & Brief Explanation***
Number of new HTP tools installed in key countries	3 (CIRAD + IITA + NACRRI)	0	During the kick off meeting in Buea/Cameroon, we decided to prioritize the sharing of the existing instruments when possible (What was done in Uganda and Nigeria). There was a plan for installation of HIS or multispectral camera. Decision was made to wait for returns of information from WP1 and WP2 about traits and the best way to quantify them in order to do the better choice. The new equipment will be installed in different laboratories (min 2) and need to be similar and relevant according to the traits/product and laboratory skills
Number of trainings to partner laboratories	5	5	NC

- *Provide an inventory of partner laboratories which are already equipped with HTP tools + type of instrument (NB: this can be done in a narrative per partner/institute or a summary table).*

Institutes	Country	Equipment 1	Equipment 2	Equipment 3
IITA	Nigeria	FOSS XDS		
NRCRRI	Nigeria	ASD QualitySpec		
NACRRI	Uganda	FOSS DS2500	Consumer Physics SCIO sensor	Consumer Physics SCIO sensor
CIAT	Colombia	FOSS 6500	FOSS DS2500	ASD Labspec
CIP	Peru	FOSS XDS	FOSS 6500	
	Mozambique	FOSS XDS		
	Ghana	FOSS XDS		
	Uganda	FOSS XDS		
INRA/CIRAD	Guadeloupe	FOSS 6500		

- *Provide a Summary for each of the 5 trainings (Del. G.2.1 to G.2.4) including: Dates, Trainers Curricula, Training Objectives, No. of participants, Institutes, any other useful information (NB: you can provide the abstract of the training reports or a summary table).*

Location	***Institutes***	***Date***	***Trainer***	***# Participants***	***Objectives***
Uganda	NACRRI	23-28 May 2018	F. Davrieux / CIRAD	19	• Principle and theory of NIR spectroscopy • Initiation to multivariate analysis • Calibration development • Spectral acquisition and measurement protocols
Nigeria	IITA	12-14 June 2018	Ugochukwu Ikeogu / Cornell University	8	• Principle and theory of NIRS • Configuration and Data collection using a portable NIRS • Management and processing of NIRS data.
Uganda	CIP / NARO	11-12 October 2018	Thomas zum Felde / CIP	1	•Principles of NIRS •Needed lab conditions •Data management •Application of NIRS analysis to evaluate macro- and micronutrient concentration, routine analysis of freeze dried sweetpotato samples
Peru	CIP	11-13 June 2018	Thomas zum Felde and	4	• Refreshing on field sampling and sample preparation of potato,

Location	Institutes	Date	Trainer	# Participants	Objectives
			Eduardo Porras / CIP		sweetpotato for HTPP • NIRS basics, calibration development, validation procedures and applications • Hands on!
Nigeria	NRCRI	4 -8 June 2018	Ugochukwu Ikeogu/ Cornell University	9	• Principle and theory of NIRS • Configuration and data collection using a portable NIRS • Management and processing of NIRS data.

- *Beyond training objectives, what did the training « bring in » for the WP3 framework? Lessons learnt? (e.g. knowledge, experience share, whatever being all together brought to the team)*

Trainings were different in terms of objectives and participants skills, mainly depending of the background in NIRS technology of the institutes. However, the common outcomes of these training were:

- Strengthening of the laboratory capacities
- A clear evaluation of the state of knowledge and knowhow of the already existing NIRS teams
- A review of the protocols, when existing, for routine analysis
- A definition of sampling and measurement protocols (eg. Fresh material)
- Adaptation and configuration of instruments (eg. Portable instrument, brand new spectrometer)
- A cohesion of the different research teams (chemists, geneticists, agronomists…) with a clarification of the different roles and inputs for calibration
- An opportunity for the research team managers and the WP3 leaders to identify and qualify the persons in charge of the NIRS management and development.

Output 1.4.2: *Operational HTP (or MTP) protocols platform for screening users' preferred quality traits developed*

Activities conducted	Deliverables
Desk literature review	H.1.1- State of knowledge on HTPP work done on RTB crops and products
Description of existing /ongoing calibrations at partner level	H.3- Description of existing / ongoing calibrations: H.3.1- Dried yam (flour) at IITA, Nigeria H.3.2- Dried yam (flour) at INRA/CIRAD, Guadeloupe H.3.3- Fresh Cassava for Dry Matter Content at CIAT, Colombia H.3.4- Fresh Cassava for Total Beta-Carotene at CIAT, Colombia H.3.5- Fresh Cassava for Total Carotenoids Content at CIAT, Colombia H.3.6- Freeze dried milled sweetpotato at CIP, Peru, Ghana, Mozambique, Uganda H.3.7- Potato flour (freeze dried, milled) at CIP, Peru H.3.8- Raw and Fresh, cut/blended sweetpotato at CIP, Peru H.3.9- Cooked sweetpotato (freeze dried, milled) at CIP, Peru, Uganda, Ghana, Mozambique

Activities conducted	*Deliverables*
	H.3.10- Fresh Cassava at NRCRI, Nigeria H.3.11- Fresh Cassava at IITA, Nigeria

Output Indicators 1.4.2	*Targets / Milestones*		
	Planned for Period 1	*Achieved*	*Variance & Brief Explanation*
Number of HTP (or MTP) protocols adapted and developed	State of knowledge on HTP work done on RTB crops and products	Yes	NC
Number of calibrations available for a group of prioritized quality traits	Description of existing calibrations for quality traits	Yes	NC

- *Key findings from the SoK (Del. H.1.1): gaps identified and lessons learnt from previous HTP work done on RTB crops.*

The literature reviewed highlights the potential of non-destructive techniques to qualify, sort and/or characterize roots, tubers or bananas. The techniques used vary in terms of complexity, accuracy, performances, robustness, costs and ease to use. A large part of the techniques involved is based on the interaction between electromagnetic radiations and matter that refers to vibrational properties of the chemical bonds. Because of this, these technologies are known as vibrational spectroscopy and cover the spectral range from visible to mid-infrared light. Moreover, other non-invasive techniques, such as NMR, Raman spectroscopy, imaging, ultrasound technology and X-ray, have shown the potential for successful applications in quality monitoring of fruits, vegetables, roots and tubers.

Researches using non-destructive techniques concern fresh and processed products. Most of the time, quality control or process monitoring are reached through the quantification of biochemical compounds: carbohydrate, protein, vitamins, minerals, carotenoids, moisture, starch, phenols, fat among others. Another part of the researches refers to physical properties such as specific gravity, skin color and texture. And some researches focus on contaminant quantification such as acrylamide in processed products or concern different quality aspects and potential use: external or internal defects, greening, bruises, enzymatic browning, non-enzymatic browning, and physiological disorders.

The products were analyzed in different conditions and presentations or forms (intact, peeled, sun-dried, freeze-dried, mashed, crushed, sliced, cooked, deep frying, chips, crisp, etc…). Regarding vision and spectroscopic techniques, the measurements were done in, backscattering, diffuse reflectance, transmittance or interactance mode using static or moving sample holding systems. Reflectance mode measurements do not need contact with the sample and light levels requirement are relatively high. However, spectral fingerprint is dependent of the skin properties of the roots and tubers, in case of intact crops. Transmission mode measurements can be done without contact and spectra are less dependent to skin properties. Transmittance mode is suitable for detecting internal disorders. Interactance mode requires to be in contact with the sample but provides a compromise between reflection and transmission modes. Moreover, the direct contact between the fiber bundles and the sample eliminates the effect of surface reflection and maximizes the penetration depth. Depending of application different range of electromagnetic spectrum are concerned from visible to mid infrared. Hyperspectral imaging (HIS) covering visible and/or NIR is one of the most recently emerging tools and provides advantages of vision and spectroscopic systems. The tool can be used, after speeding up image acquisition time, in prediction of processing-related constituents as well as

defects detection. HIS gives the advantage to provide both, quantification and information on spatial distributions of the traits in the whole tuber, root or banana. There is an inevitable trend for multispectral imaging with only a few important bands instead of full wavelengths in the non-destructive and rapid evaluation of food quality.

The chemometric methods used to achieve calibration are many and depend on the product and on the trait to be characterized. The approaches cover linear methods (PCA, PCR, PLSR, LDA, PLSDA, SIMCA…) and non-linear methods (ANN, Local Regression, SVM, KNN, CART...), and are divided into two groups: quantification and classification. In some cases, classification (supervised or unsupervised) gives the opportunity to perform HTP screening when quantification is not relevant. These methods are associated to various signal preprocessing methods which cover and solve a large part of the problems due to the techniques involved and to the mode of measurements.

According to the different publications, NIRS (1D or 2D) presents a real potential for HTP screening and quality control of a great number of samples of RTB. Applications concerns chemical characterization as well as physical properties were also presented. Some studies on potatoes and potato products report evaluation of sensorial attributes (hardness, firmness, springiness, adhesiveness, graininess, mealiness, moistness and chewiness) using NIRS with promising results. The instrumentally measured texture of RTB products was also assessed using NIRS.

However, robust models must be based on large data sets to precisely predict quality attributes for new samples, especially for breeding purpose. The datasets should be obtained from different destinations, growing conditions and post-harvest conditions in order to cover the variability of the trait to be quantified/characterized. Additionally, these HTP techniques are indirect which implies that model accuracy highly depends on the precision of reference methods used to quantify the constituent or trait.

The challenge for RTBfoods will be to translate in measurable variables or in indirect correlated variables the quality traits of interest in order to develop a strategy for calibration. The strategy will cover the choice of the optimum non-destructive HTP technique, the sampling, the sample presentation and preparation, the measurement protocol, and the choice of chemometric methods. This work, ones the traits are identified by WP1, should be done in close collaboration between WP2 and WP3.

- *Write a brief narrative on each existing calibrations (Del. H.3.1 to H.3.11): Traits/Constituents concerned, RTB crops & food products concerned, Nb of values acquired on samples, Product presentation, Funding project, Institute/partner. + any essential information from your expertise.*

Different calibrations are already applied in routine analysis such as total carotenoid and DM contents in fresh cassava or as protein, starch, individual sugars, beta carotene, zinc and iron contents for sweetpotato flour. Other calibrations are ongoing such as DM, beta-carotene and total carotenoid contents for raw sweetpotato or protein, sugars, starch for yam flour. The calibrations were developed in the frame work of different projects linked to RTBfoods project.

- **Cassava**
  1. A calibration for fresh cassava was developed by CIAT in the frame work of Harvest Plus Challenge Program. This calibration is based on spectra of ground fresh cassava. The quality traits calibrated are DM, total carotenoid content (TCC) and beta carotene content (TBC), the number of samples used for calibration are respectively: 8091, 4996 and 5007. Also, IITA developed calibration for fresh yellow cassava roots for 9-cis BC, 13-cis BC, trans BC, TCC under HarvestPlus Challenge program and

over 2200 samples were assessed. Breeders use this calibration to select high carotenoid content genotypes.

2. A calibration for fresh cassava (whole fresh roots and mashed roots) was developed by NRCRI in Nigeria using a portable NIR spectrometer. This work was a part of Next Generation Cassava and RTBfoods projects. Calibrations were developed from samples at the NRCRI Umudike, Nigeria and CIAT, Cali-Palmira, Colombia in two different years – 2015 and 2016 and from intact and mashed samples. The quality traits calibrated are DM and TCC. Calibrations were developed for whole root (DM, 373samples) and mashed roots (DM, 367 and TCC 173 samples).

- **Yam**
  1. A calibration, based on 163 samples of yam flour, is developed by IITA in Nigeria. This calibration is a part of Africa Yam project and focuses on quantification of moisture, ash, protein, crude fiber, starch and tannin contents. The calibration is ongoing, but the first results show interesting performances with R^2 ranged between 0,57 (starch) and 0,87 (DM). A total of 360 ascensions of yam flour were predicted for selected traits to test the equations, and results were comparable with data from conventional methods.
  2. INRA/CIRAD started also a calibration for dried ground yam, the 560 samples analyzed will be used for DM, sugar, starch, protein, amylose, amylopectin quantification and texture profiles. This development was initiated in the frame work of CavalBio (40%) and RTBfoods (60%) projects.

- **Sweet Potato**
  1. CIP has developed in the frame work of HarvestPlus and SASHA projects a calibration for sweetpotato flour (freeze dried, milled). The calibration aimed at quantifying protein, starch, glucose, fructose, sucrose, maltose, beta carotene, iron and zinc contents. This calibration is based on samples from four countries (Peru, Uganda, Ghana and Mozambique).
  2. CIP did also a calibration for cooked dried ground sweetpotato. This calibration supported by SASHA project, is being developing over 4 countries (Peru, Uganda, Ghana, Mozambique). The calibration will be applied to quantify starch and individual sugars contents.
  3. Another calibration is being developing by CIP is dedicated to raw sweetpotato (FRESH, cut/blended). This calibration is applied to quantification of DM, total carotenoid and beta carotenoid contents. The calibration development started in the SASHA frame work in Peru.

- **Potato**

  A calibration for dried milled potato was developed by CIP in Peru in the frame work of HarvestPlus and IssAndes project. The calibration is applied to flour characterization for its content of DM, starch, fructose, glucose and sucrose.

- Summarize the information filling-in the table below with the total Number of values used for calibration development

Partner Laboratory	***List of quality traits/ constituents for which existing calibrations are available***	***Product Presentation***	***RTB crops concerned***				
			Cassava	***Cooking banana***	***Sweet potato***	***Yam***	***Potato***
CIAT	DM/TCC/TBC	Fresh ground	**X**				
IITA	Moisture, ash, protein, crude fiber, starch, tannin.	Dried ground				**X**	
INRA / CIRAD	Protein, sugar, starch	Dried ground				**X**	
CIP	Protein, starch, sugars, beta carotene, iron, zinc	Dried ground			**X**		
	Starch, sugars	Cooked dried ground			**X**		
	DM, total carotenoids, beta carotene	FRESH, cut/blended			**X**		
	DM starch fructose glucose sucrose	freeze dried, milled					**X**
NRCRI	DM carotenoids (TCC, ATBC, AC, etc.)	Fresh intact and mashed roots	**X**				
NACRRI	DM/TCC		**X**				

Output 1.5.3: *RTB databases developed / enriched for users' preferred quality traits with spectral data on 5 RTB crops and 11 RTB food/processed products*

Activities conducted	***Deliverables***
Spectra acquisitions on RTB food products and fresh crops Development / Enriching of large RTB databases with spectral data on users' preferred quality traits	K.1- Descriptions of existing spectral databases for RTB products: K.1.1- Fresh Cassava at CIAT, Colombia K.1.2- Dried Yam at IITA, Nigeria K.1.3- Fresh Cassava at IITA, Nigeria K.1.4- Dried Yam at INRA/CIRAD Guadeloupe K.1.5- Dried Milled Sweetpotato at CIP, Peru, Ghana, Mozambique, Uganda K.1.6- Dried Milled Potato at CIP, Peru K.1.7- Fresh Cassava at NRCRI, Nigeria K.1.8- Fresh Cassava at NaCRRI, Uganda K.1.9- Cooking Banana at NaCRRI/NARL/IITA, Uganda K.1.10- Fresh Yam at IITA, Nigeria

Output 1.5.3 Indicators	***Targets / Milestones***		
	Planned for Period 1	***Achieved***	***Variance & Brief Explanation***
Number of new spectra in RTB databases (with passport data and eventually physico-chemical data when acquired for calibration purposes)	Description of existing spectral databases for RTB crops	Done	NC
	Total new spectra 2018: - Cassava : 3000 - Cooking banana: 200 - Sweet potato: 500 - Yam: 100 - Potato:300 - Fresh yam: 1000	**Fresh Cassava:** CIAT=1543 IITA= 1200 NRCRI=380 NACRRI= 148 **Cooking Banana** NARL= 120 **Sweetpotato (dried milled)** CIP=16189 **Potato dried milled** CIP=16 **Yam (dried milled)** INRA/CIRAD=570 IITA=2278 **Fresh Yam** IITA=1200	Cassava: NC Cooking banana: The gap is due to the delay in starting analyses as NARL has to share the NIR spectrometer with NACRRI. Sweet potato: NC Potato: Growing of potato clones for RTBfoods is planned in year 2 in Uganda Yam dried: NC Fresh Yam: NC

- *Write a brief narrative on each existing database (Del. K.1.1 to K.1.10): Traits/Constituents concerned, RTB crops & food products concerned, Type of instrument, Product presentation, Years of acquisition, Total Nb of spectra, Funding project, Institute/partner + any essential information from your expertise.*

Different databases for RTB products are already developed and ongoing. The databases are built for RTBfoods project or in the frame work of different projects linked to RTBfoods project.

- **Cassava**

1. A database for fresh cassava has been developed by CIAT in the frame work of RTB Harvest Plus Challenge Program and is still ongoing for RTBfoods project. This calibration is based on spectra of ground fresh cassava. The quality traits calibrated are DM, TCC and TBC. The number of samples scanned is equal to 12237, this was done over 10 years of harvesting. The meta data on genotype identification, genotype growing location, age of sample at harvest, year of harvest complete the database.

2. A database was developed for fresh cassava by NRCRI in Nigeria as part of Nextgen and RTBfoods projects. A portable Vis/NIRS device (QualitySpec Trek: S-10016) was used to collect spectral data on mashed/homogenized, chopped and intact root samples. Mashed and chopped fresh root samples were placed inside quartz sampling cups and placed against the window of the portable NIRS device for spectra data collection whereas the device was directly placed in contact with the intact roots for intact sampling. Two technical replications were usually collected per genotype. Samples (N=380) were collected at the NRCRI Umudike, Nigeria and International Center for Tropical Agriculture (CIAT), Cali-Palmira, Colombia in two different years – 2015 and 2016. The meta data on sample identification, Sample location, Year of harvest and wet chemistry (DM, TCC) complete the database.

3. A data base for fresh cassava is ongoing in IITA, Nigeria. Blended, grated and chopped fresh roots samples were scanned using a FOSS XDS spectrometer. 1200 samples were analyzed in 2018. The database is ongoing in the frame work of RTBfoods project. The Meta data associated are genotype identification, genotype growing location, age of sample at Harvest, year of harvest and wet chemistry (DM, starch, cyanide and color).

- **Yam**

1. Dried yam. A database comprising 2278 spectra of yam flour, is developed by IITA in Nigeria. This database is a part of Africa Yam project. Dried flour was scanned in reflectance mode using a FOSS XDS spectrometer. The meta data available are genotype identification, genotype growing location, age of sample at harvest, year of harvest and wet chemistry (DM, starch, protein and color).

2. Fresh yam. A database of 200 yam genotypes comprising of Dioscorea rotundata and D. alata harvested from two locations is ongoing in IITA in Nigeria. Three sample processing methods i.e. chopped, blended and grated were used and three set of samples were generated. Each of the sample set was scanned two times by NIRS. A total of 600 samples were scanned twice to generate 1200 spectra. This database developed for RTBfoods project is completed with meta data on genotype identification, genotype growing location, age of sample at harvest, year of harvest and wet chemistry (DM, starch, protein and color)

3. Dried yam. INRA/CIRAD are building a database for dried ground yam. 285 samples were analyzed twice using a FOSS 6500 spectrometer. The data base started in the frame work of CavalBio (40%), RTBfoods (60%) projects; 570 spectra are stored. The meta data available are genotype identification, genotype growing location, growth cycle length, weight of sample tuber, year of harvest, texture profiles and wet chemistry (DM, sugar, starch, protein, amylose, amylopectin)

- **Sweet Potato**

1. CIP has developed in the frame work of HarvestPlus and SASHA projects a calibration for sweetpotato flour (freeze dried, milled). CIP has 2 NIRS models in Lima/Peru, FOSS 6500 and FOSS XDS, which are standardized and used simultaneously. Measurements were made on raw, lyophilized, milled root samples. The freeze-dried and milled samples were scanned once (2-3 g per

sample) by NIRS monochromator model FOSS 6500 or FOSS XDS using small ring cups with sample autochanger (FOSS 6500). The database, started in 2006, comprise a huge number of samples (n=219311) which covers four countries (Peru, Uganda, Ghana, Mozambique). The meta data available are genotype identification, genotype growing location, year of harvest, responsible scientist, trial description, replication, unique Lab codes, 6500 or XDS equipment used, responsible technician and estimated values (protein, starch, glucose, fructose, sucrose, maltose, beta carotene, iron and zinc).

2. CIP starts a database for cooked dried ground sweetpotato. This database supported by SASHA project, is being transferred over 4 countries (Peru, Uganda, Ghana, Mozambique). Freeze dried and milled sample was scanned by NIRS within the range of 400 to 2500 nm using a FOSS XDS and using small ring cups. The database comprises 89 spectra and the meta data available are genotype identification, genotype growing location, year of harvest, responsible scientist, trial description, replication, unique Lab codes, 6500 or XDS equipment used, responsible technician and wet chemistry (starch, glucose, fructose, sucrose, maltose).

3. Another database is developed by CIP and is dedicated to raw sweetpotato (FRESH, cut/blended). This database development started in the SASHA frame work in Peru. A total of 96 fresh harvested, for beta-carotene concentration improved, sweetpotato genotypes were obtained from the experimental fields of CIP in San Ramon and Chiclayo, Peru. Each sweetpotato genotype was scanned 7 times: 3 roots, a round piece cut in the middle and scanned from both sides and finally once as mashed sample by NIRS within the range of 400 to 2500 nm, registering the absorbance values log (1/R) at 0.5nm intervals for each sample using a NIRS monochromator (model FOSS XDS, solid module) and using ring and course cell cups. The meta data available are genotype identification, genotype growing location, year of harvest, responsible scientist, trial description, replication, unique Lab codes, 6500 or XDS equipment used, responsible technician and wet chemistry (DM, total BC in FW, Total BC in DW, total carotenoids in DW).

- **Potato**

A database for dried milled potato was built by CIP in Peru in the frame work of HarvestPlus and IssAndes project. The database is simultaneously built by CIP onto two NIRS models, FOSS 6500 and FOSS XDS, which are standardized. Measurements were made on raw, lyophilized, milled tuber samples. The freeze-dried and milled samples were scanned once (2-3 g per sample) by NIRS monochromator model FOSS 6500 or FOSS XDS using small ring cups with sample autochanger (FOSS 6500). The potato data base was built over 13 years (2006 to 2018), the total number of spectra is 46852. The meta data available are genotype identification, genotype growing location, year of harvest, responsible scientist, trial description, replication, unique Lab codes, 6500 or XDS equipment used, responsible technician.

- **Banana**

The first banana database is being developed through a partnership between IITA, NaCRRI and NARL. IITA and NARL provide banana samples, and these are analyzed by NaCRRI to generate the first NIRS spectra for cooking banana. The activity started in June 2018, and so far, 129 samples have been analysed, representing 81 genotypes with 1 to 5 bunches per genotype. These include landraces and hybrids. The same genotypes are analyzed for sensory quality and physical-chemical content by NARL. Data are yet to be analyzed, and the work will continue through 2019.

4.3.3 Team coordination

- *Challenges faced in coordination of WP3 partner teams & strategies to be reinforced/developed by WP3 coordination team for Risk mitigation?*

Obviously, the main challenge faced in coordination of WP3 partner teams was to have a clear picture of the partners' capacities and facilities. This took times and great effort to be completed mainly due to the diversity of the teams involved in WP3: seven different teams off more than 5 countries. These teams are diverse in terms of background knowledge on HTP methods and

especially NIRS, in terms of human resources ready to be mobilized in the project and in terms of capacities (different equipment or no equipment). This first challenge was for a part resolved by having inventory of capacities and facilities of all partner countries and institutions and visits of the three WP3 leaders to the teams. An effort has been done on capacity development by carried out series trainings. This was addressed the following three main objectives 1) train the scientific and technical team on NIRS, 2) help the team managers to identify/select the persons in charge of the NIRS, 3) to initiate the use of HTP tools.

However, this support through visiting the teams and training sessions should be reinforced for the second year, especially during the measurement joint campaigns with WP2.

The second challenge was to know exactly what was already done on HTP and RTB crops by the different teams and how to decide between what will be useful for the project and what should be reorganized or improved. This was also partly addressed by compiling a complete description of the existing database and existing calibrations applied to RTB realized by each partner.

This work will be a solid base for the next year step, when quality traits will be delivered by WP1 and translate in physico-chemical variables by WP2. To be efficient, WP3 leaders and teams leaders will have to work closely with WP2 leaders and WP2 teams leaders.

The third challenge is inherent to the project and consisted in starting an analytical activity, with the implementation of sampling designs and measurement protocols, even though the criteria to be measured were not defined.

The existing knowhow and the knowledge of the work done on RTB crops and HTP methods by the teams will help to define the strategy and the choice of the methods. But, to be efficient this should be done as soon as the quality traits are known. To do the best, the WP3 leaders and team leaders will have a meeting in order to define the priorities and organize the work.

In complement the WP3 leaders acted to have a monthly meeting (skype) in order to be informed of any problems and to be reactive.

Success Story Box: *If relevant, other WP Success Stories you want to make appear in the Annual Report: Narrative on WP framework, or set of activities that illustrate well the dynamism and the innovative framework of RTBfoods research project. List the teams involed (Institution+Country+RTB crop or food product concerned), the type of Activity and the Point(s) of Interest you want to put the lights on (300 words max per Success Story).*

SHARING NIRS INSTRUMENTS AND COMPETENCIES: THE CASE OF THE NaCRRI-NARL-IITA PARTNERSHIP

In an RTB meeting held in Uganda in May 2018, it was agreed that the NIRS instrument and competencies at NaCRRI be used by partners to develop HTPPs for different RTB crops. It was also agreed that partners work out modalities for handling samples and in turn, the partners provide modest facilitation for acquiring services. To kick start this, NaCRRI, through the Nutrition and Bioanalytical lab partnered with IITA banana breeding team to provide NIRS services for banana spectral acquisition and analysis.

In essence, the partnership process was straight forward and coordinated at laboratory level. The banana breeding team is tasked with the delivery of the samples to the laboratory every Monday for analysis. The same samples are shared with NARL and used for undertaking physicochemical analyses. NaCRRIs' assigned technician then handles the samples and provides feedback on the samples numbers, and their state before spectral acquisition. On arrival to the lab, the banana fingers are selected from the clusters, peeled, and blended. Spectra are then acquired from the blended samples. The data generated is the property of the banana breeding team at IITA and NaCRRI has no specific rights to share the data or in any way use it for any purposes. Therefore, any analyses involving such data is the responsibility of the IITA breeding team. The IITA banana breeding team is meant to pay a modest fee to cater for labor and sundry services in the lab. However, such modalities are still being discussed.

So far, we have scanned over 120 banana samples with respective spectra available at NaCRRI NIRS platform. The physicochemical characterization of these samples is carried out at NARL. It is envisaged that model development will involve the utilization of data from NARL in defining the spectral data available at NaCRRI.

4.3.4 Cross-WP Coordination & Collaboration

- *Fill-in the table below with a brief description or bullet-point lists of interactions with other WPs (successful ones & gaps) and propositions for risk mitigation.*

	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed form other WPs? (NR = not relevant)***	***Risk mitigation : How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP1	• No specific inter action was schedule with WP1 for this first year	• Need to know relevant quality traits to be calibrated	
WP2	• Interactions concern mainly inventory of capacities and facilities as the teams and laboratories are most of the time shared by WP2 and WP3. This was done on through sharing files and skype meeting • For Cassava at CIAT a common protocol for texture analysis was set up in interaction between WP2 and WP3. The texture protocol was applied to raw roots and boiled roots (155 and 159 genotypes respectively), and potential correlations between NIRS data and texture data were investigated. The dataset proved limited to identify correlations, hence more data need to be accumulated in the next years of the project. • An experimental protocol for NIRS and wet chemistry was set up for yam in Benin. • For cassava and yam in IITA, there was close collaboration between WP1 , WP2 and WP3. There was a joint meeting of RTBfoods partners (IITA, NRCRI and Bowen University) organized by the Product Champion in IITA). This gave opportunity for WP1, WP2 and WP3 teams to share work plans and achievement which include tools and materials	• The main gap in interaction was probably that there was not enough specific meeting dedicated to WP2/WP3	• The priority to improve the work and interactions will be to do meeting with all the WP3 and WP2 team leaders (and WP leaders) with two objectives: 1) give a clear summary of the capacities and facilities 2) decide of the quality traits to do first and to schedule the work. • The second point is to plan specific and regular meetings with WP2 & 3 leaders.

	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed form other WPs? (NR = not relevant)***	***Risk mitigation : How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP4	• No specific interaction was schedule this year	• Need to have a calendar with clear dates of availability of plant material by crops and products.	• The interaction should start as soon as the quality traits will be known from WP1. This interaction will focus on logistic and coordination in order to be sure that the plant material will be available on time for analysis
WP5	• No specific interaction was schedule	• NR	• NR
WP6	• A lot of interaction took place with WP6. In regular contact trough mail, meeting and skipe meetings. • Documents were shared on dedicated numerical platform	• NR	• NR

4.3.5 Conclusion on Progress & Key Achievements

Synthesis on what worked well in Period 1 - Successful achievements – Strenghts & Complementarities of WP3 teams in the different countries.

The main objective of period 1 was to have a clear view of the facilities and capacities of the different teams involved in WP3. In fact, a precise knowledge of the analytical potential of the various teams must enable optimum programming and organization of WP3's work by including the sharing of instruments and the sharing of know-how.

This was successfully achieved through an exhaustive inventory of the instruments with a description of human resource and their background knowledge. The inventory was done, on a base of a common template, by team's leaders in each country. This inventory was completed by five trainings adapted to needs of the teams. WP3 took advantage of the background knowledge of researchers to share experience and to boost team through these training sessions. Finally, this approach was completed by a description of the existing and ongoing calibrations and databases on RTB products.

At the end of this first period, the joint analysis of the state of the art on high throughput phenotyping tools applied to RTB products and the description of the teams (facilities / knowledge / capacity) is a decision aid for the choice of equipment and their sharing. Indeed, sharing an instrument between NaCRII and IITA and NARL, was decided for banana in Uganda. The decision regarding new instruments is postponed to second period annual meeting in March 2019, in Abuja in Nigeria. The reason is that we need more information about consumer's preferences quality traits.

4.3.6 Perspectives for Period 2

Trainings, Spectra acquisition on major quality traits and/or for new food products, Development of Calibrations, Publications, Interactions with WP2 & WP4 (results sharing on product profiles), etc.

Workplan 2019 -**All partners**- Period 2

- Purchasing of new HTP technology such as MID-IR and imaging appropriate for screening of relevant consumer preferred traits in close collaboration with WP1 and 2.
- Intensive training on new HTP technology and NIRS, backstopping on hubs (Nigeria, Uganda), workshops.
- Joint workshop / training across crops in March 2019 in Nigeria before the annual meeting, cross learning on sampling and sample preparation protocols, spectra repeatability and representativeness, outliers detection, calibration development, validation, extension etc.
- Standardizing of sample preparation and scanning protocols, data collection and analysis across crops and institutions.
- Standardized reporting templates.
- Development of new calibrations for all crops and products with diverse genotypes grown in different locations, include different agronomic practices, different storage practices.
- Validate existing NIRS calibrations.
- Ring test protocols between laboratories.

Workplan 2019-CIP Period 2

- New sharing agreements of spectrometers. Sweet potato and/or potato can use the same instrument as banana and cassava do in Uganda (NaCRRI-NARL-IITA (+CIP?) partnership).
- Joint hands-on workshop for potato and sweetpotato in May 2019 in Peru and July 2019 in Uganda, spectral collection of crop varieties (fresh and dried) maybe together with banana, cassava (TBD), reference data TBD, with final purpose to development of calibration models

for biophysical traits based on the reference analysis from WP2

Workplan 2019-IITA-Nigeria Period 2

- Sources of plant materials: Cassava- Nextgen project; Yam- Africa Yam project, Banana- BBB project
- Training on the developed joint sampling and sample preparation protocols and calibration developments for cassava, yam, potato and sweetpotato and banana
- Spectral collection of crop varieties (fresh and dried) for selected traits named by WP1 and WP 2
- Development of calibration models for biophysical traits based on the reference analysis from WP2
- Validation of the existing calibrations model for some biophysical traits related to RTBfoods project
- Backstopping NRCRI and Bowen University in Nigeria on WP3 activities

Workplan NaCRRI, Uganda, Period 2, 2019

- Purchasing of new software for HTP technologies and increasing on our data processing robustness (including software upgrades)
- More spectral acquisition for both NIRS and Scio scans
- Validation of the existing calibration model
- Backstopping IITA and NARL-Kawanda in Uganda on WP3 and WP2 activities

Workplan CIAT, Colombia, Period 2, 2019

- Continue to produce biophysical characterization data and NIRS spectra of fresh and boiled cassava roots, to feed the database for NIRS / HTPP calibrations. At least 250 genotypes are planned for harvest, biophysical characterizations (including texture and cooking time) and NIRS.
- Further exploratory research will be conducted on the potential of MIRS to characterize cell wall materials and seek correlations with texture of boiled cassava, in complement to NIRS.

Workplan CIRAD/INRA, Guadeloupe, Period 2, 2019

- Develop a generic analysis pipeline for NIRS calibration from yam flour based on machine learning and model assembling.
- Develop an image processing pipeline for batch analysis of yam tuber shape, size, color and oxidation characterization (a trainee will be dedicated to this task).
- Supervision of the experimental platform and ongoing experiments (3 sites, 55 genotypes, INRA-CIRAD)

Workplan CIRAD, Coordination WP3, Period 2, 2019

- In collaboration with INRA, Guadeloupe, NIRS Training and set up of measurement protocol for fresh yam.
- In collaboration with CIAT, Colombia, set up of an experimental design for cassava cooking time and boiled cassava texture characterization.
- In collaboration with IITA, NACRRI and NARL, Uganda, specific training on calibration development and treatment of existing data (2018 and 2019) for cassava and banana.

- In collaboration with IITA and NRCRI, visit of Nigeria facilities and audit of existing databases and calibrations (cassava and yam).
- In collaboration with WP3 co-leaders, organization of a workshop in Nigeria in March.

4.4 Annex 4: WP4 Extensive Activity Report

Activities Conducted, Key Research Findings & Perspectives

Main Author(s): CHAIR, Hana, CIRAD, France

Contributor(s):

- KOUAKOU, Michel Amani, CNRA, Côte d'Ivoire
- KAWUKI, Robert, NaCRRI, Nigeria
- EGESI, Chiedozie, NRCRI, Nigeria
- OBIDIEGWU, Jude, NRCRI, Nigeria
- MENDES, Thiago, CIP, Kenya
- UWIMANA, Brigitte, IITA, Uganda

This synthesis refers to the following teams

	Partner Institution(s)	***Country***	***RTB crop(s) of interest for RTBfoods***	***Names of people involved in the team for this WP***
Team 1	CIAT	Colombia	Cassava	Hernan Ceballos
Team 2	NaCRRI	Uganda	Cassava	Robert Kawuki; Esuma Williams; Michael Kanaabi; Emphraim Nuwamanya; Enock Wembabazi
Team 3	IITA	Nigeria	Cassava	Peter Kulakow ; Ismail Rabbi
Team 4	NRCRI	Nigeria	Cassava	Chiedozie Egesi
Team 5	IITA	Nigeria	Yam	Asrat Amale
Team 6	NRCRI	Nigeria	Yam	Jude Obidiegwu
Team 7	CNRA	Côte d'Ivoire	Yam	Michel Amani Kouakou ; Ehounou Adou
Team 8	CIRAD/INRA	France	Yam	Fabien Cormier ; Gemma Arnau ; Hana Chaïr
Team 9	CIP-SSA	Uganda	Sweetpotato	Robert Mwanga ; Reuben Ssali
Team 10	CIP	Uganda	Potato	Thiago Mendes
Team 11	IITA	Uganda	matooke	Brigitte Uwimana

4.4.1 Abstract

of the full document summarizing each section *(NB: This section will be copied & pasted in the Annual Report delivered to BMGF). (2 pages)*

The goals of WP4, as written in the proposal, are to assess the variability for quality traits that exist in current breeding populations, to support development of complementary populations when necessary, to apply high-throughput phenotyping protocols (HTPP) in order to determine the genetics of the trait and the possibilities for marker-assisted selection and to identify and rank the most promising accessions already available to be used as released varieties and/or progenitors. As described in the narrative, the inputs of WP1, 2 and 3 are strategic for breeders and geneticists to properly define the heritability of the quality traits and for the development of sensible breeding strategies to improve them. In fact, little knowledge is available regarding the heritability of roots, tubers and banana quality traits valued by processors and end-users.

This first year, the different teams involved in the WP4 worked on the identification of the populations to be used for the implementation of HTPP. These teams are already involved in different projects and have several populations (GS, biparental, GWAS, etc.). The challenge was to identify the most suitable for RTBfoods *ie* the one encompassing enough variability for the targeted product profile to be used for the implementation of the HTPP and the genetic architecture dissection. The teams have also already started working on the product quality, since it is part of most of on-going projects (exp. Africayam, NextGen, SASHA, etc.), using the common methods of phenotyping. Depending on the equipment available, the proximity of food quality laboratory and the knowledge, the progress of the teams is not the same.

Each team has written a state of the art on the breeding for quality for the crop it is working on. It was the opportunity to review what has been done so far. The fact that each team reported activities, which has not been published elsewhere before, was a way to inform each other in order to start sharing approaches and methods. In this document, gap analyses were identified for each crop. It was one of the objectives of the state of knowledge document. Some gaps are shared while others are not. RTBfoods should address this lack of knowledge and try as much as possible to fill up the gaps. We expect at the end of the project to increase our knowledge on the breeding for quality traits by identifying the key traits involved in quality, their heritability and the genomic regions underlying these traits.

We have also built a tracker to follow up our work progress. So, first we reported the context (institute, product profile, persons involved), then the origin of the population(s) which will be made available for RTBfoods activities (developed within the project or within on-going bilateral project) and the traits related to quality measured this year. This tracker will be complemented each year in order to summarize our activities, showing the synergies and the progress. It is a tool to monitor the activities and to keep all the partners and other WPs (1,2,3,5 and 6) informed on on-going breeding activities. It will also be a good tool for quickly identifying threats or weaknesses, so that we can deal with them early.

From a team coordination perspective, as WP leader, Hana Chair visited Uganda, Nigeria and Guadeloupe. It was the opportunity to meet all the collaborators working on cassava, sweetpotato and matooke in Uganda and cassava and yam in Nigeria. The objective was to know more precisely the activities carried out by the different partners within the other projects they are already involved in. Hana took also time to visit the Food Technology Laboratories, in these countries, to get a better idea of the facilities available for the breeders. During these visits, the objectives of WP4 for each crop were discussed in each country. We have thus identified the populations that will be used in the RTBfoods project, while avoiding any duplication with the other on-going projects. To complement this work, Hana plans to visit Côte d'Ivoire and Colombia in 2019. Intra-WP4 coordination challenges are of two types. First, the limited of Availability of breeders involved in partner breeding programs

had an impact on their reactivity and promptness. Besides, WP4 partners felt it difficult to identify populations to be used in the RTBfoods project without compromising previous commitments in partner breeding programs nor duplicating activities. Communication with other WPs could and should be reinforced especially because WP4 breeders are keen to get feedback on their strategy and their varieties as early as possible. To get back on good tracks, a more efficient communication strategy should be defined for Period 2 during the next RTBfoods annual meeting between WP4 breeders and other WP partners.

In terms of perspectives for Period 2 and to continue to contribute to the output 2.2.1 concerning the identification of the genetic architecture of users' preferred quality traits, field trials will be repeated in 2019 in the different identified environments for GxE studies. The traits will be adjusted, after the annual meeting at Abuja, following the discussion with WP2, 3 and other colleagues from WP4 in order to measure the more relevant traits before the HTPP method is made available. Data storage and management will be in the agenda of the annual meeting in order to define the best practices.

4.4.2 WP4 Results Tracker: Activities & Milestones achieved

Output 2.1.1: *Genetic architecture of users' preferred quality traits for VUE improvement in RTB breeding programs identified*

Activities conducted	***Deliverables***
State of Art on breeding populations and breeding for quality	M.1.1- State of Art on previous works on quality traits informing breeding (for each targeted RTB crop)
Unravelling genetic architecture of traits for VUE improvement in RTB breeding programs	M.2.1- Breeding population tracker in Period 1

Output 2.1.1 Indicators	***Targets / Milestones***		
	Planned for Period 1	***Achieved***	***Variance & Brief Explanation***
Nb of reports on correlation between traits, heritability and genetic gain per crop and product profile	1	1 document on State of Art with chapters per crop and per institute and a WP4 activities Tracker developed	Both documents were produced.

- *Key findings from the State of Art (Del. M.1.1), disaggregated by crops: gaps identified and lessons learnt from previous work on breeding for quality for the 5 RTB crops.*

In this document, for each crop in each country, the breeders described the knowledge acquired in terms of breeding for quality based on published papers, their published or unpublished works and finally the gap analysis. To summarize:

Four institutes work on **cassava**: CIAT (Colombia), NRCRI and IITA (Nigeria) and NaCRRI (Uganda). These institutes are involved in several projects including NextGen and HarvestPlus. Through their involvement in these projects, they have already started working on breeding for quality. Through the Sate of Knowledge document, we can retain that:

In Colombia, the target product profile is boiled cassava. At CIAT, a lot of work has been done to understand the traits important for consumers. Trials have been conducted to assess them and

heritability studies have been conducted. So, the DMC is considered as a key trait for boiled cassava quality. When DMC is low, the uncooked root looks “watery” and, after boiling, it assumes a “glassy” appearance (tends to be translucent and its texture is hard to penetrate). A reduction in the level of DMC (and a parallel increase in sugar content) results in glassiness in the boiled root, which is highly undesirable. Harvesting at the end of the dry season increases heritability of DMC. Similarly, the reliability of phenotypic evaluations, after cassava reinitiates its growth with the arrival of the rains, decreases. HCN content is also an important target trait. The cassava-breeding program at CIAT has established a threshold of 200 ppm in the selection for genotypes suitable for the table consumption markets. Perhaps the most relevant trait to identify cassava roots suitable for table consumption (in addition to low cyanogenic potential) is that they soften upon boiling. The biochemical basis for softening in response to boiling or fermentation have not yet been established. The degree of association between these two response variables has not been determined either. What is clear is that boiling results in a gradual and consistent reduction of starch and cyanogenic glucosides in the root. Cooking time and texture profiles can be linked to root physico-chemical and starch gelatinization properties

In Uganda, cassava marked its 158th anniversary since its introduction in 2018. For NaCRRI, boiled cassava is the main product profile targeted within RTBfoods project. As cassava virus incidences and severities decreased owing to breeding interventions, farmers reluctantly cultivated these improved varieties, and resorted back to their locally adapted varieties, for which, they have had a long historic association. This was partly attributed to the notion that many of the released varieties lacked desirable root quality attributes (taste, mealiness, texture and aroma) as compared to locally adapted varieties. At NaCRRI such as at CIAT, root dry matter (DMC) is recorded for all breeding trials at harvest (12 months) using two methods; specific gravity or the oven dry method. Total carotenoid content is analysed both on fresh and processed samples. Cyanide content is determined using the method of Howard et al., 1994. Finally, the softness of cooked roots is assessed routinely.

In Nigeria, current emphasis is on gari and fufu as the most widely consumed in Nigeria. Gari is most preferred because of its convenience, long shelf life and it is easy to eat either as a snack or a meal. The priority is genetic improvement of cassava varieties for identified quality traits based on diverse end-user preferences. These traits of preference include root dry matter content (relevant for root mealiness), product consistency (for gari and fufu) associated with cassava starch content, colour (especially with respect to beta-carotene content), aroma and taste. Biofortified cassava with enhanced levels of beta-carotene has been cultivated by Nigerian farmers since 2012 and it has become apparent that scaling out will be more successful if the biofortified varieties have higher dry matter and starch contents. Genomic dissection of the genes controlling both beta-carotene and dry matter indicated that they are co-located on at least chromosome 1. Genetic methods to manipulate this in a pleitropic manner might be helpful.

Four institutes work on **yam**: IITA and NRCRI (Nigeria), CNRA (Côte d’Ivoire) and CIRAD (France). These institutes are also involved in several projects including Africayam. They are already working on breeding for quality. Unlike cassava, two main yam species are concerned. Through the Sate of Knowledge document, we can retain that:

In Nigeria at IITA, the yam quality phenotyping routinely used in yam breeding programs includes fresh tuber physical quality assessment, and physico-chemical and functional properties of fresh tuber for predicting boiled yam and pounded yam food quality. These included traits such as colour of tuber flesh, tuber oxidation, tuber shape, dry matter, peel loss, starch yield, pasting property of starch, flour yield, and other functional properties such as ash content, total protein, fat, amylose and sugar. In addition, tuber micronutrient density, specifically for iron, zinc, total carotenoids, ascorbic acid (vitamin C), phytate, and tannin content have been assessed in different yam germplasms. Many populations have been produced and varieties are at different stage of evaluation.

In Nigeria, the objective, at NRCRI, of the genetic improvement component has been to develop and disseminate improved yam genotypes with high and stable yield of tubers with good storage and food qualities suited to the relevant cropping systems. Yam breeding has resulted to 21 varietal releases and more recently official registration of five landraces. At the early stage of breeding cycles, NRCRI breeders characterize and advance clones based on yield, response to diseases and pest. Food quality traits often considered alongside the agronomic traits include tuber flesh colour, physico-chemical factors in fresh yam tubers (granule morphology; starch granule size, histological

structure of the cells), physico-chemical composition of yam starch (amylose/ amylopectin ratio, swelling, water binding capacity), pasting characteristics of fresh yam tubers, as well as calcium, phosphorus and cellulose contents of yam tubers that are indicators of textural quality in 'pounded yam. Starch accounts for 80% (on dry weight basis) of the yam tuber. Based on breeders experiences and literature, it has been reported that granule size, swelling power, amylose and water binding capacity of yam starch can be indicators of textural quality in "pounded yam". Investigating the physico chemical properties of yam flour, starch and also non-starchy polysaccharides (lignin, pectin, cellulose, hemicelluloses) in yam could also give insight to quality factors which can predict the quality of food products such as boiled yam, thus serving as screening tools to breed for these specific traits in order to produce tubers with qualities that will be acceptable by the end users (farmers, consumers, processors).

In Côte d'Ivoire, the main target product profiles at CNRA are boiled and pounded yam. Here again, a lot of work has been done to develop varieties and conduct participatory evaluation. Quality traits studied are DMC, yam tubers shapes, flesh color, flesh oxydation and the quality of the boiled and pounded yam assessed by consumers. Physico-chemical studies will link that traits with the quality of the boiled and pounded yam.

In France, populations developed by CIRAD breeders are under evaluation for quality. The main criteria linked to quality applied during the selection process are related to the tuber form, the flesh browning and colour and are visually assessed. Several "high-throughput" phenotyping methods are under development to measure other traits related to quality. These methods are mainly based on image analysis and will allow the phenotyping of large populations. For example, tuber flesh browning and colour are now automatically assessed using repeated images of sliced tubers.

Concerning the potato, CIP has adopted standard procedures for determining: i) specific gravity and dry matter content, ii) texture and flavour components of cooking quality, iii) storage behaviour, iv) chipping and French-frying performance, v) oil content, and vi) contents of undesirable secondary products such as glycoalkaloids. However, quality traits have not been a target on CIP's breeding population. It is expected that through the project there will be greater genetic gain combining new tools (HTPP, GWAS, GWS) accessing in earlier breeding stages, characteristics such as sugar profiles, texture profile (dry matter, cooking time, cell wall, cooking time), nutritional and antinutritional (glycoalkaloid) and sensorial (aroma, taste).

In Uganda, CIP has been involved for many years on different sweetpotato projects (SASHA, HarvestPlus, GT4SP, etc.). The traits in preferred sweetpotato are high yield, resistance to common pests and diseases, early or medium maturity with good in-ground storability, suitable for piecemeal harvest with no fibers, and of good marketability, medium sweetness, and powdery texture. Since, many varieties have been released. These populations are likely to have the diversity of user preference traits of interest for the targeted product profiles. NIRS is used for quality traits – beta-carotene, minerals and sugars at all the sweetpotato support platforms in SSA (Ghana, Mozambique and Uganda).

In Uganda, cooking banana cultivars are locally known as 'matooke' and serve as a staple food to a large part of the population. IITA has been working on this crop for many years. However, the "matookiness" is complex and little is known about the traits underlying this product profile. IITA in collaboration with NARL is conducting sensory analysis. Genomic selection panel will be used to understand the traits linked to matookiness and to develop a HTPP method.

In this State of Knowledge document, breeders have identified the gap analysis. They are mainly related to the traits underlying the product profile and the need for high throughput phenotyping method.

- The populations which will be used within RTBfoods and the traits targeted are summarized below per crop and per institute:

<u>Cassava Breeding program-Hernan Ceballos-CIAT-Colombia</u>

Target Cassava Populations: One of the salient features of the trait CIAT focuses on (quality of boiled roots) is the large impact of environmental factors affecting the trait. It is only after many years of evaluation in different conditions that a given clone would be generally accepted to produce good

quality boiled roots. CIAT, therefore, has screened a large data set in search of a group of clones that can reliably be used as source of good cooking quality as follows. Good cooking quality (white parenchyma): CM 2600-2; CM 2766-5; CM 5253-1; CM 7436-7; SM 1127-8; MCOL 1505M; MCOL 2066; MCOL 2246; MCR 138; MGUA 24; MMAL 3; MMEX 2; MPAN 70; MPAN 139; MPAR 57; MPAR 98; MPER 183; MPER 496; MVEN 77; MVEN 208; MVEN 218; MCUB 74.Good cooking quality (yellow parenchyma): GM 3674-41; GM 8373-46; GM 8391-4; GM 8413-1; SM 3759-36. CIAT also needed a set of clones known to have very poor cooking quality and selected the following genotypes: MBRA 318; MBRA 325; MBRA 512; MCOL 1722; MCOL 1910; MCUB 46; MVEN 25. There will be two main activities conducted with these genotypes: 1) Make crosses to generate biparental populations that will offer wide segregation for the trait of interest; and 2) Grow these materials in different locations to confirm that indeed they offer contrasting features.

Target Cassava Traits: The ultimate objective is to understand the factors affecting good quality traits when cassava roots are boiled. Some factors are already well known (e.g. cyanogenic potential should be lower than 100 ppm), but other have remained elusive for many decades. CIAT will select 2-3 biparental populations (100 to 200 genotypes per full-sib family) and evaluate them initially in one location but as soon as possible in 3-5 locations. Roots from each genotype, grown in different locations will be boiled to assess cooking quality, processed through NIRs to obtain spectra (hopefully a high throughput phenotyping protocol would be developed), while sections of these roots will be used for other traits (e.g. dry matter and sugar contents, proportion of amylose in the starch, different polysaccharides, etc.). The main purpose for these analyses is to gain a better understanding of the heritability of the main trait (cooking quality of boiled roots), develop high-throughput protocols for efficient selection for this trait and dissect the different factors affecting it.

Cassava Breeding program-Chiedozie Egesi-NRCRI-Nigeria

Target Cassava Populations: NRCRI has different cassava populations and/or clones at different evaluation stages. It is these populations and/or trials that we shall use to constitute the target populations for WP 4. First, for 2018, our target population was the NextGen mother trials and C1 population in advanced yield trials that comprised of ~200 clones. These trials will be harvested at different times corresponding to their planting schedules starting from June 2019. Roots will be sampled and taken to the laboratory for trait analyses.

Target Cassava Traits: The traits to be targeted includes “must-have-traits” and/or “value-added traits”. The “must-have-traits” are those that will entail optimal field agronomic performance and resilience to biotic and abiotic stresses. We will also pay attention to the “value-added traits” root quality and end-use characteristics. We will target dry matter content, starch content, gari and fufu yield, etc. and these would be done in a participatory manner.

Cassava Breeding program-Robert Kawuki-NaCRRI-Uganda

Target Cassava Populations: At NaCRRI, we have different cassava populations and/or clones at different evaluation stages. It is these populations and/or trials that we shall use to constitute the target populations for WP 4. First, for 2018, our target population was the NextGen C_1 population that comprised of ~730 clones established at Namulonge (NaCRRI). This trial was harvested in September 2018, roots sampled, waxed and shipped to the laboratory for trait analyses. Second, we specifically established a WP 4 trial comprising of 73 clones (52 elite and 21 local). This trial was established in August 2018 at two sites: Namulonge (central region) and Serere (eastern region), and will be due for harvesting in August 2019. Third, if resources permit, we shall also target a portion (~400 clones) of the NextGen C_2 cassava seedling population that was established at Namulonge in October 2018; this trial will be due for harvesting in October 2019.

Target Cassava Traits: Our desire is to have cassava varieties characterized by “*must-have-traits*” and/or “v*alue-added traits*”. The “*must-have-traits*” ensure that cassava optimally yields despite the prevailing pests, diseases and abiotic stresses in farmers’ fields. Of keen interest for WP 4 is to focus

on the "v*alue-added traits*" most of which are within realms of root quality and use. Accordingly, our immediate target traits for 2018 are: 1) root dry matter content; 2) softness; and 3) cyanogenic potential. For 2019, our target traits will be: 1) root dry matter content; 2) beta-carotene content; 3) softness; 4) cyanogenic potential; and 5) starch content. Beyond 2019, we may add fibre content to these aforementioned root quality traits. Prioritization of this trait list will be informed by information collected from end-user surveys conducted under WP1.

Yam breeding program-Asrat Amal-IITA-Nigeria

Target Yam Populations: The yam breeding team at IITA has developed different populations for genetic studies and selection in two dominantly grown species of yams in West Africa: *D. rotundata* and *D. alata*. The populations are structured as bi-parental mapping population and diversity panels. The populations are genotyped with different genotyping platforms and currently under field phenotyping for agronomic and biotic stress traits. From these populations, two bi-parental mapping populations (one for white yam and one for water yam) and one diversity panel of water yam are nominated to constitute the target population for WP4. The bi-parental populations are TDr1401 constituting 151 white yam clones and TDa1402 constituting 207 water yam clones. The diversity panel includes 100 water yam accessions representing genebank collections and advanced breeding lines. In 2018, the bi-parental mapping populations were grown at one site in Nigeria while the diversity panels were planted at three locations. The trials will be harvested in January 2019 and will be replanted in April 2019 for more detail phenotyping for quality traits under WP4.

Target Yam Traits: The phenotyping efforts with these populations include agronomic, biotic stress and quality traits. Traits to phenotype within WP4 include physicochemical and functional properties for predicting major food quality of fresh yams. The immediate targets for 2018 are tuber dry matter content, starch content, and tuber oxidation. For 2019 and beyond, our focus will be on tuber flesh color, NIRS scan for tuber quality traits, boiled tuber quality (texture, taste, color, after cooking hardening and darkening), pounded tuber quality (color, texture, stretchabiliy, aroma, consistency), and yam flour quality (% dry matter, color, peel loss %).

Yam breeding program- Jude Obidiegwu -NRCRI-Nigeria

Target yam populations: NRCRI is nominating one (1) breeding population (TDr 1620). This bi-parental population comprises of 128 individuals of D*. rotundata*. This population in the last two years has undergone some sort of multiplication so as to regenerate sizeable tubers for phenotyping of our numerous routine post-harvest quality traits within our breeding pipeline. These materials will be planted out in 2019 farming season. The diversity panel for WP2 will be nominated from advanced and early breeding lines consisting of 10 individuals. Three (3) Nominations will be made from advanced breeding materials to actualise the target of WP5.

Target yam traits: Harvesting of 2018 yam field trials was just recently concluded. The dry matter and tuber flesh colour of this population is ongoing. In 2019 we envisage phenotyping tuber flesh oxidation potential of this population. Most critical is the post boiling qualities for boiled yam including texture, aroma, colour, cooking time and rate of hardening after cooking. Target for pounded yams alongside others earlier mentioned will include stickiness, mouldability and stretchability.

Yam breeding program-Michel Amani Kouakou-CNRA-Côte d'Ivoire

Target yam populations: CNRA has two kinds of populations for yam: 1- Panel of diversity consisting of more than 419 accessions of *D. alata* and *D. rotundata*; 214 accessions of *D. alata* and 205 accessions of *D. rotundata.* All these accessions are characterized for dry pounded yam and boiled yam quality. 2- Breeding populations deriving from crosses within each species. There are 4 generations of populations. For *D. alata*: 177 hybrids at clonal evaluation, 183 hybrids at preliminary yield evaluation, and 6 hybrids are tested for release. For *D. rotundata* 568 hybrids at clonal evaluation and 762 hybrids at preliminary yield evaluation stages.

Target yam traits: Boiled and pounded yam are measured by the lumpiness, the springiness, the looseness, the sweetness, the steakiness, the smoothness, the brown spot, firmness, elasticity. Other traits on the yam tuber are: yam tubers shapes, flesh color, fresh flesh oxidation, brown spot in the flesh, cooking time, aroma, acceptability, flavor and dry matter content of the tuber.

Yam breeding program-Fabien Cormier-CIRAD-France

Target yam populations: CIRAD is working on two types of populations genotyped by GBS: a diversity panel developed for the project and two biparental populations already developed within AfricaYam project. The diversity panel is replicated in three different environments to allow research on GxE interactions. In each environment, each accession is replicated 20 times. In 2018, this panel of 43 accessions has been developed to maintain statistical power while a sample of CIRAD and INRA collection is studied (independent and complementary accession). During the project, this panel will increase to a final one of around 70 accessions. The biparental populations are composed of 130 progenies for population A (74F × Kabusa) and 200 from population B (74F × 14M). They are actually in field (two complete block of 9 replicates).

Target yam traits: For the diversity panel the targeted traits are: tuber weight, tuber shape, browning and flesh colour, dry matter, starch and protein content, starch grain size, amylose/amylopectine ratio and pounded ability. For the biparental populations, within the AfricaYam project, the targeted traits are tuber weight, shape and size and physico-chemical parameters estimated through NIRS. Within the RTBfoods project, they are: tuber flesh browning (started) and other physico-chemical parameters (*e.g.* amylose/amylopectine ratio).

Sweetpotato breeding program-Robert Mwanga and Reuben Ssali-CIP-Uganda

Target Sweetpotato Populations: The sweetpotato food product profile selected for the study under WP4 includes: a) boiled sweetpotato – which is the commonest form in which sweetpotato is consumed in most countries in SSA b) puree (mashed sweetpotato) – for producing bakery and other products is increasing in importance. c) and fried sweetpotato. Overall, CIP-Uganda has the following sweetpotato specific breeding objectives: (1) continue to improve sweetpotato population development in sub-Saharan Africa (SSA), linked with participatory varietal selection at the national level; (2) breed for key biotic constraints in Africa; in East Africa the focus is on sweetpotato virus disease (SPVD) resistance and weevil resistance; and (3) breed quality types of sweetpotato for urban markets. The populations used for the three specific objectives at the East and Central Africa Sweetpotato Support Platform are: 1) 80 Population Uganda B x 50 Population Uganda A (130 genotypes/parents); 2) 80 x 50 diallel population for SPVD resistance (diallel progeny, over 6,000 genotypes); 3) 8 SPVD resistant x 6 SPVD resistant population (diallel progeny, over 2,000 genotypes); 4) Beauregard x Tanzania (BxT) population (317 genotypes) and 5) Mwanga diversity panel (MDP) of 1886 genotypes (from 8 x 8 population Uganda B x population Uganda A parents). Under WP4, the BxT and the MDP populations will be used [i.e. 4) and 5) above].

Target Sweetpotato traits: Within RTBfoods, the targeted traits are dry matter content, quality traits related to boiled and mashed sweetpotato, beta-carotene, minerals and sugars. However, SPVD resistance, Alternaria blight and weevil damage are major traits in sweetpotato breeding. The traits related to yield are also of importance (storage root yield, foliage yield, biomass yield, commercial root yield, percentage of marketable roots, harvest index, number of roots per plant, yield per plant, establishment index, and number of commercial roots per plant).

Potato breeding program-Thiago Mendes-CIP-Uganda

Target Potato Populations: The genetic population is comprised of most groups of CIP's advanced tetraploid populations B3, B1 and LTVR and is a dynamic collection of bred clones previously subject to analysis of structure and successfully used for GWAS. Population B is under improvement for

high levels of horizontal resistance to late blight along with economically important traits such as tuber yield, quality for table and industry, adaptation to wide environments and tolerances to other biotic/abiotic stresses. The LTVR population is characterized mainly for its resistance to the most important virus diseases (PVY, PVX and PLRV) of potato, early tuberization in short days, mid-maturity under long days and adaptation to warm, arid environments. A group CIP's advanced tetraploid clones was introduced in Uganda (Oct/2018) as potato minituber and multiplication for further testing in the field has started. All the activities have been planned and executed in collaboration of our local partners on potato - National Agricultural Research Organisation (NARO). The most popular varieties for farms, industry and consumers (Kabele red, Wanale, Singo, Cruza, Victoria, Rwangume, Bumbamagara) have also be considered for further field evaluation. In 2019 a trial will be established in the highland area of South Western Uganda.

Target Potato traits: Fried and boiled are the target product profiles on potato. It's be agreed with colleagues that the traits to starting work with will be: sugar profiles, texture profile (dry after, cooking time, cell wall, cooking time), nutritional and antinutritional (glycoalkaloid) and sensory analysis. A group of 20 clones have been already delivered to WP2 for the first round of quality assessment in the laboratory and second round of materials will be delivered in Feb/19 for a second wave of assessment. Agronomical evaluation will be done in field, as yield and the level of resistance to the main diseases (Late blight and Virus). It's expected that the results from WP1 in 2019, will help to better define the traits that has to be considered.

matooke breeding program- Brigitte Uwimana- IITA-Uganda

Target banana "matooke" populations: A number of mapping populations have been developed by IITA together with BBB project partners. However, these populations are from diploid parents, with no "matooke" background. Moreover, their progenies are full of seeds and have no pulp. Consequently, they are not qualified to be used to the quality of "matooke". One population in particular is better suited for RTBfoods WP4. This is the Training Population (TP), used to develop predictive models for yield and other agronomic traits in "matooke" breeding. The population comprises almost all the breeding material used by IITA and NARO for "matooke" improvement. It is made of 3x, 4x and 2x parents and their hybrids, making up 320 genotypes. However, some of the hybrids have bunches without pulp (something common in banana breeding). Therefore, only genotypes with bunch containing pulp will be used under WP4. These are about 260 lines. The population is planted in Sendusu, IITA breeding station and in Mbarara, Western Uganda. It has been phenotyped for agronomic traits, and genotyped using the GBS platform, resulting in about 11,000 SNPs scored bi-allelically, and 5,300 SNPs scored by allelic dosage (taking into account the ploidy of each line).

Target "matooke" traits: At this phase of the project, it is not clear yet which traits will be targeted for "matooke" quality. In the breeding programme, "matooke" quality of the hybrids is evaluated in acceptability evaluation, looking at pulp colour, aroma, taste, mouthfeel and general acceptability. The process is tedious, involving a lot of logistics, people, and it not accurate. We are waiting for the results of WP1 to fine-tune the traits linked to "matooke" quality. Meanwhile, WP2 to convert the qualitative traits into quantitatively lab-based measurable traits. We hope that WP3 will come up with a high throughput phenotyping method, which can be used in remote areas, given that banana trials are conducted far from the laboratory, and bananas are harvested around the year, few mats at a time, making it difficult to transport the bunches to the laboratory for analysis.

4.4.3 Team coordination

- *Challenges faced in coordination of WP4 teams & Strategies to be reinforced/developed by WP4 coordination team for Risk mitigation?*

This first year, the major challenge was to know more precisely the activities carried out by the different partners within the different projects they are already involved in. In WP4, the breeding programs on the five crops targeted by the project are carried out by 11 different teams. To get

informed, skype meetings were organized. In addition, as WP4 coordinator, Hana Chair visited Uganda, Nigeria and Guadeloupe. It was the opportunity to meet all the collaborators working on cassava, sweetpotato and matooke in Uganda and cassava and yam in Nigeria. Hana also visited the Food Technology Laboratories, in these countries, to get better idea of the facilities available for the breeders. To complement this, she plans to visit Côte d'Ivoire and Colombia in 2019.

The second challenge is the fact that most of the partners are already engaged in bilateral projects and have included breeding for quality as a deliverable of their projects. It took time for the partners to identify the populations to be used in the RTBfoods project without compromising their commitments in their current projects or duplicating their activities. Through visits to partners and discussions, populations have been identified. The traits that will be measured in the bilateral projects and those to be developed in the RTBfoods project have been separated but are no less complementary. We must remain vigilant so that no confusion will come later.

Finally, since the breeders are the next users of deliverables and it is their responsibility to produce varieties that meet the users 'needs, they want to be more informed and as much as possible involved in the other WPs in progress. They are one of the users to be considered in WP1. They are ready to provide varieties to be used in WP2 and WP3 and are keen to get feedback on their strategy and their varieties. At the next annual meeting, we plan to organise a workshop with the different WP leaders, so that the breeders can discuss with them and define an efficient communication strategy.

4.4.4 Cross-WP Coordination & Collaboration

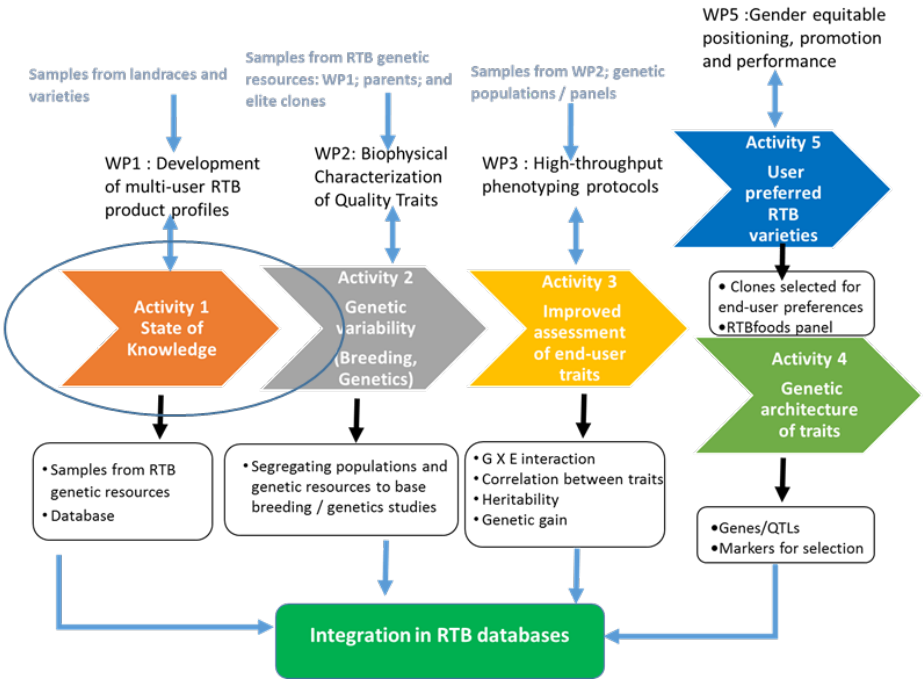
- *Fill-in the table below with a brief description or bullet-point lists of interactions with other WPs (successful ones & gaps) and propositions for risk mitigation.*

	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed from other WPs?*** ***(NR = not relevant)***	***Risk mitigation: How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP1	We had very little interaction with WP1. Just a skype meeting and some e-mail exchanges.	WP1 in building an important database on farmers' varieties (location, use, culinary properties, etc.). This database is very valuable for genetic studies under the project and beyond it. Indeed, it can be used for diversity studies as well as the identification for candidate genes, GWAS panels or progenitors for breeding programs. Better communication with this WP is essential. It will prevent duplicating the work and consolidate information for RTBfoods, other bilateral projects and future research questions.	More frequent meetings with WP1 and WP4 partners that would result in: o A strategy of working together per crop, o Country meetings are also needed. The frequency of meetings should not be the same. That per crop can be done once or twice a year only. That by country can be done a little more frequently especially as researchers are often in the same institute or not very far geographically.
WP2	Few e-mail exchanges	More interaction is needed	Through annual and WP leaders' meetings.
WP3	Few interactions	Breeders need to interact with WP3 in order to prepare the plant material for NIRS calibration.	The annual meeting should be the opportunity to establish a timetable for the delivery of plant material to WP3 and to get feedback on the NIRS analyses carried out.

	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed from other WPs?*** ***(NR = not relevant)***	***Risk mitigation: How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP5	• None	The breeders have varieties (see SoK document) that can be tested in farming systems. Better communication with WP5 would allow to begin their participatory evaluation.	Meetings and communication strategy.
WP6	• Meetings, Visit of Project leader, work with the PMU	• NR	• NR

4.4.5 Conclusion on Progress & Key Achievements:

- *Please, Modify / Re-design / Annotate the WP4 flow chart from project proposal narrative hereunder.*
- *Indicate (e.g. circle or underline) the steps achieved or started in Period 1.*



4.4.6 Perspectives for Period 2:

Activities, Publications, Planification of Interactions with WP2 & WP3, etc

Breeding activities: For period 2, field trials will be repeated. The trials will be resized to fulfil the objective of unravelling the genetic architecture of quality traits. The breeders have conducted a number of traits measures in 2018. The traits will be adjusted, after the annual meeting at Abuja, after discussion with WP2, 3 and other colleagues from WP4. The objective is to measure the more relevant traits and adjust them along the project before the HTP protocols and calibrations are made available four a routine use.

Data management: For each crop, the data produced will have to be stored in the database. Data storage and management will be in the agenda of the next RTBfoods annual meeting.

Communication within WP4 : One of the objectives of RTBfoods is sharing experience and create synergies between groups. In 2018, we had a cross-crops meetings. In 2019, we plan to start crop-based meetings (mainly on cassava and yam) to begin sharing approaches and experiences.

Communication between WP4 and other WPs: We plan to have more interactions with WP2 and 3 (how and when will be defined during the next RTBfoods annual meeting in Abuja). Increased interactions between breeders and food scientists is an overall objective within RTBfoods project and more widely. These interactions are particularly important and necessary to start adjusting the traits to be measured and not to end up with time-consuming but inefficient investment. Of course, a trade-off must be found between the frequency of the meetings and their contribution or added-value to the project success.

4.5 Annex 5: WP5 Extensive Activity Report

Activities Conducted, Key Research Findings & Perspectives

Main Author(s):

- CAREY, Ted, CIP, Ghana,
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- MAYANJA, Sarah, CIP, Uganda
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- BELLO, Abolore, IITA, Nigeria

This synthesis refers to the following teams (or scientists)

	Partner Institution(s)	***Country***	***RTB crop(s) of interest for RTBfoods***	***Processed/Food Product(s) of interest for RTBfoods***	***Names of people involved in the team for this WP***
Team 1	IITA/NRCRI/CIRAD	Nigeria	Cassava and Yam	Fufu, Gari, Boiled and pounded yam	Bela Teeken, Tessy Madu, Duffour
Team 2	CIP/NARL	Uganda	Sweetpotato	Boiled/fried	Mwanga, Mayanja, Kyalo, Tinyiro
Team 3	NARL/Bioversity	Uganda	Banana	matooke	Akankwasa/van den Berg
Team 4	CARBAP/IITA/CIRAD	Cameroon	Plantain and cassava	Plantain – boiled, fried, pounded	Noupadja (Ngoh)/Lienou, Fotso
Team 5	CNRA	Cote d'Ivoire	Cassava, plantain, sweetpotato, yam	Attiéké, fried plantain, fried sweetpotato, boiled	N'Zué, Ebah , TIEMELE; TRAORE Kouakou, Dibi

4.5.1 Abstract

of the full document summarizing each section *(NB: This section will be copied & pasted in the Annual Report delivered to BMGF). (max 2 pages)*

Work Package 5 represents the advanced testing stage prior to release. The main objective is to develop useful protocols for effectively evaluating and getting feedback on performance of advanced clones from users (producers, processors, consumers) in order to ensure that only acceptable varieties are released and promoted by breeding and seed programs. Sequencing of activities under the RTBfoods project anticipated major efforts in other WPs in the first year of the project, as critical information was gathered on validation of product profiles, methods of engaging with processors and consumers to determine preferred attributes, understanding the basis of preferred attributes, introducing selection for these in breeding programs through the use of high throughput phenotyping methods, and ultimately molecular approaches to selection. There were, however, some opportunities to take advantage of on-going advanced testing of genotypes by research teams interested in systematically engaging with processors and consumers in addition to the usual engagement with producers through on-farm trials.

In Nigeria WP5, multidisciplinary IITA/NRCRI/CIRAD teams engaged with cassava processors, producers and consumers through mother-baby trials that were on-going under the NextGen project and provided substantial information on varietal suitability for gari and fufu, as well as insights on engaging with users. Similar work was also conducted in Nigeria on evaluation of yam genotypes under the Africa Yam project for boiling and pounding. In Uganda, on-farm trials of sweetpotato genotypes under a USAID-funded project (MENU) provided the opportunity for engagement with processors and consumers to conduct evaluations of boiled and fried sweetpotato. In Uganda, methods for engagement with users in the evaluation of bananas for matooke were also underway by the NARL/Bioversity team, but results are not yet in. Elsewhere, WP5 activities were deferred until the effective engagement with the RTBfoods WP1 team could be assured so as not to rush ahead without agreed-upon protocols. However, preparations were underway for WP5 activities on targeted crops and products in each of the remaining RTBfoods countries, including Cameroon, Benin and Cote d'Ivoire, and Uganda. In the case of banana, this was largely through idenfication and multiplication of genotypes for inclusion on WP5 trials in coming years.

Preliminary reports of the the cassava and yam assessments from Nigeria and of the sweetpotato assessment from Uganda were received and salient points of methods used are summarized here.

- The cassava trials used mother-baby trials and a multidisciplinary approach to evaluate gari-eba, and fufu at locations in 2 states in Nigeria (Osun and Imo). Between 20 and 25 genotypes were evaluated, including widely grown Nigerian varieties, experimental genotypes (some from the NextGen project) and local preferred checks. The mother trials included all genotypes in replicated 60-plant plots, which were used to gather agronomic data and provide 3 expert processors at each location with roots for processing into gari, and its cooked product, eba. In Osun state, cassava was also processed into two types of fufu. During the processing operations, detailed data on relevant processing attributes and conditions such as time of peeling, yield of gari, toasting temperature, etc, was taken by researchers, while processors were interviewed on their assessment of processing quality of each cultivar for each product. Eba quality was also evaluated by processors. Baby trials were established with 20 producers in each state and used to engage with a diversity of carefully selected users chosen to represent different social groups. A sub-set of experimental genotypes and local checks was used in smaller, replicated trials at each farm, with all experimental genotypes evaluated at an equal number of farms. Regular visits during growth and after harvest provided insights on the genotype performance by the various users. Detailed data collection protocols and forms were developed and used by the team for both the mother and baby and processing trials, and used rating scales, ranking and detailed

probing to elucidate producer and processor assessments. Preliminary report and forms are posted on the RTBfoods portal.

- Similar trials were conducted for boiled and pounded yam using expert processors at 3 locations in 2 states, Oyo and Ondo, in Nigeria. Results remain to be reported, but certainly generated a wealth of information on genotype performance and provided input to each of the WPs.
- Sweetpotato trials in Uganda expanded on standard CIP on-farm trial methods, which included community engagement under the MENU project, a project aimed at evaluating and promoting orange fleshed sweetpotato varieties in selected Districts. A set of genotypes, including local white fleshed check, were evaluated boiled or fried. Three tests [Hedonic, Just-About-Right (JAR) test and Check All That Applies (CATA) test] were used. Preliminary results indicated preferred genotypes for both boiled and fried sweetpotato. However, in some cases, sweetpotato yields were very poor, and did not permit the full range of anticipated consumer sensory assessments.

The first reporting period has been a period of intensive activity across the project, with major efforts undertaken to a greater extent in WPs other than WP5. During the initial stage of project implementation there will be a need for strong interaction of WP5 with WPs 1 and 2 for development of protocols for user assessment and provision of materials for physiochemical analysis. However, WP5's ultimate objective is to provide standard, easily implementable protocols to elicit producer, processor and consumer feedback on advanced materials prior to release. Standard methods will certainly include user of "mother trials" and collaboration with expert processors. The use of citizen science approaches including the triadic comparison of technologies (tricot) Climmob methods developed by Bioversity also appear to offer promise, and the potential to use this method to complement and amplify the results of baby trials will be systematically investigated as a WP5 method in the coming seasons.

4.5.2 WP5 Results Tracker: Activities & Milestones achieved

Output 3.1.1: *Methodology for participatory assessment of VUEs acceptance developed*

Activities conducted	***Deliverables***
Participatory evaluation of new hybrids (from partner RTB breeding programs) with adapted WP1 Guidance	For Period 1, a summary of preliminary results is provided in WP5 Extensive activity report for Period 1.

Output 3.1.1 Indicator	***Target / Milestone***		
	Planned for Period 1	***Achieved***	***Variance & Brief Explanation***
Nb of new hybrids from partner breeding programs assessed against users' quality preferences	10 new hybrids from partner breeding programs (Nextgen, Sasha, BBB)	*Mother-baby cassava evaluations in Nigeria : Included ~25 genotypes and 3 nextgen hybrids* *Yam evaluations in Nigeria : On-farm trials, 12 genotypes, 6 new hybrids from IITA breeding effort* *Sweetpotato*	*Ongoing project activities had genotypes, including breeding program products for evaluation in WP5 advanced trials.*

Output 3.1.1 Indicator	Target / Milestone		
	Planned for Period 1	Achieved	Variance & Brief Explanation
		evaluations in Uganda : 9 genotypes in multi-locational on-farm trials with 7 genotypes from CIP/NARO breeding program *Several bananas in multiplication for evaluation in Cameroon and Cote d'Ivoire.* *Yam, cassava, sweetptato available in Cote d'Ivoire anticipated for trial once recommended testing methods developed*	

4.5.3 Methodology development

- *Relevance: For which reasons is a « new » methodology being developed within RTBfoods project? What for? Which Originality as compared to existing methodologies for participatory assessment of new RTB hybrids?*
  - At this initial stage, trials have been and will be done with the multiple purposes of defining user-preferred attributes, including sampling for laboratory analysis and sensory analysis, and development of efficient methods of engaging with users including processors. In the three substantive cases conducted this year : cassava and yam in Nigeria and sweetpotato in Uganda, trial methods already determined by partner projects were used : mother-baby (cassava), and standard single-rep multilocational on-farm trials (yam and sweetpotato) were used by implementing scientists and partners, with the additional facet of engagement with experienced processors and/or consumers. Lessons learned during these initial trials will help us to develop recommended practices for efficient engagement with users at the advanced trial stages.

- *Lessons Learnt from participatory assessments of new hybrids conducted by WP5 in Period 1: Which major methodological learnings from activities conducted in Period 1 by WP5 partners on the different RTB crops?*
  - Engagement with expert processors, an approach used for cassava and yam evaluation in Nigeria provided useful results from the mother-baby trials. However, the effort required was quite significant. Furthermore, the effort required to engage with all of the baby trial producers also added demands for monitoring visits. The sweetpotato trials in Uganda involved careful engagement with consumers for the assessment of boiled and fried products, and this too required a very significant effort on the part of the researchers. However analysis and reporting of these results was

only preliminary, and a complete assessment cannot be made at this time.

- *How first learnings from WP5 could benefit partner breeding programs (learning dimension)?*
  - Lernings from year 1 will be discussed with partners to determine lessons learned, and develop plans for year 2 trials. What is ultimately needed, once user needs are understood, will be relatively simple protocols for engagement with users. Ideally these methods should be simple and powerful, and readily taken up and used by a range of partners. Though trials were not conducted using the Climmob method, the approach is being used by NextGen cassvava and the BBB projects, and discussions were held within the project and with external partners to seriously assess the suitablity of this approach for routine application during statge 4 (advanced) trialing.

- *Gaps/Risks identified & Next steps in methodology development: what is missing to have an exhaustive methodology shareable within the RTB breeding community & likely to attract their attention? What need to be done in the next coming years within WP5 to reduce these gaps / limit these risks?*
  - We need to consider feedback of all partners with regards to lessons learned from year 1. Trials will be continued in year 2, with possible revisions to year 1 designs in the case of cassava, yam and sweetpotato. Preliminary results for potato and banana trials will also be available for consideration. Ultimately, for each crop, we require suitable, relatively low input trials that will allow us to efficiently determine user assessments (agronomic, and quality) of varieties proposed for release in order to make informed decisions about whether to advance materials under evaluation or not.

Output 3.1.2 : *Acceptability of VUEs validated by RTB users (farmers, processors, retailers and consumers)*

Activities conducted	***Deliverables***
Inventory of ongoing or planned on-station or on-farm assessments of advanced selection prior to release	For Period 1, a summary of on-ongoing or planned on-station or on-farm assessments is provided in the WP5 Extensive activity report.

All trial work conducted so far has been on-farm. On-station work is not anticipated. Cassava and yam work in Nigeria is planned for repeat. Sweetpotato work in Uganda will need to be repeated, while potato and possibly cassava trials in Uganda will need to be planned and discussed at the RTBfoods annual meeting. As mentioned previously, work may be planned in each country, but awaits consultation based on results of WP1 findings, and recommendations of initial WP5 trials.

4.5.4 Team coordination

- *Successful collaborations on some activities and/or for some food products among WP5 partners?*
  - The strong engagement of the cassava and yam teams in Uganda was not anticipated during the planning for year 1, but was most welcome, and will provide significant information for discussion when planning for the next season's trials, and for providing input to the methods of others.

- *Challenges faced in coordination of WP5 team work?*
  - WP5 was not anticipated to start strong, so challenges are not great. The great

disappointment was less than optimal results from the sweetpotato trials in Uganda, based to some extent on reliance on the HarvestPlus MENU project, which experienced delayed funding in 2018, and hence delays in project implementation.

- *Strategies to be reinforced/developed by WP5 coordination team for Risk mitigation & Partner mobilization in WP5 activities? If possible, refer to the teams (Institution+Country+RTB crop or food product concerned) you would like to see more involved in WP5 activities in the future.*
  - Annual meeting for year 2 planning should allow resolution of any potential problems and adequate interaction to lead to clear plans and commitments by relevant partners.

Success Story Box **:** *If relevant, WP Success Stories you want to make appear in the Annual Report: Narrative on WP framework, or set of activities that illustrate well the dynamism and the innovative framework of RTBfoods research project. List the teams involved (Institution+Country+RTB crop or food product concerned), the type of Activity and the Point(s) of Interest you want to put the lights on (300 words max per Success Story).*

Nothing at this time.

- *Fill-in the table below with a brief description or bullet-point lists of interactions with other WPs (successful ones & gaps) and propositions for risk mitigation*

	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed form other WPs ? (NR = not relevant)***	***Risk mitigation: How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP1	• CIP WP5 funds were used to support WP1 training in Benin and for survey work in Uganda because WP1 funds were inadequate for required work. Furthermore, WP1 results are essential to implementation of WP5 activities.	• Continuing need for discussion and interaction	• We are making plans for this interaction, incuding with WP4 and WP2.

4.5.5 Conclusion on Progress & Key Achievements

- *Synthesis on what worked well in Period 1 - Successful achievements – Strengths & Complementarities of scientists involved in WP5.*
  - Interaction of gender specialist, Bela Teeken, with cassava and yam trials in Nigeria was really appreciated. Lessons learned from this work will guide further efforts in year 2.

4.5.6 Perspectives for Period 2:

Draft of work plan for WP5 (new *hybrids from partner breeding programs to be assessed, food products concerned, teams (& product champion(s)) to be involved, etc). .*

Lists of genotypes and work plans for period 2 will be confirmed during the review process. See below for tentative list products, partners and places to be addressed in the coming period(s).

Annex 1: Targeted RTB crops, food products by countries within RTBfoods project.

RTB Crops	***Food/Processed Products***	***Primary countries***	***Spillover countries***	***National partners***	***International partners***	***Product Champions***
Cassava	**Boiled & Pounded cassava**	**Uganda, (Colombia)**	Benin	NaCRRI, NARL, Benin-UAC,	CIAT, CIRAD, INRA, NRI	*Robert Kawuki & Thierry tran*
	Granulated cassava: Gari, Eba, attiéké	**Nigeria**	Cameroon, Côte d'Ivoire, Benin (?)	IRAD, CNRA, UAC/FSA/NRCRI	IITA, CIRAD, NRI	*Bussie Maziya D. / Ugochukwu Ikeogu*
	Fufu	**Nigeria**	Cameroon	NRCRI, NaCRRI	IITA, CIRAD, NRI	*Ugo Chijioke / Apollin Fosto*
Cooking banana	**Boiled plantain**	**Cameroon**	Nigeria (might be done together with Fried Plantain), Côte d'Ivoire	CARBAP, CNRA	CIRAD, INRA, Bioversity, IITA	*Gérard Ngoh Newilah*
	matooke	**Uganda**		NARL	BIOVERSITY, CIRAD, IITA	*Kephas Nowakunda*
	Fried plantain, Alloco	**Nigeria** (can be done together with boiled plantain)	Cameroon	CARBAP	IITA/CIRAD	*Josephine Agogbua / Delphine Amah*
Sweet potato	**Boiled Sweetpotato (& purée?)**	**Uganda**		NARO (NaCRRI)	CIP, JHI, North Carolina State University, NRI	*Robert Mwanga*
	Fried Sweet potato	**Nigeria**	Cote d'Ivoire, Uganda	NARO (NaCRRI), CNRA	CIP, CIRAD, NRI	*Jan Low*
Yam	**Boiled Yam**	**Benin**	Nigeria, Cote d'Ivoire	Bowen U., UAC/FSA, CNRA, NRCRI	CIRAD, IITA, INRA, NRI	*Noël Akissoé*

RTB Crops	*Food/Processed Products*	*Primary countries*	*Spillover countries*	*National partners*	*International partners*	*Product Champions*
	Pounded Yam	**Nigeria**	Cote d'Ivoire, Benin	Bowen U., UAC/FSA, CNRA, NRCRI	CIRAD, IITA, INRA, NRI	*Jude Obidiegwe / Bolanle Otegbayo*
Potato	**Boiled potato & Potato fries (?)**	**Uganda**		Kazardi	CIP, JHI	*Thiago Mende / Elmar Shulte*

4.6 Annex 6: WP6 Extensive Activity Report

Main Author(s):

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This synthesis refers to the following teams

	Partner Institution(s)	***Country***	***RTB crop(s) of interest for RTBfoods***	***Processed/Food Product(s) of interest for RTBfoods***	***Names of people involved in the team for this WP***
Team 1 PMU	CIRAD	France	All	All	Dominique DUFOUR Eglantine FAUVELLE Cathy MEJEAN Philippe VERNIER
Team 2 Finance	CIRAD	France	NR	NR	Delphine MARCIANO Anne-Laure PERIGNON
Team 3 Contracting officers	CIRAD	France	NR	NR	Marion MILLE Ghislaine VOLLE

4.6.1 Key achievements

Monitoring Evaluation & Learning

During the RTBfoods Inception Meeting, a whole day was dedicated to Monitoring and Evaluation. Partners organized in workpackages (WPs) were asked to revise the list of outputs they will produce and outcomes they will contribute to within RTBfoods project. This lists of outcomes and outputs produced during the inception meeting were re-worked during Period 1 by the PMU after reception of WP work plans. It was necessary to check the alignment between work plans and the RTBfoods Results Tracker against which CIRAD committed to report annually to the Foundation. The PMU worked closely with R. Ofei to revise the Results Framework and Results Tracker that were submitted

for approval to the Foundation. Each proposed change was explicitly justified and documented. Most of the changes that were submitted for validation were rewording (i.e. better formulation for outputs and outcomes, most of them were initially phrased activities or deliverables in the first version from July 2017 attached to the Project Narrative). Milestones that were missing in the first version of the Results Tracker were defined with clear qualitative and quantitative indicators for monitoring and evaluation purposes. The new versions of the Results Framework and Results Tracker were agreed upon by the Foundation on 16 November 2018. Reporting for Period 1 will then be done on these versions.

In parallel, a survey on breeders practices was designed by the PMU to inform the initial situation prior to RTBfoods project. This survey is to be used at the beginning and at the end of the project with the objective of assessing the progress towards achieving outcomes. Partner breeders will be first interviewed during the Period 1 Annual meeting before targeting a broader RTB breeding community.

For monitoring purposes, the PMU also developed a panel of monitoring tools to ensure a weekly tracking of the progress of each WP toward the completion of the activities listed in the work plan and the production of deliverables. Regular coordination meetings were organized between the project manager and WP leaders and co-leaders, with a timeframe that differs between WPs according to coordination specific needs. Some cross-WP calls were also organized especially between WP1 & 2, WP1 & 5.

Finally, an online MEL platform was set up to be used during the project lifespan for reporting purposes and to provide open access to its products and results. This platform is already used by the CGIAR to store and give access to deliverables produced by its different programs. The RTBfoods PMU together with the PMU of the CGIAR program CRP RTB took the decision to map the RTBfoods project to 2 flagships of the CRP RTB. More precisely, 11 out of the 17 project outputs are mapped to flagship 4 and cluster CC4.1 and the 6 other outputs are mapped to flagship 1, cluster D1.1. This configuration shown the best consistency with the RTBfoods Results Framework as a whole. Once uploaded on the MEL platform, each RTBfoods deliverable is made open access and downloadable through a unique hyperlink.

Project Coordination

The project leader visited partners and targeted countries during missions in Nigeria, Uganda, Benin and Colombia. In parallel to visits of laboratory facilities, fields and experimental trials, RTBfoods coordination meetings were organized to follow-up on partners' progress and address challenges faced in the development of activities. Most of the time, all partners based in the country participated to these coordination meetings. These events allowed the project leader to identify gaps and risks in coordination of activities between teams, partners and/or WPs. These missions to partner countries were key moments for the PMU to develop strategies, methods and tools to mitigate risks to effective collaborative work.

In addition to the regular coordination meetings between the project manager and the WP leaders and co-leaders, the PMU organized - first monthly, then bimestrial - virtual coordination meetings with WP leaders and co-leaders. These coordination meetings allowed PMU and WP coordinators to follow-up on activities carried-out by each teams in the targeted countries, inform partners in a consistent and uniform way (e.g. on project strategies and deadlines), to get their feedback on strategic orientations or adjustments to be made at project and/or in a specific WP. Missions to partner countries, coordination meetings are the main methods used by PMU to continuously adapt its coordination and to ensure an efficient flow of information.

As project coordinator, CIRAD PMU was responsible for the development of the project Global Access Strategy. This document required by the Foundation details the principles and the process by which the results produced will be made publically available. Long term storage of data produced on secured on-access repositories and the compliance with the current international regulations (e.g., the EU General Data Protection Regulation (GDPR)) were addressed in specific sections. Global Access Strategy was shared with partners and approved by all of them prior to validation by the Foundation.

Administrative Support & Logistics

The project assistant daily supported CIRAD staff involved in RTBfoods in the organization of their mission to partner countries. During Period 1, she also actively supported the logistical and administrative organization of the WP2 Sensory Training workshop which took place in Uganda and was hosted by NARL.

The project assistant and the project manager were also implicated in the development of the RTBfoods sharing and collaborative platform used by partners to securely store their working documents, protocols and literature references. In the perspective of the development of a secured RTBfoods dataverse repository for the storage of socioeconomic, physicochemical and spectral data on the long-term, the PMU attended a 2-day training organized internally at CIRAD.

During the first months of Period 1 The Finance team was actively involved in money transfer to partners. At the end of Period 1, the finance team has leaded the interim financial report, they were responsible of checking the alignment of expenses reported by partners with the budget initially planned on the one hand and the narrative on activities carried-out by staff involved on the second hand.

Benchmarking & Strengthening links with partner programs & institutions

The project leader was invited to participate in meetings and visits organized by partner projects, members of the RTBfoods Advisory Committee and partner institutes. Among others, he attended the AfricaYam, Nextgen and Sasha 2018 annual meetings and was invited to the discussions prior to BBB phase 2, by the BBB project leader Rony Sweenen. The project manager and the project leader also participated in the Symposium of the International Society of International Root Crops in Cali, Colombia. These meetings with the RTB breeding community of practice were the opportunity to remind the complementarities between the partner RTB breeding programs and to identify opportunities for joint activities and/or new collaborations.

The project leader was also invited by Hans van Doorn, who is a member of the RTBfoods Advisory Committee, for a 2-day visit of HZPC laboratories. The PMU also received a delegation of Nestlé, member of the Advisory Committee, at CIRAD offices, in Montpellier. Among other topics discussed the parties reminded their willingness to collaborate within RTBfoods framework.

4.6.2 Team Coordination

Successful collaborations on some activities and/or for some food products among WP6 teams?

RTBfoods Steering Committee

WP6 teams, i.e. PMU, Finance and Contracting officers teams met regularly during either bilateral meetings or during the regular meetings of the RTBfoods Steering Committee. This committee was set up internally at CIRAD level specifically for RTBfoods project. The Directors of the 3 scientific

CIRAD departments are part of this committee, as well as the Director of the newly created Department of Marketing of Science and Impact, and the members of RTBfoods WP6 listed in the table above. During Period 1, this committee met every two months and helped WP6 teams address coordination issues and develop risk mitigation strategies.

Need-oriented intra-WP6 meetings

Bilateral meetings between PMU and Finance or Contracting officers teams are not planned in advance and are set up at the initiative of one of the parties when specific needs appear or specific questions have to be addressed jointly. WP6 Teams worked closely at the beginning of Period 1 and successfully managed to solve subcontracting and financial issues. During Period 1, the PMU and the Contracting officers teams met 3 times to prepare the Consortium Agreement to precise rules and responsibilities of project parties (i.e. partners and coordinator).

During Period 1, PMU and the Finance team met in average once per month; face-to-face meetings were a lot more frequent at the end of the Period to plan financial reporting to the Foundation. At the beginning of Period 1, money transfer to partners was an issue that was very well addressed by close and nearly continuous discussions between the PMU and the Finance team. Similarly, at the end of Period 1, these two teams met nearly once a week in December and January, to consolidate RTBfoods budget and be sure that financial reports received from partners are aligned with their narrative.

Collaborative tools

In complement to face to face discussions, specific collaborative tools were developed to ensure a proper workflow within WP6 (e.g, share agendas, collective emails address, collaborative editing tools, etc.). This regular and efficient communication between WP6 teams resulted in an adaptive management of the project during Period 1 whatever the evident challenges linked to contracting with a large number of partners.

4.6.3 Cross-WP Coordination & Collaboration

Fill-in the table below with a brief description or bullet-point lists of interactions with other WPs (successful ones & gaps) and propositions for risk mitigation.

As they are dedicated to provide support to RTBfoods partners, WP6 were contacted for different specific issues met at WP, team, partner or individual levels. In addition to these exceptional exchanges to deal with specific topics, the PMU maintained regular exchanges with WP leaders and partner focal points in order to coordinate and monitor activities carried out in the field. Daily exchanges for coordination purposes with other WPs, gaps identified and risk mitigation strategies proposed are summarized in the table below.

	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed from other WPs ? (NR = not relevant)***	***Risk mitigation: How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP1	Project manager participating in regular (once a month in average) WP1 coordination meetings with WP leader & co-leaders (NB: the WP1 coordination team set-up weekly skype calls)	More cross WP1 & WP2 coordination meetings More communication with WP5 for the development of the methodology for new hybrids assessment	Cross-WPs meetings should be facilitated by the PMU and Project manager in particular
WP2	Project manager organizing and participating in every WP2 coordination meeting (in average 1 skype call per month and more regularly when specific topics need to be discussed or special events organized by the coordination team)	Coordination meetings to be set up on a more regular basis	Idem previous Set-up an agenda to facilitate more regular meetings with WP leader & co-leaders
WP3	Project manager organizing and participating in most of the coordination meetings (but few of them in Period 1)	More regular meetings will be needed from Period 2 and + More cross WP3 & WP2 / WP4 meetings	Cross-WPs meetings should be facilitated by the PMU and Project manager in particular Project manager to ensure that the WP3 agenda for coordination meetings (agreed upon in October 2018) is put in place and respected by WP3 coordination team
WP4	Project manager participating in all coordination meetings (few of them in Period 1)	More regular meetings will be needed from Period 2 and + Role of co-leaders (by crop) to be clarified and reinforced	Set-up an agenda to facilitate more regular meetings with WP leader & Co-leaders

	Successful Interactions/ Coordination with other WPs (specific actions concerned, frequency, tool sharing)	***Gaps in Interactions/Coordination with other WPs: What is needed from other WPs ? (NR = not relevant)***	***Risk mitigation: How to Improve (specific actions to be taken, frequency, tool sharing?)***
WP6	Project manager organizing and participating in most of the coordination meetings or cross-WP coordination meetings (but very few of them in Period 1)	More regular coordination meetings will be needed from Period 2 and + More communication with WP1 for the development of the methodology for new hybrids assessment	Set-up an agenda to facilitate more regular meetings with WP leaders & Co-leaders Cross-WP1 & 5 meetings should be facilitated by the PMU and Project manager in particular

Challenges faced in coordination & Strategies to be reinforced/developed by WP6 partners for Risk mitigation?

Delays in Sub-grant agreements & Money transfer

It took months for the agreements to be signed by the responsible of each partner institute. The delay in signature generated a delay in money transfer to partner teams. This challenge was tackled by WP6 partners who interacted and took decisions jointly.

External Communication challenges

One of the challenges regarding the communication within RTBfoods, both internal and external communication, is due to the fact that no budget was initially dedicated to communication purposes during the budget process. Later, the PMU was asked to develop a website by the Direction of CIRAD, eager to take this opportunity to communicate widely on CIRAD activities on RTB crops. RTBfoods project was quickly pointed out to become a benchmark at the institution level. Due to the lack of specialised communication staff within the PMU, the decision was taken to first consult external communication companies to ask for quotations for the development of the RTBfoods communication strategy. After realising that this challenge was common to several CIRAD projects, this topic was taken up by higher spheres within the institution. Being discussed now is the subscription to one license at CIRAD level and the development of an online platform customizable by each project PMU to fit project needs. Such a platform would serve several objectives: internal communication & knowledge management by project partners, external communication for target audiences. The tool should be developed by an external IT company and ready for RTBfoods partner use before the end of Period 2. The PMU is currently interacting with the company to refine the project needs.

Internal Communication & Coordination

The coordination meetings organized between PMU and WP leaders should be defined on a more regular basis to ensure an even more efficient information flow and to be sure the challenges are

addressed as soon as they are identified by the project manager and/or the WP leaders and that they are discussed in a collective arena. An agenda for the PMU & WP leaders coordination meetings should be defined during the first RTBfoods Annual Meeting taking place in March 2019, in Abuja. In the same way, an agenda for meetings between the PMU and the 11 product profile champions should be agreed upon in Abuja. Now all State of Knowledge reports have been produced and need to be consolidated by product profile -jointly between WP1 and WP2 teams- and now first data needs to be transferred from one WP to another (especially from WP1 to WP2), the facilitation of cross-WP interactions becomes a priority. In parallel to regular PMU/product champion meetings, the project manager should be responsible for organizing bilateral monitoring meetings with each of the product champions on a regular basis. More generally, interactions between WPs through cross-WP coordination meetings have to be facilitated by the PMU and the initiative belongs to the project manager. The process for coordination meetings between PMU/the project manager and the WP leaders or product champions will be discussed collectively and agreed upon during the Annual Meeting in Abuja.

An increased role for product champions

At the end of Period 1, the needs for more coordination in the planification of activities linked to a specific product profile have emerged. In this perspective, the roles and responsibilities of product champions will be redefined in plenary session in the next RTBfoods Annual Meeting. For Period 1, the decision was taken by the PMU to focus more on reporting at the WP level and not to require too much from the product champions' side. However, we need to agree collectively on a better definition of the responsibilities of product champions especially regarding reporting. This will be formalized in the Consortium Agreement that is being written by WP6 members and will be shared with partners after the Annual Meeting in March, in Abuja.

4.6.4 Conclusion on Progress & Key Achievements

Synthesis on what worked well in Period 1 - Successful achievements – Strengths & Complementarities of WP6 teams in the different countries.

- Development of the Global Access Strategy validated by the Foundation;
- Revision of RTBfoods Results Framework and Results Tracker through interactions with the Foundation for a better alignment with WP and partner work plans;
- Setting-up of the MEL platform for reporting purposes with open access hyperlink for each RTBfoods deliverable;
- Development of collaborative and monitoring tools to ensure an operational workflow between teams and an efficient production of deliverables by partner teams.

4.6.5 Perspectives for WP6

- Completion of the RTBfoods **Consortium Agreement** report and sharing with partners for feedbacks and signature. This document will describe the roles and responsibilities (with a focus on reporting duties) of the parties at 3 different levels, tailored to RTBfoods framework (i.e. WP leaders, product champions and partner focal points).
- Development of an external **project Communication Strategy & tool/interface** that can also be used as a knowledge management system for project partners.
- Development of a RTBfoods **Data Management Plan** describing more precisely where the

different types of data (i.e. socioeconomic, physicochemical, spectral, phenotypic and genotypic data) produced by the project will be securely stored on the long term, the process and the responsible person(s) for the transfer to this/these repository(ies). The topic of data management should be addressed during the next RTBfoods Annual Meeting and discussed with the Boyce Thomson Institute in charge of the existing RTB crop specific databases we committed to store RTBfoods data on (cf. RTBfoods Global Access Strategy)

- Development of a **Monitoring Plan** to ensure that activities are actually carried out in alignment with work plans and in coordination between WPs, countries and in particular between teams working on the same product profile. The Monitoring Plan should also address how to better assess and monitor the progress towards the outcomes.
- Conducting the **outcome survey on RTB breeding practices** (with RTBfoods partner breeders and RTB breeders outside of the project framework) to inform the project baseline and later being able to assess the progress toward outcome achievement as mentioned in the RTBfoods Results Tracker.

4.7 Annex 7: Bioversity Synthesis Report for Period 1

Bioversity achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s): PRICILLA, Marimo, Bioversity International, Uganda

Collaborator(s):

4.7.1 Bioversity Summary

(10 to 15 lines of Partner achievement for Period 1)

Bioversity International is involved in work packages (WP) 1, 2 and 5 in Uganda. During period 1, activities related to WPs 1 and 2 were conducted. This section highlights the activities and achievements of Bioversity and partners in these work packages which were jointly coordinated with the National Agricultural Research Laboratories (NARL). Bioversity participated in the project inception meeting held in Cameroon in January 2018; WP1 pretesting of tools workshop in September in Uganda and WP2 Sensory panel training workshop also in Uganda in September. As part of WP1, Bioversity and NARL: completed a state of the knowledge (Sok) review focusing on desired product characteristics, demand segments, trends, and socio-cultural context for cooking banana; participated in piloting of tools and conducted farm level individual surveys and focus group discussions to characterize food consumption habits and preferences for men and women in Central and Western regions. In WP2, Bioversity contributed to the Sok. Two Masters students- Moureen Asasira (Makerere University) and Nelson Willy Kisenyi (Kyambogo university), were recruited and research costs will be shared with NARL. Moureen's thesis will focus on the trait preferences of urban banana value chain actors – she is finalizing her proposal and working on the data collection tools under WP1. Nelson will work on laboratory characterization and consumer preferences of local east African highland cooking bananas and hybrid varieties under WPs 1 and 2. He is currently working on his thesis proposal. Bioversity is complementing RTBfoods activities with the Breeding Better Bananas (BBB) project.

4.7.2 Bioversity activities

(Describe activities, collaborations between teams within the institution, project implementation)

In which WPs is the PARTNER team involved? For which activities conducted in Period 1? How is internally organized communication/coordination between WPs?

PARTNER participation in the different WPs & cross-WP interactions

Bioversity contributes to activities in WPs 1, 2 and 5. In Period 1, activities under WP1 and WP2 were conducted. In all project activities, Bioversity is working closely with NARL and has regular face to face meetings with NARL colleagues. In Uganda; CIP, NARL and Bioversity teams operate jointly as one project implementation team particularly supporting each other with general technical expertise especially during (a) customization of the project tools and methods to suit our specific commodities. NARL and Bioversity conducted the SoKs for WP1 and WP2 and jointly recruited two master's students were research costs will be shared. WP5 activities will begin in period 2.

WP1 activities in detail: Bioversity and NARL conducted a Sok on the desired product characteristics, demand segments, trends, and socio-cultural context for cooking banana which was submitted to the WP leader. Bioversity participated in the WP1 workshop on pretesting tools for activity 2

(gendered food mapping) and together with NARL conducted individual surveys, key informant interviews and focus group discussions with male and female farmers in Mbarara (Western region) and Luwero (Central region). We are in the process of coding and data entry. Scanning and upload of filled questionnaires will take place early next year.

WP2 activities in detail: Bioversity contributed to the SoK for WP2. An MS student was recruited who will contribute to activities in WP1 and 2.

4.7.3 Bioversity geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

- Activities are being conducted in Uganda - Central region (Luwero) and Western region (Mbarara). These regions were selected because they are high producing and consuming cooking banana areas and link with the ongoing BBB project.

4.7.4 Bioversity Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

- Bioversity is working on the steamed matooke product profile and was involved in WP1 and WP2 activities. The team members have been mostly being involved in activities with gender, socioeconomic and food nutrition/science elements.

4.7.5 Bioversity Personnel involved & Students activities

*List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab "**3a) PERSONNEL COSTS" of Partner Financial Report)***

List of personnel involved

Pricilla MARIMO (WP1 and WP2, Uganda; Bioversity WP1 coordinator and overall RTBfoods focal point. Involved in tools development for WP1)

Beatrice Ekesa (WP1 and WP2, Uganda; involved in WP2 activities particularly recruitment of Nelson Kisenyi and technical backstopping for WP2 activities that the student will be undertaking)

List of Students involved in RTBfoods activities in Period 1:

NAME Surname	***Master Student or PhD or Post-Doc***	***Subject Title***	***University of affiliation***	***Fellowship Starting Date***	***Fellowship Ending date***	***Tutor(s) in RTBfoods project***
NELSON WILLY Kisenyi	Master student	Biophysical and Physicochemical characterization of cooking bananas and consumer preferences	Kyambogo University	Sept 2018	Sept 2019	Pricilla Marimo (Bioversity), Moses Matovu (NARL) Kephas Nowakunda (NARL) Beatrice Ekesa (Bioversity)
MOREEN Asasira	Master student	Urban consumer's preferences for cooking banana	Makerere University	Sept 2018	Sept 2019	Kenneth Akankwasa (NARL); Pricilla Marimo (Bioversity) Kephas Nowakunda(NARL)

4.7.6 Bioversity Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

*(For more accuracy you can refer to: Tab "**3b) TRAVEL COSTS" of Partner Financial Report)***

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
1 person	RTBfoods inception meeting		21-29 January 2018
3 people	WP1 Pretesting of tools workshop and piloting of tools in the field		10-14 September 2018
2 people	WP2 Sensory panel training workshop in Uganda		16-22 September 2018

4.7.7 Bioversity Capital Equipment or investment (co-investments)

*List of equipment acquired on RTBfoods budget (e.g. texturometer, RVA, pHmeter, etc.) (For more accuracy you can refer to: Tab "**3d) EQUIPMENT COSTS" of Partner Financial Report)***

- NA

4.7.8 Bioversity Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
WP1 Pretesting of tools workshop and piloting of tools in the field	WP1	Uganda	10-14 September 2018	Daudi Mubiru Nelson Willy Kisenyi Moureen Asasira
WP2 Sensory panel training workshop in Uganda	WP2	Uganda	16-22 September	Beatrice Ekesa Nelson Willy Kisenyi Moureen Asasira

4.7.9 Bioversity Sub-awards & Consultants

*List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab **3c) CONSULTANT COSTS** and "**3f) SUB AWARDS COSTS" of Partner Financial Report)***

- Costs for the MS student (N. Kisenyi) were covered as consultant costs

4.7.10 Bioversity Other Sources of Support for RTBfoods activities

Which complementary / partner projects (other sources of fundings) contributed to RTBfoods activities in Period 1?

- Bioversity own contribution for Period 1 was USD427. These funds were used to cover a 2% CSP cost sharing percentage. Bioversity is obliged to pay this to the CGAIR System Management Office on all research grants.

4.7.11 Bioversity List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

- NA

4.7.12 Bioversity Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution?

Risks identified & Risk mitigation proposed?

- Communication was at some point overwhelming. Suggest streamlining communication process/protocol- it would be more manageable if communication is through WP leaders and product champions.
- Due to the limited budgets, Bioversity is collaborating with other research partners in particular NARL to cover research costs and also linking activities with the BBB project.

4.7.13 Bioversity Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 across WPs, Product profiles (& countries)?

- In period 2, Bioversity will continue to collaborate and share the product (steamed matooke), research costs and expertise with CIP and NaCRRI but particularly with NARL where we share research activities and students.

4.8 Annex 8: Bowen University Synthesis Report for Period 1

Bowen achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s): OTEGBAYO, Bolanle O., Bowen University, Nigeria

Collaborator(s): ORONIRAN, Oluyinka, FAWEHINMI, Olabisi, AYANDIJI, Adebamiji

4.8.1 Bowen Summary

(10 to 15 lines of Partner achievement for Period 1)

Bowen University team attended the inception meeting at Buea in Cameroon in January, 2018.

We also attended two capacity building trainings: WP1 April, 2018 (15-26th) members that attended include Bolanle Otegbayo (Food Technologist). Oroniran Oluyinka (Food Technologist), Fawehinmi Olabisi (Gender specialist/Economist). WP2: Sensory panel Training workshop in Kampala Uganda in September (17-21st). Members that attended were: Bolanle Otegbayo (Food Technologist). Oroniran Oluyinka (Food Technologist)

Bowen team was involved in writing State of Knowledge report on Pounded yam; this was delivered for both WPI & WP2. The conclusion of the SoK for WP1 which included document review and information gotten from interviewing key informants, farmers, processors, consumers is that review, textural quality is an important index of yam food quality to farmers, consumers and processors that consumers prefer food products; boiled and pounded yam from stored yam tubers than from fresh yam tubers. For WP2 SoK report which was mainly document review we concluded that there exists relationship between chemical composition (amylose, dry matter, starch, calcium, pectin) of Yam tubers, Histological structures (Starch granules, cell shape, cell size) that may be used to predict the textural quality of pounded yam as reported by various authors. Various authors used different instrumental methods to measure textural quality of pounded yam, the RTBfoods project should establish the best method that can be used to measure preferred textural quality attributes of pounded yam.

We were also involved in the food product profiling and gender mapping survey (activity 3) of WP1. The questionnaires and the excel data has been forwarded to the coordinator.

4.8.2 Bowen activities

PARTNER participation in the different WPs & cross-WP interactions

(Describe activities, collaborations between teams within the institution, project implementation)

Inception meeting:

- Bowen University team participated in the inception meeting
- Cotonou meeting: the team was present at the workshop on WP1 activities, training and mapping held in April
- Uganda meeting: sensory panel training was attended by the Food Scientists in the team
- IITA meeting: a regional meeting held at IITA, Ibadan was attended for progress reporting and harnessing of methods
- Field trip: survey was done at four yam farming and consumption communities (Ife Odan, Iwo, Gbongan and Ilesa) in Osun State. Focus group discussions (farmers (male and female), traders) market interviews, key informants and individual interviews and transect walks were done. (we found it very hard to get clusters of processors of pounded yam, hence we could only do one focus group discussion on pounded yam processors, however, we

were able to do individual processor's interview)

In which WPs is the PARTNER team involved? For which activities conducted in Period 1?

WPI and WP2

WP1:

- Cotonou training workshop,
- State of Knowledge on pounded yam
  Gender mapping and product profiling survey

WP2:

- Laboratory *Inventory of protocols for biochemical analysis*
- *State of knowledge for fresh yam and pounded yam*
- Training on sensory evaluation
- *Participation in global call conference*

How is internally organized communication/coordination between WPs?

This was done very well and effectively.

4.8.3 Bowen geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

Nigeria

Osun State

4.8.4 Bowen Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

Pounded yam, boiled yam.

How?:

WP1:

- Cotonou training workshop,
- State of Knowledge on pounded yam
  Gender mapping and product profiling survey

WP2:

- Laboratory *Inventory of protocols for biochemical analysis*
- *State of knowledge for fresh yam and pounded yam*
- Training on sensory evaluation
- *Participation in global call conference*

4.8.5 Bowen Personnel involved & Students activities

*List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab "**3a) PERSONNEL COSTS" of Partner Financial Report)***

List of Students involved in RTBfoods activities in Period 1:

NAME Surname	***Master Student or PhD or Post-Doc***	***Subject Title***	***University of affiliation***	***Fellowship Starting Date***	***Fellowship Ending date***	***Tutor(s) in RTBfoods project***

4.8.6 Bowen Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

*(For more accuracy you can refer to: Tab "**3b) TRAVEL COSTS" of Partner Financial Report)***

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
2	Inception meeting	Cameroon	Jan, 2018
3	WP1 workshop	Cotonou	April, 2018
2	Sensory panel training	Uganda	Sept, 2018

4.8.7 Bowen Capital Equipment or investment (co-investments)

*List of equipment acquired on RTBfoods budget (e.g?. texturometer, RVA, pHmeter, etc.) (For more accuracy you can refer to: Tab "**3d) EQUIPMENT COSTS" of Partner Financial Report)***

The capital equipment that we budgeted for is the FIbertec, this is yet to be purchased.

4.8.8 Bowen Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
Gender mapping training and product profiling	WP1	Benin	April, 2018	Otegbayo, Bolanle Fawehinmi, Olabisi Oroniran, Oluyinka
Sensory panel training	WP2	Uganda	Sept, 2018	Otegbayo, Bolanle Oroniran, Oluyinka

4.8.9 Bowen Sub-awards & Consultants

*List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab **3c) CONSULTANT COSTS** and "**3f) SUB AWARDS COSTS" of Partner Financial Report)***

Consultants

OGUNTUNJI, A. O.	Field assistant
OMILANI O.	Field assistant
ALAMU A. D.	Field assistant
TANIMOLA A.R	Field Assistant
OLAWUYI Y.	Field Assistant
LALA O.	Field Assistant
AYANDIJI A.	Agric. Extensionist
FAWEHINMI O.	Gender specialist
Contact Farmers (5)	

4.8.10 Bowen Other Sources of Support for RTBfoods activities

Which complementary / partner projects (other sources of fundings) contributed to RTBfoods activities in Period 1?

Research time was granted by the University.

4.8.11 Bowen List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

Not yet.

4.8.12 Bowen Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution?

Risks identified & Risk mitigation proposed?

Unplanned and unbudgeted for training activities negatively affected the project financially

Mitigation: we had to readjust some expenses

WP1: The work expanded beyond the initial proposed activities during proposal writing stage

- Difficulty in getting clusters of processors for pounded yam during interview reduced the number of focus group discussion for pounded yam processors.
- Lengthy questions wherein some were repeated thus wearing out the participants during the interview

4.8.13 Bowen Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 across WPs, Product profiles (& countries)?

Work plan

WP	***Activity***	***Date***
WP1	Activities 4 - processor's demonstration	*January - February, 2019*
	Activities 5 - consumer acceptability	*January - February, 2019*
WP2	Collection of yam samples	*January, 2019*
WP2	Training of panels for sensory evaluation	*February, 2019*
	Sensory evaluation	*February - April, 2019*
	Review meeting	*March, 2019*
	Commencement of biophysical analyses	*May, 2019*
	Sample preparation, dry matter, yam flour, yam starch extraction, pasting characteristics	*May – August, 2019*
	Biochemical analyses - Proximate analyses	*September-November, 2019*

4.9 Annex 9: CARBAP Synthesis Report for Period 1

CARBAP achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s): NGOH NEWILAH, Gérard, CARBAP, Cameroon

Collaborator(s): KENDINE VEPOWO, Cédric

4.9.1 CARBAP Summary

(10 to 15 lines of Partner achievement for Period 1)

During Period 1, CARBAP delivered a State Of Knowledge (SoK) review on boiled plantain (activity 1). The SoK review focused on food science, gender and demand context. CARBAP actively participated in the Capacity Strengthening Workshop (Activity 2) which was held in Cotonou-Benin from the 16th to the 25th of April 2018. From the 5th to 20th of September 2018, surveys on boiled plantain were carried out in the West and Littoral regions of Cameroon within the framework of activity 3 of WP1. In each of these regions, four localities were of interest and the participants were selected randomly based on their ability to grow, prepare or consume plantain. Finally, eight key informant interviews, sixteen focus group discussions, seventy-eight individual interviews and eight market interviews were conducted. Excel spreadsheets, consent forms, filled questionnaires and activity 3 report were submitted. Concerning WP2, a SoK review was reported by CARBAP on the composition and structure of raw bananas and plantains, processing conditions of plantain pulps, sensory analysis and consumer preferences, boiled plantain characterization and relationship with sensory evaluation. CARBAP Also participated in the sensory panel training workshop held in National Agricultural Research Laboratories – NARL in Kawanda-Uganda from September 17th to 21st, 2018. For WP5, meetings were organized in collaboration with IITA in order to elaborate the protocols for the validation of agronomic and user preferred traits in selected genotypes. We settled on: the localities for trial setup, the plantain hybrids and local cultivars to be evaluated, the number of accessions and the agronomic practices.

4.9.2 CARBAP activities

PARTNER participation in the different WPs & cross-WP interactions

(Describe activities, collaborations between teams within the institution, project implementation)

In which WPs is the PARTNER team involved? For which activities conducted in Period 1? How is internally organized communication/coordination between WPs?

CARBAP is involved in WP1, WP2, and WP5. CARBAP elaborated the SoK review of WP1 and WP2 in collaboration with libraries of the universities of Yaoundé I, Dschang and Douala in Cameroon. The WP1 Capacity Strengthening Workshop was coordinated by CIRAD in collaboration with *Université d'Abomey Calavi*. It aims at designing a robust interdisciplinary methodology bridging economics, food science, gender and employing participatory approaches to identify trait preferences in RTBfoods products. The workshop was an occasion for CARBAP representatives to meet and discuss with researchers and personnel from various countries implicated in WP2 and WP5. Activity 3 surveys were carried out with the participation of a gender specialist from the University of Dschang – Cameroon. In WP2 CARBAP participated in the training workshop on sensory panel. It helps the leaders from RTBfoods partner institutions to better understand processes related to recruitment, selection and forming a panel, in order to establish, with a harmonized methodology, the sensory profile for each of the 11 final products under study in

RTBfoods project. The leaders were also trained in the setting up of tests (sampling, service,...), data collection and data processing. For WP5, CARBAP strongly interacted with IITA on decisions concerning the accessions to be involved in the trials and the agronomic practices to be implemented. Furthermore, as product profile champion, CARBAP helps IITA to setup the questionnaires for the activity 3 of WP1 concerning fried plantain.

4.9.3 CARBAP geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

CARBAP conducted activities related to SoK and surveys in three regions of Cameroon namely West, Littoral and Centre. The capacity strengthening workshops were held in Benin and Uganda in Africa.

4.9.4 CARBAP Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

CARBAP has been involved with “Boiled Plantain” during Period 1 through i) SoK review for WP1 and WP2, and ii) surveys carried out in eight localities of two regions in Cameroon (Littoral and West regions). In each locality questionnaires were administered to Key informants, during focus group discussions, to marketers and individuals who were all knowledgeable on raw and boiled plantain.

4.9.5 CARBAP Personnel involved & Students activities

List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab “3a) PERSONNEL COSTS” of Partner Financial Report)

Personnel of CARBAP and of the University of Dschang as well as internship students. They include:

1. Dr Gérard Ngoh Newilah, CARBAP
2. Mme KONZEM FOMBASSO Anliette Aimée, CARBAP
3. Dr Meli Meli Vivien (consultant hired for activity 3 of WP1)
4. Kendine Vepowo Cédric (PhD Student)
5. TAKAM NGOUNO Annie (Student hired for activity 3 of WP1)
6. YONG LEMOUMOU Judeon (Student hired for activity 3 of WP1)

List of Students involved in RTBfoods activities in Period 1:

NAME Surname	***Master Student or PhD or Post-Doc***	***Subject Title***	***University of affiliation***	***Fellowship Starting Date***	***Fellowship Ending date***	***Tutor(s) in RTBfoods project***
KENDINE VEPOWO Cédric	PhD student		University of Dschang			Dr Ngoh Newilah
TAKAM NGOUNO Annie	Master student		University of Dschang			Dr Ngoh Newilah
YONG LEMOUMOU Judeon	PhD student		University of Dschang			Dr Meli Meli

4.9.6 CARBAP Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

(For more accuracy you can refer to: Tab "3b) TRAVEL COSTS" of Partner Financial Report)

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
Dr Gérard Ngoh Newilah	Kick off Meeting	International meeting	January 2018
Carbap team	Kick off Meeting	International meeting	January 2018
Dr Gérard Ngoh Newilah	WP1 training workshop in Benin	International workshop	April 2018
Kendine Vepowo Cédric	WP1 training workshop in Benin	International workshop	April 2018
Dr Gérard Ngoh Newilah	WP2 training workshop in Uganda	International workshop	September 2018

4.9.7 CARBAP Capital Equipment or investment (co-investments)

List of equipment acquired on RTBfoods budget (e.g?. texturometer, RVA, pHmeter, etc.) (For more accuracy you can refer to: Tab "3d) EQUIPMENT COSTS" of Partner Financial Report)

No equipment acquired during period 1.

4.9.8 CARBAP Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
Capacity Strengthening workshop	WP1	Benin	16th – 25th April 2018	NGOH NEWILAH Gérard; KENDINE VEPOWO Cédric
Sensory Panel	WP2	Uganda	16th – 22nd September 2018	NGOH NEWILAH Gérard

4.9.9 CARBAP Sub-awards & Consultants

List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab 3c) CONSULTANT COSTS and "3f) SUB AWARDS COSTS" of Partner Financial Report)

A consultant (gender specialist) was hired for activity 3 implementation.

4.9.10 CARBAP Other Sources of Support for RTBfoods activities

Which complementary / partner projects (other sources of fundings) contributed to RTBfoods activities in Period 1?

None

4.9.11 CARBAP List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

Publications:

1. **Ngoh Newilah Gérard Bertin, Tembe Tembe Jonas, Nkouandou Mama, Ngombi Ngombi Eric, Kendine Vepowo Cédric, Fokou Elie, Etoa François-Xavier & Dhuique-Mayer Claudie. (2018). Effects of drying and boiling on some specific dietary carotenoids profiles and levels of plantain pulp (*Batard* cv.) produced in Cameroon. *International Journal of Agriculture, Environment and Bioresearch*.** 3 (6): 212-231. http://ijaeb.org/link2.php?id=272
2. Ngoh Newilah Gérard Bertin, Njapndounke Bilkissou, Tembe Tembe Jonas, Nkouandou Mama, Ngombi Ngombi Eric, Kendine Vepowo Cédric, Manjia Ngoungoure Solange Ulrich & Zambou Ngoufack Francois (2018). Optimization of process conditions for jam production from plantain-like hybrid (CARBAP K74) grown in two agro-ecological zones of Cameroon. *International Journal of Agricultural Policy and Research*. 6 (4): 50-63. https://doi.org/10.15739/IJAPR.18.006

4.9.12 CARBAP Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution?

Risks identified & Risk mitigation proposed?

During Period 1, the implementation of RTBfoods project activities were disturbed by:

1. A strike in CARBAP due to lack of funds for functioning, followed by the resignation of the formal Director. Up to date, the situation is not yet stable.
2. Lack of budget for IITA to participate in WP5 activities defined in collaboration with CARBAP. It was planned that IITA will conduct WP5 trials in two localities and CARBAP in three.
3. The security situation in North-west and South-west regions of Cameroon where surveys on boiled plantain were supposed to be carried out. Furthermore, a WP5 trial was supposed to be settled in the South-west region at 400 m above sea level during Period 2.

4.9.13 CARBAP Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 across WPs, Product profiles (& countries)?

Planned from February to October 2019, CARBAP will continue WP1 activities related to:

- Activity 3: management of data from “gendered product mapping and user profiles”,
- Activity 4: participatory processing diagnosis and quality characteristics,
- Activity 5: Consumer testing in rural and urban user segments.

CARBAP will also contribute in WP2 activities concerning the biophysical and biochemical characterizations of plantain accessions, the establishment of standardized protocols for: i) uniform sensory testing validation related to boiled plantain, ii) conducting sensory testing on boiled plantain, iii) preparing boiled plantain.

For WP3, CARBAP hosts the largest on-farm plantain collection and will therefore strongly contribute through sampling and analysis in order to generate quantitative and qualitative predictive models based on reference analysis.

Activities of WP5 will be focused on planting material production – trial setup in contrasted localities – follow up and trial maintenance.

Finally for period 2, CARBAP will participate in the training sessions (sensory and physico-chemical

analyses) organized within the framework of RTBfoods project and to the annual meeting.

CARBAP will technically support partners working on plantain derived products such as chips and fried ripe plantains.

4.10 Annex 10: CIAT Synthesis Report for Period 1

CIAT achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s): TRAN, Thierry, CIAT/CIRAD, Colombia

Collaborator(s): CEBALLOS, Hernan, CIAT, Colombia

4.10.1 CIAT Summary

During Period 1, CIAT has implemented the following activities: Firstly, a database of biophysical traits (composition, cooking time & texture of raw and cooked roots) and NIRS spectra was established for 150 genotypes of cassava harvested in 2018, in preparation for investigating correlations and predictive algorithms between NIRS and biophysical data. This database will be expanded to 450-500 entries by adding data from upcoming harvests in 2019 and 2020. We expect this number will allow identifying robust correlations, and hence reliable HTPP predictions by NIRS of some of the quality traits of boiled cassava. As part of this work, to better describe the texture of cassava roots, a new texture protocol was developed, by screening several types of probes and measurement conditions to identify the configuration that optimizes coefficients of variation. This protocol was used to generate the texture data in the database of biophysical traits of boiled cassava.

Secondly, exploratory research was conducted to extract cell wall materials (CWM) from cassava roots and investigate correlations between CWM and quality traits of boiled cassava (texture, etc.). An extraction protocol of CWM was established, and CWM from 30 genotypes with contrasting cooking times (15 to more than 60 mins) were extracted. The extracts were characterized by NIRS and MIRS, and potential correlations with texture are being investigated.

Thirdly, seven standard operating protocols (SOPs) in use at CIAT for biophysical characterizations of cassava roots were inventoried and made available on the RTBfoods online platform.

Fourthly, genotypes with short to long cooking times, together with low cyanide, were selected and planted for crossings, in order to determine the heritability of the trait short cooking ability. Flowering and crossing are expected in the first quarter of 2019

4.10.2 CIAT activities

PARTNER participation in the different WPs & cross-WP interactions

In Period 1 CIAT was involved in WP2, WP3 and WP4.

WP2:

1. Inventory of the biophysical methods used at CIAT for characterization of RTB crops, in particular cassava. The standard operating protocols (SOPs) of these methods were uploaded to the RTBfoods online platform.

2. Development of the following two methods:

- A method to measure the texture of raw cassava roots and boiled cassava roots. After screening several texture probes, a penetration test with a cylinder probe (3 mm diameter) was identified as the most practical. Key advantages were to avoid breaking the roots during the test (in particular boiled roots), and minimizing the coefficients of variation. A SOP was developed and uploaded to the RTBfoods online platform, together with a report (powerpoint format) on the various tests conducted during texture method development.

- A method to extract cell walls materials (CWM) from cassava flours. The method is adapted from references in the scientific literature, and is based on enzymatic hydrolysis of starch followed by precipitation of the CWM with increasing concentrations of acetone. The method development is reported in a MSc report uploaded to the RTBfoods online platform.

3. Application of the new texture method to characterize raw cassava roots from 270 genotypes and changes in texture during boiling of 150 genotypes of. Initial results indicate the following:

Firstly, hardness dropped quickly within the first 10 minutes, with an average decrease of 77% from the initial hardness (measured at total area under the texture curve). All genotypes, in spite of the diversity of origin and specific hardness, behaved in a remarkably similar way on this aspect, with a coefficient of variation of 7.6% for the loss of hardness, compared to a coefficient of variation of 27.4% for the hardness after 10 minutes boiling. This points to an underlying molecular mechanism nearly identical for all genotypes, most probably starch gelatinization.

Secondly, in spite of this major change in hardness, further boiling until “optimum cooking time” was necessary to achieve the mealy texture preferred by consumers. Whereas the initial drop in hardness was similar among all genotypes, optimum cooking time was highly diversified, ranging from 15 up to 60 minutes with a coefficient of variation of 40%. Some genotypes never actually reached the target mealy texture. These observations confirmed the distinct roles of starch (general drop in hardness) and of other components such as pectins and cell wall materials (CWM) in developing the final texture of boiled cassava. Given the higher variability in cooking time, the key determining factor of cooking ability and quality seems to be the CWM fraction (and its composition and changes during boiling), rather than the starch fraction

Finally, the texture of the raw roots was a poor predictor of the texture of roots after boiling, i.e. the hardest raw roots are not necessarily the hardest roots after boiling.

4. Application of the CWM extraction method to flours from 30 cassava genotypes, for which cooking time and texture data are available. The 30 flours were selected from the 2018 harvest to represent a wide range of cooking times, from short cooking (15-25 minutes) to long cooking (60 minutes or more).

WP3:

WP3 activities were developed in collaboration between CIAT and CIRAD (Fabrice Davrieux, Karima Meghar).

- NIRS analysis of the 30 CWM extracts from cassava genotypes representing a wide range of cooking times, from short cooking to long cooking. The NIRS spectra of the corresponding flours (before CWM extraction) and fresh roots were also recorded and are available.
- MIRS analysis of the 30 CWM extracts. The MIRS spectra of the corresponding flours (before CWM extraction) were also recorded and are available.
- Search for correlations between texture data and NIRS & MIRS data. Further investigations are pending (data analyses, detailed analysis of the composition of the CWM, improvement of the texture protocol). In period 1 it was possible to carry out 30 CWM extractions; however further extractions will be needed in order to increase the size of the database, considering that the minimum to investigate correlations between biophysical data and NIRS data is 150-200 samples.
- Transfer of the equations for prediction by NIRS of dry matter and carotenoids developed with CIAT cassava materials (2013 version), to RTBfoods partner NaCRRI.

WP4:

Genotypes with short to long cooking times, together with low cyanide, were selected and planted for crossings, in order to determine the heritability of the trait short cooking ability. Flowering and crossing are expected in the first quarter of 2019. The materials selected for the crosses are listed below. Crossing nurseries will benefit from the recently developed protocols to induce earlier and more profuse flowering in cassava through the extension of photoperiod by illuminating plants with red light during the night, application of plant growth regulators, and/or pruning of young branches to promote ealier and more abundant fruit and seed set.

Good cooking quality (white parenchyma): CM 2600-2; CM 2766-5; CM 5253-1; CM 7436-7; SM 1127-8; MCOL 1505M; MCOL 2066; MCOL 2246; MCR 138; MGUA 24; MMAL 3; MMEX 2; MPAN 70; MPAN 139; MPAR 57; MPAR 98; MPER 183; MPER 496; MVEN 77; MVEN 208; MVEN 218; MCUB 74.

Good cooking quality (yellow parenchyma): GM 3674-41; GM 8373-46; GM 8391-4; GM 8413-1; SM 3759-36

Poor cooking quality and high cyanogenic potential: MBRA 318; MBRA 325; MBRA 512; MCOL 1722; MCOL 1910; MCUB 46; MVEN 25

In addition, nurseries to increase planning material for clones adapted to the sub-humid environment of Colombia contrasting for their root quality traits were planted by mid-2018. The stem cuttings from these genotypes will be used to assess the effect of genotype x environment interaction on cooking quality (including age of the plants and harvesting season).

4.10.3 CIAT geographic implementation / strategy

Activities are implemented in Colombia, making use of the genetic diversity of the cassava germplasm collection available at CIAT to characterize the variability of user traits, in particular for boiled cassava. The outputs (protocols, infrared calibrations, etc.) can be applied in other countries of the RTBfoods project.

4.10.4 CIAT Product Profile participation

In Period 1, CIAT has worked on the boiled cassava product profile.

4.10.5 CIAT Personnel involved & Students activities

During period 1, the following persons were involved in the RTBfoods project, all in Colombia on the boiled cassava product profile:

Name	***WPs***	***Activity***
Jhon Larry Moreno	WP2	Preparation and analyses of samples from raw cassava roots and boiled cassava Supervision of MSc student Nourdène Dhaouadi
Monica Pizarro	WP2	Preparation and analyses of samples from raw cassava roots and boiled cassava
Maria Alejandra Ospina	WP2	Development of the new texture SOP for raw and boiled cassava Preparation and analyses of samples from raw cassava roots and boiled cassava
Andrés Escobar	WP2	Development of the new texture SOP for raw and boiled cassava
Jorge Luna	WP2	Preparation and analyses of samples from raw cassava roots and boiled cassava
William Trivino	WP2	Preparation and analyses of samples from raw cassava roots and boiled cassava Development of the new texture SOP for raw and boiled cassava
John Belalcazar	WP2	As head of the post-harvest laboratory, planning and coordination of the activities for the RTBfoods.

Name	*WPs*	*Activity*
		Analyses of the NIRS data from the CWM extracts, as well as from fresh roots.
Thierry Tran	WP2	Scientific leadership Inception meeting in Cameroon
Nelson Morante	WP4	Coordinator of crossing nurseries to produce botanical seed from selected genotypes. Will produce botanical seed for segregation studies
Jorge I. Lenis	WP4	Coordinator of research activities in the sub-humid environment in Colombia. Will coordinate planting and harvesting trials to assess GxE studies on cooking quality
Hernan Ceballos	WP4	Scientific leadership in the area of cassava breeding

List of Students involved in RTBfoods activities in Period 1:

NAME Surname	*Master Student or PhD or Post-Doc*	*Subject Title*	*University of affiliation*	*Fellowship Starting Date*	*Fellowship Ending date*	*Tutor(s) in RTBfoods project*
DHAOUADI Nourdène	MSc	Extraction and analysis by NIRS of cell walls from cassava roots	Supagro Montpellier (France)	01 April 2018	30 September 2018	Jhon Larry MORENO Thierry TRAN

4.10.6 CIAT Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

Number of People or List of NAMES	*RTBfoods meetings*	*International / Regional Conferences*	*Dates*
Thierry Tran	Kick-off meeting, Buea, Cameroon		22-28 January 2018
Luis Augusto Becerra	Kick-off meeting, Buea, Cameroon		22-28 January 2018

4.10.7 CIAT Capital Equipment or investment (co-investments)

Two equipment were acquired in 2018:

- NIRS Foss DS2500
- RVA 4500 (Newport / Perten) (delivery expected in early 2019)

Co-funding from other projects (Harvest+, RTB) have enabled purchasing both equipment in Period 1.

4.10.8 CIAT Training participations (within RTBfoods framework and other trainings)

No training participation was planned in Period 1. Fabrice Davrieux (WP3 leader) and Karima Meghar (NIRS specialist at CIRAD – UMR Qualisud) came to CIAT from 26 October to 2 November 2018 (one week). In collaboration with the CIAT team, they revised the data generated in 2018 and investigated correlations between biophysical characterizations and NIRS of cassava genotypes, in particular dry matter, starch content, cyanide and texture of raw roots and boiled roots. Traits such as dry matter and starch content yielded promising results for NIRS predictions, while more data need to be accumulated for texture traits.

4.10.9 CIAT Sub-awards & Consultants

There were no sub-awards and consultants activities in Period 1.

4.10.10 CIAT Other Sources of Support for RTBfoods activities

The RTBfoods activities at CIAT are organized in synergy with other projects of the Cassava Program, in particular the CGIAR RTB (Roots, Tubers and Bananas). Key contributions from RTB funding include (i) production of the cassava roots from 270 genotypes representative of the genetic diversity of cassava in Latin America; (ii) personnel time not covered by RTBfoods; (iii) co-funding for capital equipment (RVA 4500).

In Period 1, the Harvest+ program also contributed co-funding for capital equipment (NIRS DS2500).

4.10.11 CIAT List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

Conference communications:

Dufour D., Fliedel G., Bouniol A., Davrieux F., Tran T., 2018. Cassava traits and end-user preference. *IVth International Cassava Conference - GCP21*, Cotonou, Benin, 11-15 June 2018.

Ospina M.A., Tran T., Pizarro M., Luna Melendez J.L., Trivino-Palacios W., Belalcazar Martinez J.E., Salazar S.M., Dufour D., Becera Lopez Lavalle L.A., 2018. Diversity of post-harvest phenotypic traits among the CIAT cassava germplasm collection. *IVth International Cassava Conference - GCP21*, Cotonou, Benin, 11-15 June 2018.

Ospina M.A., Tran T., Pizarro M., Luna Melendez J.L., Trivino-Palacios W., Belalcazar J., Martinez J.E., Salazar S., Dufour D., Becerra Lopez Lavalle L.A., 2018. Phenotyping postharvest physiological deterioration (PPD) in cassava: Implications for selection. *18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC)*, Cali, Colombia, 22-25 October 2018.

Luna Melendez J.L., Tran T., Pizarro M., Ospina M.A., Trivino-Palacios W., Belalcazar J., Martinez J.E., Salazar S.M., Dufour D., Becerra Lopez Lavalle L.A., 2018. Diversity of post-harvest phenotypic traits among the CIAT cassava germplasm collection. *18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC)*, Cali, Colombie, 22-25 October 2018.

Pizarro M., Ospina M.A., Luna Melendez J.L., Belalcazar Martinez J.E., Salazar S., Tran T., Becerra Lopez Lavalle L.A., Dufour D., 2018. Cyanide content and distribution in cassava plants, in association with physiological age. 18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Cali, Colombia, 22-25 October 2018.

Publications in peer-reviewed journals:

Escobar A., Dahdouh L., Rondet E., Ricci J., Dufour D., Tran T., Cuq B., Delalonde M., 2018. Development of a Novel Integrated Approach to Monitor Processing of Cassava Roots into Gari: Macroscopic and Microscopic Scales. *Food and Bioprocess Technology*, **11**, 1370-1380. **doi.org/10.1007/s11947-018-2106-5.**

Giraldo Toro A., Briffaz A., Gibert O., Dufour D., Tran T., Bohuon P., 2018. Modelling of heat and water transport in plantain during steeping to predict gelatinization and in vitro starch digestibility. *Journal of Food Engineering*, **235**, 1-8. **doi.org/10.1016/j.jfoodeng.2018.04.022.**

Standard operating protocols (SOPs):

Enzymatic determination of cyanhydric acid

Colorimetric determination of amylose content in cassava starches

Enzymatic determination of total starch

Laboratory scale extraction of cassava starch

Determination of post-harvest physiological deterioration of cassava

Determination of starch paste clarity

Boiling cassava: determination of cooking time and texture of cassava roots

4.10.12 CIAT Gaps & Constraints faced

Several projects on cassava post-harvest quality run in parallel at CIAT, which optimizes our use of resources by enabling synergies (e.g. shared fields and planting materials) and economies of scale. One challenge is to plan the yearly calendar of planting and harvests, so that the activities of all the projects, including RTBfoods, can be carried out timely and successfully, while also leaving flexibility to accommodate unplanned activities that arise from time to time.

Our practice to address this is to keep strong links between the field operation team and the post-harvest team, including daily communications during periods of harvest, in order to anticipate and address immediately any issue with harvests and post-harvest characterizations and analyses.

4.10.13 CIAT Perspective & Internal organization for Period 2

In Period 2, we will continue the activities of WP2 and WP3 to produce biophysical characterization data and NIRS spectra of fresh and boiled cassava roots, and feed the database for NIRS calibrations. The texture protocol developed during Period 1 will be revised and updated to increase accuracy and improve the chances of identifying correlations with NIRS.

Further exploratory research will be conducted on the usefulness of MIRS to characterize cell wall materials and seek correlations with texture of boiled cassava, in complement to NIRS characterizations.

For WP4, the first crossings of genotypes with various cooking qualities will be conducted in the first quarter. The seeds will be collected and planted by end of 2019, and the characterization of heritability of cooking traits in F1 is expected in Period 3.

4.11 Annex 11: CIP Synthesis Report for Period 1

CIP achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s):

- MAYANJA, Sarah, CIP, Uganda
- MUDEGE, Netsayi, CIP, Kenya
- CAREY, Edward, CIP, Ghana
- MUZHINGI, Tawanda, CIP, Kenya
- LOW, Jan, CIP, Kenya
- BURGOS, Gabriela, CIP, Peru
- MALAVI, Derick, CIP, Ghana
- BANDA, Linly, CIP, Kenya
- MBOGO, Daniel, CIP, Kenya
- ZUM FELDE, Thomas, CIP,
- MWANGA, Robert, CIP, Uganda
- MENDES Thiago, CIP, Kenya
- GRUNENBERG, Wolfgang, CIP, Peru

4.11.1 CIP Summary

CIP's key scientists in RTBfoods by work package

WP1, **Sarah Mayanja**, Netsayi Mudege, Ted Carey and Tawanda Muzhingi

WP2, **Tawanda Muzhingi**, Jan Low and Gabriela Burgos, Derick Malavi, Linly Banda and Daniel Mbogo

WP3, **Thomas zum Felde**, Jan Low, and Gabriela Burgos

WP4, **Robert Mwanga and Thiago Mendes**, Jan Low and Wolfgang Gruneberg

WP 5, **Edward Carey** and Sarah Mayanja

CIP's contributions to the RTBfoods project encompass Work Packages 1, 2, 3, 4 and 5. CIP successfully coordinated WP2 and WP5 while also contributing collaboratively to other WPs, working with and supporting RTBfoods NARS partners deliver on the objectives set out in the work packages.

- In WP1: CIP established successful collaborations with NARO in Uganda, produced three state of knowledge reviews for boiled and fried sweetpotato and jointly conducted WP1 field activities.
- In WP2: CIP teams worked with partners to develop state of the knowledge reviews for potato and sweetpotato. Protocols for biochemical and biophysical characterization in WP2 were identified and new ones pre-tested with partners at NCSU, JHI and ETHZ. CIP staff contributed to the successful sensory evaluation training workshop in Uganda.
- WP3: A NIRS training for breeding and quality technicians was conducted by CIP in Uganda and Peru. Lab facilities and available calibrations were evaluated. A webinar with Brimrose Corp on field based NIRS for raw sweetpotato and potato was conducted.
- WP 4: CIP breeders compiled an inventory on previous sweetpotato breeding for root quality traits and identified two mapping populations developed under the Genomic Tools for Sweetpotato Improvement (GT4SP) project for RTBfoods. CIP Potato breeders in partnership with NARO Uganda identified quality traits and breeding populations and timelines in collaboration with WP1 and 2.
- WP5: CIP conducted consumer taste tests in Lira Town, Kamwenge Town and in Byabasambu Parish, Kamwenge district. Six clones obtained from the MENU project trials were used during the tests.

4.11.2 CIP activities

PARTNER WP participation and inter WP interactions

(Describe activities, collaborations, project implementation)

In WP 1: State of Knowledge (SoK) Reports were prepared as a collaborative effort between CIP and NARO partners. Three SoK reports for boiled and fried sweetpotato were produced focusing on gender, food science and markets.

In WP2: The Food and Nutritional Evaluation Laboratory (FANEL) worked collaboratively with potato and sweetpotato breeders to develop planting schedules and set priorities for quality traits. This was reinforced with a joint CIP/CIRAD visit to HZCP in the Netherlands. This visit informed CIP to invest in a test kitchen, capacity for sensory evaluation and texture analysis at FANEL and in our breeding hubs. WP2 collaborated with James Haddon Institute (JHI) in Scotland. CIP shared seven very different sweetpotato genotypes that were used for texture analysis protocol development. Preliminary results showed that the seven genotypes analyzed exhibited a wide variability in cooking time/textural properties. Another collaboration with ETH Zurich found striking starch granular shape difference among seven sweetpotato genotypes. This could partially explain difference of texture and cooking behaviors. However, more work is required in this area. CIP WP2 scientists worked with CIRAD and NCSU in WP2 to coordinate and execute the sensory panel trainings. The sensory evaluation training was well conducted and attended with over 40 participants, across disciplines and from more than 10 countries in Kampala, Uganda, September 2018. The sensory evaluation training was attended by RTBfoods WP1, 2, and 4 members. After the sensory panel training, CIP with matching funds purchased an ISO certified mobile sensory booths for use in our regional food science analytical platform (FANEL) in Nairobi, Kenya. A test kitchen was also established in FANEL and was used by visiting Chinese scientists to study the proximate analysis, carotenoids, antioxidants, after cooking darkening and texture of sweetpotato clones from the MDP trials in Uganda. Potato samples from Kenya were also used for traits to evaluation within RTBfoods project and protocols were developed for sugar profiles, texture profile, nutritional and antinutritional (glycoalkaloid) and sensory analysis.

In WP 3, CIP scientists contributed to the writing of SoK. In Uganda and Peru, new and existing CIP staff participated in NIRS and sample preparation trainings. CIP quality traits scientists and breeders also had discussions with CIRAD in WP3 on the development of NIRS calibrations to be used on fresh/raw sweetpotato and NIRS application in breeding selection as was already happening with high iron OFSP and other breeding populations in Mozambique, Ghana, Uganda and Peru. CIP WP2, 3 and 4 organized a webinar with a US based company Brimrose Corp to learn about their portable, field based NIRS for fresh and raw RTB crop samples. Their equipment is used by big agro-companies in the US for many parameters with the exception of carotenoids. It was determined that CIP needs NIRS calibration for cooked and raw/fresh samples and this will be priority going forward. Unfortunately, Brimrose Corp could not offer a solution for beta carotene in SP which is essential for CIP's NIRS research in SP and additional high costs are limiting the application of new NIRS.

In WP 4 sweetpotato, CIP breeders compiled an inventory on previous sweetpotato breeding for root quality traits and identified two mapping populations developed under the Genomic Tools for Sweetpotato Improvement (GT4SP) project, including the bi-parental Beauregard x Tanzania (BxT) population (317 genotypes) and the Mwanga diversity panel (MDP) of 1886 genotypes (from 8 x 8, population Uganda B x population Uganda A parents) to be suitable for use in genomic studies for sweetpotato root quality traits. We have also provided materials to be used by other project partners for studies like texture analysis and beta-carotene analysis. WP4 Potato. It was discussed and agreed that the panel for WP2 will be a set of local varieties and advanced CIP clones - Uganda and Kenya. A 100 clones and 176 genotypes were introduced to Uganda in Oct/18 as minituber for phenotyping assessment in 2019. Tuber multiplication has already been started. This panel is mostly comprised of CIP's advanced tetraploid populations. They will be planted in highland area of South Western Uganda. The most popular varieties for farms, industry and consumers (Kabele red, Wanale, Singo, Cruza, Victoria, Rwangume, Bumbamagara) have also been considered. CIP is working in partnership with NARO's potato breeding in the RTBfoods project. The traits to be evaluate within RTBfoods project were discussed and defined with WP2 to include sugar profiles,

texture profile (dry matter, cooking time, cell wall, cooking time), nutritional and antinutritional (glycoalkaloid) and sensory analysis.

Under WP5, CIP conducted consumer taste tests in Lira Town, Kamwenge Town and in Byabasambu Parish, Kamwenge district. Six clones obtained from the MENU project trials were used during the tests. In Lira, we did not obtain good results from consumers for fried SP. Secondly, the number of consumers for boiled SP were also few. In Kamwenge, we were able to hit the set target for both boiled and fried SP – thanks to the extra support of food scientists from NARO. Consumers were subjected to three types of tests [Hedonic, Just-About-Right (JAR) test and Check All That Applies (CATA) test]. Preliminary results from the JAR test are given below. For boiled SP, clone KML756(OP) was the most preferred, while for fried SP, Naspot 8 was the most preferred. We sensed bias towards Naspot 8 because a large proportion of the consumers could easily identify it and revealed that they liked it a lot.

4.11.3 CIP Product Profile participation

(Describe activities, collaborations, project implementation)

- CIP is collaborating closely with NARO to access technical expertise which we do not have (food science) but also to augment the research team. This has been especially helpful given the increased number of respondents we had to deal with (compared with the original plan).
- CIP Projects have also supported financing the WP1 activities and without their support, we would never have been able to accomplish the activities undertaken.
- Hosted and discussed with Christian Mestre (WP2) the biophysical procedures previously used at the NIRS lab and Sweetpotato breeding fields at Namulonge.
- Hosted participants of the Sensory Panel Training at the NIRS and Sweetpotato breeding fields at Namulonge
- Provided root samples for Sensory Panel Training at NARL, Kawanda
- Hana Chair (WP4), Fabrice Devereaux (WP2) and Dominique Dufour (PMU) at the NIRS and Sweetpotato breeding fields at Namulonge.

4.11.4 CIP Personnel and Master, Doctoral, Postdoctoral students activities

List of Students involved in RTBfoods activities in Period 1:

None

NAME Surname	***Master Student or PhD or Post-Doc***	***Subject Title***	***University of affiliation***	***Fellowship Starting Date***	***Fellowship Ending date***	***Tutor(s) in RTBfoods project***
Linly Banda	Ph.D.	Molecular Biology and Biotechnology	Pan African University, Juja, Kenya	11/11/2018	10/11/2020	T. Muzhingi
Marilyn Muthee	MSc	Food Science	Egerton University, Nakuru, Kenya	05/11/2018	04/06/2019	T.Muzhingi

4.11.5 CIP Travel and meetings participation

Presentation at the Pheno-Harmonis Workshop, Montpellier (reported jointly for WP1 and WP5)

The CIP gender Research Associate together with the WP 1 leaders prepared a presentation on the training experience in Benin. The presentation focused on the practical process of developing the product profiles for the various cassava value chain actors. Amongst the issues highlighted was the need to share our findings with the crop ontology dictionaries – especially where new descriptors of traits were defined during the field research activities.

Table 1: Travels and Meetings by CIP RTBfoods scientists and associated staff

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
Tawanda Muzhingi Jan Low Thomas zum Felde Edward Carey Thiago Mendes	RTBfoods Inception meeting, Buea, Cameroon.		January, 2018
Tawanda Muzhingi Edward Carey Thomas Zum Felde Jolien Stasiewicz	Technical visit to HZCP with Dominque Dufour and Christian Mestre (CIRAD)		May, 2018
Tawanda Muzhingi	Partners visit with Dominique Dofour, Christian Mestre, Fabrice and Hana Chair (CIRAD)		May, 2018
	RTBfoods PMU meeting at GCP21, Benin	GCP21	June, 2018
	Institute of Food Technology (IFT), Chicago, USA	Visit CIRAD in Montpelier, France	July, 2018
	Visit with WP2 sub grantee to develop work plans, NCSU, Raleigh, NC		August, 2018
	RTBfoods sensory panel training workshop, Kampala, Uganda		September, 2018
	RTBfoods PMU and WP2 coordination meetings	ISTRC Meeting	October, 2018
Linly Banda	Texture analyzer shipment and equipment use and maintenance training, Johannesburg, South Africa		September, 2018
Sarah Mayanja	WP1 training, Benin		April, 2018
	WP1, Training research team and piloting tools for activities 3 and 4 Mukono, Uganda		September, 2018
	WP1 field-based activities in Lira, Uganda		October, 2018
Thomas zum Felde	NIRS training in Uganda		October, 2018
Daniel Mbogo	Sweetpotato roots sampling in Kisumu		June, 2018

4.11.6 CIP Capital Equipment or investment (co-investments)

After a visit to HZCP in the Netherlands, we realized that texture was the most important quality attributes that drove adoption of roots and tuber crops and also that were not yet well understood in sweetpotato. CIP WP2 decided to buy a texture analyzer to be used for biophysical, biochemical and sensory evaluation of boiled sweetpotato/potato and fried sweetpotato/potato product profiles. A Stable Micro Systems TA.XT Express Texture Analyzer an entry-level was purchased from South African. It offers cost-effective portable analysis for a wide range of low force applications. It presents a smaller portable solution for your texture analysis testing, measuring up to 10kg in force, and as such it is a cost-effective option for less complex applications.

4.11.7 CIP Training participations

- CIP staff involved in WP1-5 were from CIP Lima, Ghana, Kenya and Mozambique our sweetpotato and potato regional breeding hubs were invited and took part in the RTBfoods sensory evaluation training workshop in Kampala, Uganda. The CIP staff represented breeding, food science, gender and post-harvest research.
- CIP Research Associate (WP1) together with the WP 1 leaders prepared a presentation on the training experience in Benin. The presentation focused on the practical process of developing the product profiles for the various cassava value chain actors. Amongst the issues highlighted was the need to trait ontologies – especially where new descriptors of traits were defined during the field research activities.
- Two CIP breeders (WP4 and 5), one gender associate (WP1) and one Food Scientist (WP2) participated in a Pheno-Harmonis Workshop, 14-18 May 2018, Montpellier, France. The PhenoHarmonIS 2018 was focused on harmonization of germplasm, phenotypic and agronomic data for plants. Scientific domains tackled will include conservation, breeding including the needs of Participatory Varietal Selection, quality traits, agronomy and agro-ecology with its specific needs for surveys.

4.11.8 CIP Sub-awards and consultants

1. CIP WP2 engaged the services of Euro-ingredients Limited a food science and technology service company to assist in the development of sensory evaluation protocol, FANEL test Kitchen small equipment and training. EIL also assisted with the extraction of starch from seven sweetpotato genotypes to study the effect of starch profiles on cooking time.
2. CIP WP2 also engage faculty from North Carolina University, Raleigh, NC, USA. The official partner in the project Dr. Van Den Truong retired in 2018 and delegated Dr. Suzanne Johanningsmeier to the project. Suzanne like Den Truong are faculty members of the NCSU Food Science department but full-time employees of the Federal Government USDA ARS. Dr. Tawanda Muzhingi, travelled to NCSU in August to discuss the partnership and work plans with Dr. Suzanne Johanningsmeier. Therefore, the sub grant agreement with USDA was deem too complicated for the amount money and activities involved. It was agreed CIP will be billed for expenses incurred by NSCU/USDA ARS partners. Suzanne and her student come to Uganda and co-facilitated the sensory evaluation training workshop with CIRAD. They also wrote the final report of the sensory evaluation training.

4.11.9 CIP Other Sources of Support for RTBfoods activities

- WP1 activities in Uganda were under budgeted and CIP gender budget under RTB CC5.3 support some of the expenses for Sarah Mayanja including her FTE.

- WP2 activities in FANEL Kenya received some support from CIP SASHA 2 project's postharvest research budget
- CIP's work on potato was supported with funds from RTB

4.11.10 CIP Publications, conferences, manual, leaflet, communications

Report: Sensory evaluation training in Uganda

4.11.11 CIP Gaps and Constrains

Synchronizing activities from other work packages/partners with the harvest time from on-going phenotyping trials for populations to be used in RTBfoods project is still a challenge. Better communication needed between WP 1, 2 and 3

4.11.12 CIP expectations in period 2

1. TORs for the WP leaders and co-leaders, and also product profile champions.
2. RTBfoods PMU calendar with coordination dates, timelines etc.
3. Outputs/ results from other work packages (WP1, 2 and 3) being incorporated into ongoing breeding programs
4. In CIP WP1, finalizing data collection for the consumer taste tests – we were not able to do so in 2018 because of lack of materials due to poor performance of the trial plots which were harvested in December. We plan to work closely with Dr. G. Fiedel (sp) on this.
    - Clean, code, analyze and write the research reports for boiled and fried sweetpotato
    - Commence on data collection for boiled and fried potato

4.12 Annex 12: CIRAD Synthesis Report for Period 1

CIRAD achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s):

- FAUVELLE, Eglantine, CIRAD, France
- DUFOUR, Dominique, CIRAD, France
- MEJEAN, Cathy, CIRAD, France
- MARCIANO, Delphine, CIRAD, France

Collaborator(s):

- MILLE, Marion, CIRAD, France
- VOLLE, Ghislaine, CIRAD, France
- DAVRIEUX, Fabrice, CIRAD, France
- MEGHAR, Karima, CIRAD, France
- FLIEDEL, Geneviève, CIRAD, France

4.12.1 CIRAD Summary

(10 to 15 lines of Partner achievement for Period 1)

In Period 1, CIRAD staff was actively involved in the following domains of activity:

1- **Methodological development**: inventories of existing methodologies & protocols used by partners (WP2, WP3, WP4), production of methodological manuals for partner use and intended to be shared later with a broader scientific community (WP1 & WP2 manuals);

2- **Scientific & technical support to partner activities**: guidance & support in knowledge capitalization & production (WP1, WP2, WP3, WP4), support provided to partners in the implementation of field activities (WP1, WP5), logistical support to workshop & training organization by WP leaders (WP1, WP2).

3- **Coordination & monitoring**: visits to partners, organization of regular meetings between PMU & WP leaders and face-to-face meetings with partners in parallel to international conferences or symposiums, facilitation in the organization of regular intra and cross-WP coordination meetings, production of monitoring tools shared with WP leaders.

CIRAD is part of the WP1 coordination team. As such during Period 1, CIRAD researchers were very much involved in the adaptation of an existing methodology to RTBfoods framework and its specific outputs.
They largely contributed to the production of a set of guidance documents for partner use. After the organization of a common training on WP1 methodology with all WP1 teams, CIRAD researchers provided methodological support to WP1 partner teams in conducting surveys with RTB users.

CIRAD is involved in the WP2 coordination team. Consequently, CIRAD researchers supported the writing of state of knowledge reports on biophysical measurement of quality characteristics for the 11 targeted RTBfoods products. They also supervised the inventory of methods and protocols used by partner laboratories for biophysical analysis on RTB crops and products. Finally, CIRAD sensory experts led a training workshop to train WP2 partners to set up sensory panels on RTB products in the perspective of sensory profiling activities to be conducted in Period 2. A methodological manual compiling all training material was written by these experts and specifically adapted to meet RTBfoods needs.

CIRAD coordinates RTBfoodsWP3. As such, the team was mainly involved in the training of partner

teams on the use of HTP tools. The team was also responsible for a state of knowledge on previous use of HTP protocols on the RTB crops and products targeted within RTBfoods. The CIRAD team also developed templates to centralize the information on existing and ongoing spectral databases on RTB crops and products from all partners involved in breeding activities.

CIRAD coordinates RTBfoods WP4. As such, CIRAD coordinated the production of a state of art on previous examples of breeding for quality in the different partner programs and/or institutes involved in RTBfoods. WP4 CIRAD leader also coordinated the development of a population tracker to be used all project long to inventory and monitor information related to RTB populations to be used within the project framework.

CIRAD is involved in WP5 activities. In Period 1, CIRAD staff supported IITA team in the assessment of Nextgen new cassava hybrids.

WP6 is composed of CIRAD staff responsible for the project coordination. As such, during Period 1, the team developed several tools to manage project budget, to monitor WP activities and progress towards achievements of outputs and outcomes and more globally to facilitate communication and collaboration with and between partner teams.

4.12.2 CIRAD activities

CIRAD participation in the different WPs & cross-WP interactions

In which WPs is the PARTNER team involved? For which activities conducted in Period 1? How is internally organized communication/coordination between WPs?

WP1 & WP5

- **Development of Guidelines:**

The CIRAD WP1 co-leader adapted a methodology s in three steps previously developed by CIRAD in a previous CRP-RTB project in 2015. This methodology was adapted to answer RTBfoods needs and in particular to understand the quality required by each type of stakeholder all along the food chain. It was described in 3 specific manuals (out of the 5 manuals produced by WP1 coordination team) with food science as a major component: one for each step (i.e. surveys on quality characteristics, processing ability and the consumer testing). These manuals were shared with WP1 partners during a workshop on capacity strengthening of all partners in April 2018, Cotonou Benin and are intended to be shared widely once a DOI is generated.

- **Capacity building of WP1 partners through the organization of the WP1 workshop to build a common methodology (Benin, April 2018):**

The CIRAD WP1 co-leader had the responsibility to improve the methodology in three steps by adding with other co-leaders a gender component and a socio-economic component, mainly for the gendered product mapping and user profiles activity. The CIRAD WP1 co-leader and the CIRAD focal point for participatory processing in WP1 participated with other co-leaders in the writing of the 3 guidance manuals for partners to implement each activity, in the preparation of oral presentations, and in the workshop programme and organization.

The focal point for participatory processing activities provided support in terms of logistics and facilitation. There were 31 participants at the workshop from six partner countries.

- **Specific methodological support to WP1 teams:**

After the workshop on capacity strengthening of all partners, the CIRAD WP1 co-leader together with the other WP1 coordinators had the responsibility to provide support to all teams in the production of the State of Knowledge reports on RTB quality characteristics. A manual on SoK with food science, gender, economic parts, was written by WP1 coordination team as a guide for all the partners. This support was mainly in terms of production of a harmonized template, supply of published references and reviewing.

The CIRAD WP1 co-leader participated in several visits to bring specific scientific support to WP1 teams In September 2018, the CIRAD WP1 co-leader supported CNRA team in fieldwork and surveys. This support was mainly in a better understanding of the questionnaires, in the way to

interview groups or individual persons and in the way to take notes for a future qualitative data analysis.

In Benin, in October 2018, the CIRAD WP1 co-leader with WP1 leader visited FSA and IITA teams to launch qualitative and quantitative analysis of their first data on quality criteria of boiled yam. This collaboration was very useful. Indeed a manual on data analysis was written by WP1 coordination team, after that visit, as a guide for all WP1 partners.

In Cameroon, in July 2018, the CIRAD WP1 co-leader visited IITA Cameroon to clarify with the Director the budget allocation from IITA Nigeria to the team, the PhD inscription at the University of a young economist, the collaboration between IITA Cameroon (young economist) and ENSAI (post-doctoral fellow in food science), the funding support from CIRAD to support ENSAI young food scientist, and the contract to be signed between CIRAD and ENSAI with the CIRAD Regional Director in Cameroon. The CIRAD WP1 co-leader supported the team (young economist and young food scientist) in the implementation of the SoK report and activities on gari.

- **Assessment of new hybrids from partner breeding programs:**

The CIRAD team involved in WP5 went to Nigeria to provide support to the IITA team in the participatory assessment of Nextgen cassava hybrids processed in gari and fufu. The CIRAD team based in Guadeloupe supervised the PhD of E. Ehounou from the University Felix Houphouet Boigny (Côte d'Ivoire) for his PhD on the development of NIRS for prediction of textural quality attributes on fresh yam.

WP2

The team has been deeply involved in the organization of meetings for WP2 management.

- **Scientific support to State of Knowledge reports on RTB biophysical analysis:**

As WP2 co-leader, CIRAD was responsible to provide support to WP2 teams working on yam, banana and cassava. In Period 1, CIRAD staff had the responsibility to support these teams in the production of the State of Knowledge reports on RTB biophysical analysis. This support was mainly in terms of production of a harmonized template, supply of published references and reviewing.

- **Laboratory and analytical procedures Inventory:**

In Period 1 and prior to the development of harmonized protocols for physicochemical analyses on RTB crops and products by WP2 partners, CIRAD researchers were responsible to make an inventory of equipment, methods & protocols used by partner laboratories for physicochemical analyses on RTB crops and products. They also took part, with RTBfoods project leader, WP2 leader and some of the partners to a visit to HZPC research center that gave interesting examples of biophysical analyses important for potato quality such as NIRS hyper-spectal imaging, texture analysis of boiled or fried potato or pectin determination.

- **Capacity building of WP2 partners through the organization of the WP2 Sensory Panel Training workshop (Uganda, September 2018):**

The CIRAD WP2 co-leaders were responsible to set up the agenda of this 1-week training together with the WP2 leader and 3 sensory studies experts from CIRAD. The PMU was in charge of logistical issues. Previous training material has been adapted to fit RTBfoods' needs, products of interest and context of implementation (i.e. countries with relatively low-level of equipment). The team trained WP2 partners attending this workshop during theoretical sessions and practical sessions on sensory testing. The PMU provided logistical support to the national partner hosting this workshop (i.e. NARL).

- **Development of Guidance:**

The CIRAD sensory experts produced a methodological guidance including the material presented and used by trainees during the workshop in Uganda. This methodological toolkit is supposed to be used by WP2 partners when setting-up sensory panels on RTB products in the targeted countries. It was shared with WP2 partners after the workshop and is intended to be shared widely once a DOI is generated.

WP3

- **State of knowledge on previous use of HTPP on RTB crops & products:**

The CIRAD WP3 leader coordinated this activity. A chemometrician, recruited in September 2018 to support capacity building of WP3 partners on NIRS use also contributed to this review.

- **Coordination of Inventories (capacity, existing databases and calibrations):**

The CIRAD team coordinated several inventories: an inventory of capacities of laboratory partners (equipment and human resource), an inventory of existing and ongoing spectral database at partner level for the 5 RTB crops, and an inventory of the existing and ongoing calibrations for RTB quality traits. Several CIRAD researchers contributed to these inventories of spectral data on cassava and yam. Such inventories of existing tools and spectral data already or being acquired on RTB crops by partners did not exist prior to RTBfoods project.

- **Capacity building of WP3 partners through the organization of 2 trainings in partner laboratories (NARL/)**

The CIRAD team trained NaCRRI and NARL teams together during a mission in Uganda. This training was organized during a join mission of the project leader and the CIRAD WP4 leader visiting partner facilities and field trials. The main objective of the training was to train technician using NIRS tool on the different operations from sampling preparation to spectral acquisition so as to provide timely information for breeders during the breeding cycle. During this 3-day training, the team provided an extended overview of the principles and theory of NIR spectroscopy with an emphasis on the potential of NIRS as an HTP tool and its different applications. In brief, the trainees increased the understanding of the procedures involved in spectral acquisition and measurement protocols.

- **Development of spectral databases and NIRS calibrations:**

For both WP2 & WP3, CIRAD researchers based in Guadeloupe conducted a study on texture evaluation of yam samples and contributed to the development of spectral databases on fresh yam in Guadeloupe and of on-going calibrations for fresh yam quality traits. More details on the activities carried out by this team are provided in the INRA Synthesis Report for Period 1 due to the close collaboration between CIRAD and INRA teams in Guadeloupe.

The CIRAD WP3 leader also supervised the development of the existing and already very well documented cassava database at CIAT and supervised the development of calibrations for 3 different quality traits on fresh cassava.

WP4

- **State of knowledge on previous works on RTB breeding for quality for RTB crops:**

The CIRAD WP4 leader supervised the production of a synthesis report on previous works on quality traits informing RTB breeding. The CIRAD WP4 leader compiled the contributions from WP4 partners who described how quality traits have been considered in past or on-going RTB breeding programs.

- **Inventory of capacities & RTB populations available for RTBfoods project:**

The CIRAD WP4 leader developed a synthesis population tracker aiming at i) inventorying RTB populations developed by partner breeding programs and that could be used within RTBfoods to breed for quality traits, ii) centralizing key information on RTB populations for the 5 targeted crops.

In addition, the CIRAD WP4 coordinator visited Uganda, Nigeria and Guadeloupe. It was the opportunity to meet all the collaborators working on cassava, sweetpotato and matooke in Uganda and cassava and yam in Nigeria. CIRAD team visited the Food Technology Laboratories, in these countries, to get a better idea of the facilities available for breeders.

WP6

- **Project Coordination & technical support to partner activities:**

During the first 6 months of the project, the team was strongly involved in the contractualisation process with the 14 partner institutes.

CIRAD is responsible for the annual financial reporting to BMGF for the whole RTBfoods project. For this purpose, the team developed templates to be filled in by the financial services of partner institutes at the end of Period 1.

The PMU did several missions to coordinate activities to be carried out by partners and to ensure an effective collaboration between partner institutes working on the same RTB crop. For these coordination purposes, the project leader went to Uganda and to Nigeria where he visited partners from NARL, NaCRRI, NARO, IITA and CIP in Uganda and partners from NRCRI, Bowen University and IITA in Nigeria.

The PMU was strongly involved in the organization of the WP2 workshop on sensory panels in Uganda and in logistical support to the partner (NARL) hosting this workshop.

- **Open access strategy Development:**

The project Management Unit (PMU) produced a report describing how the BMGF open access strategy will be adopted and put in place in RTBfoods and how this strategy would impact partners in the development of their activities. For instance, a template for participant information –no matter the type of participation- and to collect their free and prior consent was customized to RTBfoods project and attached to the Global Access Strategy.

- **Monitoring, Evaluation, Learning & Reporting:**

The project manager for Monitoring Evaluation & Learning developed different tools to monitor partner progress in their work plan and to have a regular follow-up with WP leaders. The project manager went to Nigeria to be trained by R. Ofei, MEL manager at IITA on the mapping of RTBfoods Result Framework under MEL platform, an online platform used by the CRP RTB CGIAR program for reporting purposes.

The PMU developed templates for partners to report on activities carried out and main achievements from Period 1, at 3 levels: partner institute, WP and product champions' level. These are the 3 levels the PMU committed to report on annually to BMGF. For Period 1, the PMU chose to ask their contribution to partner focal points and WP leaders only, the exact role and expectations from product champions still being to be clarified and agreed with them.

- **Development of collaborative tools:**

The PMU put in place several tools to ensure a proper and efficient communication and collaboration between RTBfoods partners. A collaborative platform for documents sharing and secured storage has been set up using the system proposed by CIRAD to its staff and partners. This storage platform could be replaced soon by an online project & knowledge management system with private and public pages. This would allow a single tool (Liferay software) serve both internal and external communication purposes at the same time.

- **Coordination with RTB partner breeding programs (AfricaYam, BBB, Nextgen, Sasha)**

The project leader was invited to participate to AfricaYam, Nexgen and Sasha annual meetings. CIRAD researchers also participated in the brainstorming organized by BBB project in Bruxelles, upstream of the project phase 2.

- **Visit to external partners**

The CIRAD project leader and WP2 co-leader visited HZPC laboratories in the Netherlands by H. van Doorn who is a member of RTBfoods' Advisory Committee. It was the opportunity for them to learn more on physicochemical and sensory analyses carried out on raw and cooked material for potato breeding.

The project leader also met with a delegation of Nestlé during their visit to CIRAD; Nestlé is represented in RTBfoods' Advisory Committee. This was the opportunity for Nestlé representatives

to renew their willingness to contribute to RTBfoods activities by making their laboratories and/or human resource in Nigeria available to WP2 partners.

4.12.3 CIRAD geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

In Period 1, CIRAD partners carried-out activities in the countries listed below (activities related to and funded by RTBfoods project other than participation to meetings, conferences or symposiums):

- Nigeria: A. Bouniol (missions for WP5 activities), D. Dufour (missions for WP6 coordination + WP5 activities), H. Chaïr (mission for WP4 coordination), E. Fauvelle (missions for MEL).
- Uganda: D. Dufour (missions for WP6 coordination), H.Chaïr (mission for WP4 coordination), F. Davrieux (mission for WP3 coordination & training), C.Mestres (mission for WP2 workshop), C. Méjean (mission for WP2 workshop support), C. Bugaud (mission for WP2 workshop), N. Forestier-Chiron (mission for WP2 workshop).
- Côte d'Ivoire: G. Fliedel (mission for WP1 support).
- Cameroon: G. Fliedel (mission for WP1 coordination financed by another project).
- Benin: G. Fliedel (missions for WP1 support).
- Colombia: T. Tran (WP2 activities), F. Davrieux (missions for WP3 support & trainings), K. Meghar (mission for WP3 support & training).
- Guadeloupe-France: G. Arnau (WP3 activities), F. Cormier (WP4 activities) & D. Cornet (WP3 activities).

For each mission, more details are provided in the section "PARTNER Travels" below.

The table below illustrates how CIRAD budget for Period 1 was spent across countries for each WP and in total (in Dollars). These expenses concern all cost categories (travels, sub-awards & consultants, other costs) expect for salaries.

	WP1 / WP5	***WP2***	***WP3***	***WP4***	***WP6***	***TOTAL***
Benin	24 139.36	3 714.58	-	-	22 549.68	**50 403.63**
Cameroon	4 437.54	8 621.34	6 434.88	6 013.03	56 643.64	**82 150.45**
Colombia	-	-	14 702.64	2 562.94	-	**17 265.58**
Côte d'IVoire	5 834.71	270.37	-	-	158.20	**6 263.28**
Nigeria	2 658.53	-	-	3 810.80	19 485.21	**25 954.55**
Uganda	-	25 820.58	5 461.76	3 882.64	14 728.24	**49 893.23**
France	-	4 920.97	11 634.31	2 407.22	9 336.49	**28 298.98**
Guadeloupe	-	-	-	23 800.08	-	**23 800.08**
Netherlands	-	354.55	-	-	902.11	**1 256.65**
Belgium	-	-	-	-	285.65	**285.65**
Europe	-	-	-	-	1 499.18	**1 499.18**

	WP1 / WP5	WP2	WP3	WP4	WP6	TOTAL
TOTAL	**37 070.16**	**43 702.39**	**38 233.59**	**42 476.71**	**125 588.41**	**297 071.26**

4.12.4 CIRAD Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

Due to their role of WP leaders and co-leaders, G. Fliedel, C. Mestres, T. Tran, F. Davrieux and H. Chaïr are supporting teams working on all the 11 food products targeted by RTBfoods. Indeed, all state of knowledge reports edited and methodological guidance developed obviously concerned the 11 RTBfoods products. In the same way, A. Bouniol, focal point of WP1 Activity 4 on processing diagnosis, may work on the 11 RTBfoods products but more certainly on the more elaborated ones, with more than 1 unitary process (e.g. fermentation, cooking, pounding, frying).

Besides scientific support and methodological development activities, some CIRAD staff are more directly involved in knowledge production on some specific products:

- Granulated cassava: for the assessment of Nextgen cassava clones in Nigeria for gari production (as part of WP5).
- Pounded Yam:
  - WP1, WP2 and WP5 activities carried out on yam in Benin;
  - WP2 team in Guadeloupe involved in the assessment of the poundability of CIRAD yam varieties through the co-supervision of a PhD candidate from Côte d'Ivoire (i.e. E. Ehouno);
  - WP3 team in Guadeloupe working on the development of NIRS database and calibrations on fresh yam.

4.12.5 CIRAD Personnel involved & Students activities

*List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab "**3a) PERSONNEL COSTS" of Partner Financial Report)***

WP	NAME of CIRAD staff involved in RTBfoods	Country of intervention	RTBfoods Crop(s) / Product(s) Implication
WP1 /WP 5	BOUNIOL Alexandre	Based in Benin - Potentially in all 5 targeted countries for Support to WP1 Activity 4	All with a major focus on elaborated products (pounded yam, granulated cassava, matooke)
	FLIEDEL Geneviève	All for support to WP1 partners	All for support to WP1 partners
WP2	BUGAUD Christophe	Based in France - Missions depending on support needs to WP2 partners	Depending on support needs to WP2 partners with major specialization on banana
	DAHDOUH Layal	Based in France - Missions depending on support needs to WP2 partners	Depending on support needs to WP2 partners

WP	*NAME of CIRAD staff involved in RTBfoods*	*Country of intervention*	*RTBfoods Crop(s) / Product(s) Implication*
	FORESTIER-CHIRON Nelly	Based in France - Missions depending on support needs to WP2 partners	Depending on support needs to WP2 partners
	GRABULOS Joël	Based in France	Depending on support needs to WP2 partners
	MARAVAL Isabelle	Based in France	Depending on support needs to WP2 partners
	MBEGUIE A MBEGUIE Didier	Based in France - Missions depending on support needs to WP2 partners	Major focus on banana plantain + cassava
	MESTRES Christian	All for support to WP2 partners- based in France	Depending on support needs to WP2 partners with a major focus on yam
	OLLIER Léa	Based in France - Missions depending on support needs to WP2 partners	Depending on support needs to WP2 partners
	RICCI Julien	Based in France - Missions depending on support needs to WP2 partners	Depending on support needs to WP2 partners
	TRAN Thierry	All for support to WP2 partners - based in Colombia	All with a major focus on cassava
WP3	DAVRIEUX Fabrice	All for support to WP3 partners- based in Reunion Island (France)	All for support to WP3 partners
	MEGHAR Karima	All for support to WP3 partners- based in France	All for support to WP3 partners
	CORNET Denis	Based in France - Missions depending on support needs to WP3 partners	Major focus on yam
	MALEDON Erick	Based in France	Depending on support needs to WP3 partners
	ARNAU Gemma	Based in Guadeloupe with missions in yam producing countries	Major focus on yam
WP4	CHAIR Hâna	All for support to WP4 partners - based in France	All for support to WP4 partners with major focus on yam
	CORMIER Fabien	Based in Guadeloupe	Yam

WP	*NAME of CIRAD staff involved in RTBfoods*	*Country of intervention*	*RTBfoods Crop(s) / Product(s) Implication*
	NUDOL Elie	Based in France	Depending on support needs to WP4 partners
WP6	DUFOUR Dominique	All for coordination purposes - based in France	All
	FAUVELLE Eglantine	All for monitoring purposes - based in France	NR
	MEJEAN Cathy	All for logistical support to partners - based in France	NR
	PALLET Dominique	Based in France	NR
	LANTIER Pascale	Based in France	NR
	MARCIANO Delphine	Based in France	NR
	PERIGNON Anne Laure	Based in France	NR
	MILLE Marion	Based in France	NR
	VOLLE Ghislaine	Based in France	NR
	BLUNDO CANTO Genowefa	Depending on evaluation needs- based in France	NR

List of Students involved in RTBfoods activities in Period 1:

NAME Surname	*Master Student or PhD or Post-Doc*	*Subject Title*	*University of affiliation*	*Fellowship Starting Date*	*Fellowship Ending date*	*Tutor(s) in RTBfoods project*
Emmanuel EHOUNOU	PhD	Developpement of NIRS for prediction of textural quality attributes	Felix Houphouet-Boigny	31/01/2018	31/07/2018	emma ARNAU
Franklin	Postdo	WP1:	University of	15/06/201	-	Genevi

NAME Surname	*Master Student or PhD or Post-Doc*	*Subject Title*	*University of affiliation*	*Fellowship Starting Date*	*Fellowship Ending date*	*Tutor(s) in RTBfoods project*
NGOUALEM KÉGAH	c	Understanding the drivers of quality characteristics and the development of multi-user RTB product profiles	Ngaoundéré - ENSAI	8		ève FLIEDEL

4.12.6 CIRAD Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

*(For more accuracy you can refer to: Tab "**3b) TRAVEL COSTS" of Partner Financial Report)***

In addition to individual travels listed in the table below, the following persons attended the RTBfoods inception meeting in Buea, Cameroon, from 23 to 28 January: G. Fliedel, T. Tran, C. Bugaud, D. Mbeguie-a-Mbeguie, F. Davrieux, H. Chaïr, F. Cormier, D. Dufour, E. Fauvelle, G. Blundo-Canto, D. Marciano, Lantier P.

Number of People or List of NAMES	*RTBfoods meetings*	*International / Regional Conferences*	*Country*	*Dates*	
GEMMA Arnau		ISTRC Symposium + RTB Annual Meeting	Colombia	21-Oct.	30-Oct
BOUNIOL Alexandre	Participatory evaluation of new cassava clones for Gari production in Imo state in Nigeria with IITA team		Nigéria	16-Jun	21-Jun
	Participatory evaluation of new cassava clones for Gari & Fufu production in Imo state in Nigeria (IITA)		Nigéria	9-Sept.	20-Sept.
BUGAUD Christophe	Sensory Panel Training for WP2 RTBfoods partners		Uganda	11-Sept.	22-Sept.
CHAIR Hanâ	Visits to Banana, Yam, Sweetpotato & Potato breeding		Uganda	21-May	29-May

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Country***	***Dates***	
	programs in Uganda				
	Visits to Yam and Cassava breeding programs in Nigeria (NRCRI & IITA stations)		Nigeria	20-Jul.	27-Jul.
DAVRIEUX Fabrice	Training on spectral analysis and data analysis for RTBfoods WP3 partners		Uganda	20-May	30-May
	Participation in recruitment of the new project chemometrician		Montpellier	3-Jun	18-Jun
		ISTRC Symposium	Colombia	23-Oct.	5-Nov.
	Coordination for WP3 RTBfoods. Support to K.Meghar (RTBfoods chemometrician)		Montpellier	18-Nov.	11-Dec.
DUFOUR Dominique	Sensory profiling & measurements at HZPC - RTBfoods project		Hollande	5-May	9-May
	Inventory of high throughput method needs in Uganda for Cassava, Banana, Sweet Potato and planning of actions - RTBfoods project		Uganda	21-May	29-May
	Participatory evaluation of new cassava clones for Gari production in Imo state in Nigeria with IITA team	Participation to GCP21	Benin + Nigeria	9-Jun.	22-Jun.
	Visits to Yam and Cassava breeding programs in Nigeria (NRCRI & IITA stations)		Nigeria	20-Jul.	27-jul.
	Complementarity between RTBfoods & BBB projects & discussions with R. Sweenen on join activities & CIRAD		Belgique	5-Sept.	6-Sept.

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Country***	***Dates***	
	participation to BBB phase 2				
	Participatory evaluation of new cassava clones for Gari & Fufu production in Imo state in Nigeria (IITA)		Nigéria	12-Sept.	22-Sept.
FAUVELLE Eglantine		Training "Enhancing Results-Based Management in RTB ME&L systems"	Nigeria	20-May	1-Jun.
		Participation to GCP21	Benin	10-Jun.	17-Jun.
	Visits to Yam and Cassava breeding programs in Nigeria (NRCRI & IITA stations)		Nigeria	20-Jul.	27-Jul.
	RTBfoods monitoring & meeting with partners	ISTRC Symposium + CRP-RTB Annual Meeting	Colombia	21-Oct.	30-Oct.
		Annual Meeting of the MELIA (Monitoring & Evaluation, & Impact Assessment) community of practice at CGIAR	Rome	4-Nov.	8-Nov.
FLIEDEL Genevieve	Workshop on Capacity strengthening of all WP1 partners on a Common Methodology		Benin	13-Apr.	26-Apr.
		Participation to GCP21	Benin	10-Jun.	17-Jun.
	WP1 Coordination: support to CNRA on the implementation of surveys on quality		Côte d'Ivoire	19-Sept.	29-Sept.

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Country***	***Dates***	
	characteristics of Attiéké				
	WP1 Coordination: Qualitative & Quantitative Analysis on survey data on quality characteristics of boiled Yam with NRI, UAC-FSA and IITA teams		Benin	15-Oct.	23-Oct.
FORESTIER Nelly	Sensory Panel Training for WP2 RTBfoods partners		Uganda	11-Sept.	22-Sept.
MBEGUIE Didier		Participation to GCP21	Benin	10-Jun.	16-Jun.
MEGHAR Karima	NIRS Calibrations at CIAT	CRP-RTB annual meeting	Colombia	25-Oct.	4-Nov.
MEJEAN Cathy	Sensory Panel Training for WP2 RTBfoods partners		Uganda	11-Sept.	22-Sept.
MESTRES Christian	Sensorial profiling & measurements at HZPC		Hollande	7-May	9-May
		Participation to GCP21	Benin	9-Jun.	24-Jun.
	Sensory Panel Training for WP2 RTBfoods partners		Ougandа	11-Sept.	19-Sept.

4.12.7 CIRAD Capital Equipment or investment (co-investments)

List of equipment acquired on RTBfoods budget (e.g?. texturometer, RVA, pH meter, etc.)

*(For more accuracy you can refer to: Tab "**3d) EQUIPMENT COSTS" of Partner Financial Report)***

The acquisition of the hyperspectral camera was postponed to Period 2. WP3 leader (F. Davrieux) and the recently recruited chemometrician staff (K. Meghar) are still comparing the tools present on the market to identify the best solution according to RTBfoods needs and budget. Several suppliers identified are being asked to perform demonstrations at CIRAD Montpellier.

4.12.8 CIRAD Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
Workshop on Capacity strengthening of all WP1 partners on a Common Methodology	WP1	Benin	16-20-Apr.	FLIEDEL Geneviève BOUNIOL Alexandre
Sensory panel training	WP2	Uganda	17-21-Sept.	MESTRES Christian FORESTIER-CHIRON Nelly BUGAUD Christophe MEJEAN Cathy (org.)
Near infrared Spectroscopy: Theory and Application	WP3	Uganda	23-28-May	DAVRIEUX Fabrice
Training "Enhancing Results-Based Management in RTB ME&L systems"	WP6	Nigeria	28-31-Jun.	FAUVELLE Eglantine
Annual Meeting of the MELIA (Monitoring & Evaluation, & Impact Assessment) community of practice at CGIAR	WP6	Rome	5-8-Nov.	FAUVELLE Eglantine

4.12.9 CIRAD Sub-awards & Consultants

*List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab **3c) CONSULTANT COSTS** and "**3f) SUB AWARDS COSTS" of Partner Financial Report)***

- **Robert Ndjouenkeu** from ENSAI-Cameroon, WP1, to supervise WP1 activities on gari in Cameroon conducted by a postdoctoral student.
- **Agnes Rolland-Sabaté** from INRA-France, WP2, to communicate on her activities at the GCP21 in Cotonou, Benin.
- R**ichard Ofei** from IITA, WP6, to provide support to E. Fauvelle to RTBfoods results framework under the MEL platform to be used for reporting purposes.
- **Lora Forsythe** from NRI, WP1, in replacement of Hale Tufan for coordination purposes with NRCRI and IITA partners in Nigeria.

4.12.10 CIRAD Other Sources of Support for RTBfoods activities

Which complementary / partner projects (other sources of fundings) contributed to RTBfoods activities in Period 1?

758 637 $ are reported as CIRAD own contribution for Period 1. CIRAD contributes to the project by supporting 70% of the salaries of CIRAD staff involved and by providing access to its facilities (e.g. pilot processing platform, biophysical and sensory analysis laboratories) with the application of an indirect cost rate. The rate of indirect costs is determined annually after the closing of accounts validated by their auditor, and based on the evaluation of the structural costs of the institution. The overhead costs include all costs linked to the activity of the institute which are not directly attributable to the project but essential to its activity.

4.12.11 CIRAD List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

- ***Conference communications***

Dufour D., Fliedel G., Bouniol A., Davrieux F., Tran T., 2018. Cassava traits and end-user preference. IVth International Cassava Conference - GCP21, Cotonou, Benin, 11-15 June 2018.

Rolland-Sabate A., Sánchez T., Buléon A., Colonna P., Jaillais B., Ceballos H., **Dufour D.** (2018). The structural characterization of starches: a key to understand various cassava starch functionalities. (Plenary conference). Fourth Scientific Conference of the Global Cassava Partnership for the 21st – GCP21-IV. Cotonou, Benin, June 11-15, 2018.

Chapuis A., **Tran T.,** Giraldo Cuero F. J., Moreno Santander M. A., Precoppe M., Moreno Alzate J. L., Pallet H., Belalcazar Martinez J. E., **Dufour D.** (2018). Small-capacity flash dryers for cassava-derived products - lessons learned from the development of a pilot equipment at CIAT, Colombia (Best conference Award). Fourth Scientific Conference of the Global Cassava Partnership for the 21st – GCP21-IV. Cotonou, Benin, June 11-15, 2018.

Ospina M.A., **Tran T.,** Pizarro M., Luna Melendez J.L., Trivino-Palacios W., Belalcazar Martinez J.E., Salazar S.M., **Dufour D.,** Becera Lopez Lavalle L.A., 2018. Diversity of post-harvest phenotypic traits among the CIAT cassava germplasm collection. IVth International Cassava Conference - GCP21, Cotonou, Benin, 11-15 June 2018.

Nanyonjo A. R., Kyazze F., Esuma W., Wembabazi E., **Dufour D.,** Nuwamanya E., Kawuki R. S., Tufan H. (2018). A comparative assessment of flour-making quality in cassava landraces and breeding lines: a gender-focused case in Zombo district, Uganda. Fourth Scientific Conference of the Global Cassava Partnership for the 21st – GCP21-IV. Cotonou, Benin, June 11-15, 2018.

Becerra Lopez-Lavalle L. A., Rodriguez F., Ovalle T., Ruiz M., Gkanogiannis A**., Dufour D.,** Thome J. (2018). Capturing next-generation genome wide molecular markers in cassava helps to untangle the crop's genetic improvement history. Fourth Scientific Conference of the Global Cassava Partnership for the 21st – GCP21-IV. Cotonou, Benin, June 11-15, 2018.

Becerra Lopez-Lavalle L. A., **Dufour D**., Rodriguez F., Ovalle T., Ruiz M., Gkanogiannis A., Thome J. (2018). DNA-Based cassava variety identification: SNP-type fluidic array. Fourth Scientific Conference of the Global Cassava Partnership for the 21st – GCP21-IV. Cotonou, Benin, June 11-15, 2018.

Ezeocha V.C., **Dahdouh L.,** Escobar A., **Ricci J.,** Rondet E., Cuq B., Delalonde, M. (2018). Evaluation of Gari Cooking Process at Village Level. Fourth Scientific Conference of the Global Cassava Partnership for the 21st – GCP21-IV. Cotonou, Benin, June 11-15, 2018.

Dufour D., Fliedel G., Bouniol A., Davrieux F., Tran T. & CIRAD/CIAT Food Technologists/quality team. Progress in high-throughput phenotyping for cassava traits and end-user preferences. Harvestplus Cassava Breeders meeting, 19-20 october, CIAT, Cali, Colombia.

Tran T. et al. Recent developments on processing of biofortified cassava. Harvestplus Cassava

Breeders meeting, 19-20 october, CIAT, Cali, Colombia.

Becerra Lopez-Lavalle L.A., Ovalle T.M., Ordoñez C., Salazar S.M., Belalcazar J., **Dufour D.,**

Tran T., Ceballos H., Tohme J. (2018). DNA marker strategies for increasing vitamin A and other beneficial carotenoids in cassava. Harvestplus Cassava Breeders meeting, 19-20 october, CIAT, Cali, Colombia.

Chapuis A., **Tran T.,** Giraldo F. J., Moreno M. A., Precoppe M., Moreno J. L., Pallet H., Belalcazar Martinez J. E., **Dufour D**. (2018) Development and trials of a small-capacity pilot flash dryer for cassava-derived products. 18Th triennial symposium of ISTRC International Society for Tropical Root Crops: When, Where and How will tropical root and tuber crops lead the next Agri-Food revolution. 22-25 October 2018. CIAT, Cali, Colombia.

Moreno J. L., Chu-ky Son, Ceballos H., **Dufour D., Tran T**. (2018). No-cook process at very high gravity of various cassava starches for ethanol production. 18Th triennial symposium of ISTRC International Society for Tropical Root Crops: When, Where and How will tropical root and tuber crops lead the next Agri-Food revolution. 22-25 October 2018. CIAT, Cali, Colombia.

Alamu O.E., **Dufour D.; Fliedel G.; Bouniol A., Davrieux F., Tran T.,** RTBfoods project team (2018) End-users preferred RTB crops quality traits. 18Th triennial symposium of ISTRC International Society for Tropical Root Crops: When, Where and How will tropical root and tuber crops lead the next Agri-Food revolution. 22-25 October 2018. CIAT, Cali, Colombia.

Ospina M.A., **Tran T.,** Pizarro M., Luna Melendez J.L., Trivino-Palacios W., Belalcazar J., Martinez J.E., Salazar S**., Dufour D.,** Becerra Lopez Lavalle L.A., 2018. Phenotyping postharvest physiological deterioration (PPD) in cassava: Implications for selection. 18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Cali, Colombia, 22-25 October 2018.

Luna Melendez J.L., **Tran T.,** Pizarro M., Ospina M.A., Trivino-Palacios W., Belalcazar J., Martinez J.E., Salazar S.M., **Dufour D.,** Becerra Lopez Lavalle L.A., 2018. Diversity of post-harvest phenotypic traits among the CIAT cassava germplasm collection. 18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Cali, Colombie, 22-25 October 2018.

Pizarro M., Ospina M.A., Luna Melendez J.L., Belalcazar Martinez J.E., Salazar S**., Tran T**., Becerra Lopez Lavalle L.A., **Dufour D.**, 2018. Cyanide content and distribution in cassava plants, in association with physiological age. 18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Cali, Colombia, 22-25 October 2018.

Tran T. et al. Phenotyping postharvest physiological deterioration (PPD) in cassava implication for selection. 18Th triennial symposium of ISTRC International Society for Tropical Root Crops: When, Where and How will tropical root and tuber crops lead the next Agri-Food revolution. 22-25 October.

Ospina M. A., **Tran T.,** Pizarro M., Luna J., Triviño W., Belalcazar J., Salazar S., **Dufour D.,** Luis Augusto Becerra López-Lavalle L.A. (2018). Diversity of post-harvest phenotypic traits among the CIAT cassava germplasm collection. 18Th triennial symposium of ISTRC International Society for Tropical Root Crops: When, Where and How will tropical root and tuber crops lead the next Agri-Food revolution. 22-25 October 2018. CIAT, Cali, Colombia.

- ***Publications in Peer-reviewed journals***

Taborda L. A., **Tran T**., **Dufour D**., Garcia M. (2018). Main changes in the production of sour cassava starch in Cauca, Colombia over the last 20 years. In preparation.

Taborda L. A., Macombe C**., Dufour D.**, **Tran T.** (2018). Conflict and inequality in the region of Cauca Colombia: comparative analysis of socio economic status in cassava starch value chain 1995 and 2018. In preparation.

Ospina M. A., Pizarro M., **Tran T., Ricci J.,** Belalcazar J., Luna j., Londoño L. F., Salazar S., **Dufour D.,** Becerra López-Lavalle L. A. (2019). Diversity of cyanide content in cassava and association with carotenoid and protein contents. Submitted in: Food Research International

Adinsi L., Akissoé N., Escobar A., Kougblenou N., Prin l., **Dufour D.,** Hounhouigan J., **Fliedel G.** (2018). Sensory and physicochemical profiling of traditional gari in Benin. Position of new enriched

gari with palm oil and/or soybean. Submitted in: Food Science & Nutrition.

Escobar A., Rondet E., **Dahdouh L., Ricci J**., Akissoé N., **Dufour D., Tran T.,** Cuq B., Delalonde M. (2018). Impact of process scale and cassava variety on product quality attributes during gari making. Submitted in: Food and Bioprocess Technology, manuscript FABT-S-18-01538.

Shen G., Fernández Pierna J. A., Baeten V., Dardenne P**., Davrieux F.,** Ceballos H., **Dufour D.,** Yang Z., Han L., Lesnoff M. (2019). Local Partial Least Square based on global PLS Scores. Accepted in: Journal of Chemometrics

Iragaba P., Nuwamanya E., Wembabazi E., Baguma Y., **Dufour D.,** Earle E. D., Bezner Kerr R., Tufan H. A., Gore M. A., Kawuki R. S. (2018). Development of a consumer-validated phenotyping approach for quantitatively measuring softness of cooked cassava roots. Submitted in: African Crop Science Journal.

Nanyonjo A. R., Kyazze F., Esuma W., Wembabazi E., **Dufour. D.,** Nuwamanya E., Tufan H., Kawuki R.S. (2018). A comparative assessment of flour-making quality in cassava landraces and breeding lines: a gender-focused case in Zombo district, Uganda. Submitted in: Journal of the Science of Food and Agriculture.

Karlström A., Belalcazar J., Sánchez T., Lenis J. I., Moreno J. L., Pizarro M., **Ricci J.,** Dufour D., Tran T., Ceballos H. (2019). Impact of environment and genotype-by-environment interaction on functional properties of amylose-free and wild-type cassava starches. Stärke, 71(8p), 1700278. https://doi.org/10.1002/star.201700278

Aragón I. J., Ceballos H., **Dufour D.,** Ferruzzi M. G. (2018). Pro-vitamin A carotenoids stability and bioaccessibility from elite selection of biofortified cassava roots (Manihot esculenta, Crantz) processed to traditional flours and porridges (2018). Food & Function. (9): 4822-4835. https://doi.org/10.1039/C8FO01276H

Bechoff A., Tomlins K.I., **Fliedel G**., Becerra López-Lavalle L.A., Westby A., Hershey C., **Dufour D**. (2018). Cassava traits and end-user preference: relating traits to consumer liking, sensory perception, and genetics. Critical Reviews in Food Science and Nutrition. 58(4): 547–567. http://dx.doi.org/10.1080/10408398.2016.1202888

Escobar A., **Dahdouh L.,** Rondet E**., Ricci J., Dufour D., Tran T.,** Cuq B., Delalonde M. (2018). Development of a novel integrated approach to monitor processing of cassava roots into gari: macroscopic and microscopic scales. Food Bioprocess Technology 1-11. https://doi.org/10.1007/s11947-018-2106-5

Giraldo-Toro A., Briffaz A., Gibert O., **Dufour D., Tran T.,** Bohuon P. (2018). Modelling of heat and water transport in plantain during steeping to predict gelatinization and in vitro starch digestibility. Journal of Food Engineering, 235:1-8. https://doi.org/10.1016/j.jfoodeng.2018.04.022

- ***Posters ISTRC & GCP21***

Gil J. L., Belalcazar J., **Dufour D**., Gonzales T., **Tran T.** (2018) Biofortified cassava contributes to carotenes enrichment of egg yolks. (poster). 18Th triennial symposium of ISTRC International Society for Tropical Root Crops: When, Where and How will tropical root and tuber crops lead the next Agri-Food revolution. 22-25 October 2018. CIAT, Cali, Colombia.

Ospina M. A., Pizarro M., Luna J., Belalcazar J., Salazar S., **Dufour D., Tran T.,** Becerra López-Lavalle L. A. (2018). Cyanide content and distribution in cassava plants, in association with physiological age. (Poster) 18Th triennial symposium of ISTRC International Society for Tropical Root Crops: When, Where and How will tropical root and tuber crops lead the next Agri-Food revolution. 22-25 October 2018. CIAT, Cali, Colombia.

Ehounou E., Maledon E., **Fabien C., Cornet D**., Nudol E., Kouakou **A., Chair H. Arnau G.** (2018). Breeding for Improved tuber quality in yam Dioscorea alata L. (Poster). 18Th triennial symposium of ISTRC International Society for Tropical Root Crops: When, Where and How will tropical root and tuber crops lead the next Agri-Food revolution. 22-25 October 2018. CIAT, Cali, Colombia.

Adinsi L., Akissoé N., Hounhouigan J.**, Fliedel G., Dufour D., Tran T.** (2018). Beta-Carotene bio-

fortified cassava for Agbeli: processing and consumers perception in Benin. Fourth Scientific Conference of the Global Cassava Partnership for the 21st – GCP21-IV. Cotonou, Benin, June 11-15, 2018.

4.12.12 CIRAD Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution? Risks identified & Risk mitigation proposed?

- ***Delay in contract signature & budget transfer to partners***

The first challenge faced was the organization of the inception meeting with partners without any budget due to delay in the signatures of agreements with partners. To solve this issue, CIRAD made advances and got refund when money was transferred. The other challenge was that partners could not start their activities before money was transferred (around May for the last ones). For Period 2, money transfer is planned to happen immediately after Period 2 budget validation, i.e. during the RTBfoods annual meeting (last week of March 2019).

- ***No budget allocated to communication purposes***

No budget was initially dedicated to communication activities within RTBfoods project when the global budget was built. For this reason, PMU now has to cope with limited resource –especially human resource- to communicate regularly on activities carried out and results achieved. This is a considerable constraint since the project impacts on RTB breeders' community (i.e. RTBfoods outcomes) highly depends on its ability to communicate its methodological achievements in particular beyond the breeders involved in the project. An online knowledge management platform is being set-up at CIRAD level that could be adapted to answer RTBfoods communication needs.

- ***Staff Mobilization***

The limited availability of CIRAD researchers involved in many other projects is another challenge faced by the PMU and by researchers themselves. This mainly affected the coordination capacity of CIRAD leaders and co-leaders who have only been able to complete a limited number of visits to partner laboratories and fields. Besides, there were delay in the team building since E. fauvelle, C. Méjean and K. Meghar (i.e. the project manager for monitoring evaluation & learning, the project assistant and the chemometrician involved in WP3) joined the team in April, May and in September respectively.

- ***Cross-WP coordination***

One of the major challenges faced by the CIRAD team is the maintenance of regular cross-WP interactions, This is typically a gap observed at the level of WP coordination teams in which some CIRAD researchers are involved either as leaders (for WP3, WP4 and WP6) or as co-leaders (for WP1 and WP2). The spatial proximity of most of CIRAD staff allowed regular discussions with the coordination team (WP6) but did not favor cross-WP interactions as much as it could have. As an example, CIRAD researchers did not take the opportunity of being based in Montpellier to discuss on their respective deliverables and start thinking together about a learning process and on the knowledge flow to be supported for the transmission of results from one WP to another. During Period 1, only one meeting was organized by WP6 to bring all CIRAD staff involved in RTBfoods together. Most of people attending were researchers and especially those who have a responsibility as WP leaders or co-leaders. This meeting aimed to review expenses made on the budget for Period 1 by CIRAD staff in each WP and to start planning budget for Period 2 by WP. This meeting was an opportunity for CIRAD staff involved in the different WPs to discuss about their progress toward the achievement of their work plan collectively. Unfortunately, for more efficiency, the exercise was done independently by the CIRAD WP leader or co-leader prior to the meeting and they were too few to organize side meetings with their own team prior to or after this meeting. For future periods, the PMU should initiate more regular global CIRAD meetings to bring all staff involved in RTBfoods together on an occasion other than the annual meeting with all project partners. These meetings would allow everybody to follow-up on activities carried-out by CIRAD staff in each WP and discuss how first results should be shared appropriately with others. Such CIRAD coordination meetings would also allow the WP6 to identify challenges to be addressed at the institution level, for example with the

RTBfoods steering committee (see WP6 Extensive Activity Report for Period 1).

- ***Logistical constraints in workshops organization in African countries***

CIRAD WP leaders and co-leaders faced constraints in the organization of trainings and workshops in Africa. WP6 supported them on logistics and fund transfer was facilitated by CIRAD regional directors. The risks linked to the transfer of huge amounts of cash by CIRAD staff for the organization of such events was discussed within the RTBfoods steering committee. WP6 will keep facilitating the organization of important trainings and workshops through the logistical support provided to WP leaders and host partner by the project assistant and eventually through financial support as well.

4.12.13 CIRAD Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 across WPs, Product profiles (& countries)?

Cross-WP Coordination:

- Work plans development for Period 2 at WP level (coordinated by WP leaders) and revision of CIRAD narrative during the Annual Meeting 2019 (facilitated by PMU);,
- Review of CIRAD budget by WP and repartition by researcher to be discussed during the Annual Meeting 2019 (facilitated by WP6);
- Verification of the alignment of partners' budgets with their respective narrative for Period 2, after the Annual Meeting 2019 (by WP6);
- Support to scientific accuracy of the methodologies developed / adapted and of the content of deliverables produced by partner teams (especially by CIRAD staff involved in WP coordination).

Methodological support to scientific activities by WPs:

- WP1&WP5: support to partner teams in the following activities: implementation of surveys (key informant interviews, focus group discussions, individual interviews) to understand quality characteristics, survey data analysis, participatory processing diagnosis, consumer testing; discussions with WP5 coordination team on the development of a new participatory methodology for breeders' use to assess the users' acceptance of new RTB hybrids prior to release;
- WP2: setting-up sensory panels on targeted RTB products in partners countries, follow-up on the implementation of the training workshop for sensory profiling by WP2 teams to be coordinate by CIRAD researchers; harmonization of methods and protocols for physicochemical analysis by partner laboratories to be coordinated by CIRAD team; if relevant biophysical analysis might be conducted by all CIRAD staff involved in WP2 at CIRAD and CIAT laboratories for specific analysis;
- WP3: standardization of HTP protocols to be coordinated by CIRAD leader; trainings of partners on HTP tools, especially on the hyperspectral camera to-be-acquired by CIRAD and some partner laboratories; complementary and specific support to be provided to WP3 partner teams by CIRAD team for spectra acquisition and development of calibration models for specific quality traits;
- WP4: field trials to be coordinated by the CIRAD WP4 coordinator.
- WP6: identification and consolidation of success stories on some RTB products; development of a MEL plan; development of a data management plan, of a communication strategy and setting up an online interface for knowledge management at project level and external communication purposes by the PMU.

4.13 Annex 13: CNRA Synthesis Report for Period 1

CNRA achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s): KOUAKOU Amani Michel, CNRA, Côte d'Ivoire

Collaborator(s):

4.13.1 CNRA Summary

(10 to 15 lines of Partner achievement for Period 1)

Activities were conducted in WP1, WP4 and WP5. Most of them concerned WP1. Attiéké made of cassava is the leading product for Côte d'Ivoire. All the activities of WP1 concerned this product. Preliminary survey conducted in two (02) regions Bingerville-Dabou in the South and Yamoussoukro-Bouaké in the Center. After that, the survey was conducted in Bingerville-Dabou region where attiéké is a traditional stapple dish. In the region of Dabou the villages Akradio and Opoyounem where 226 persons were interviewed among which 136 of them were females and 90 males. As regards to Bingerville, 05 villages (Bregbo, Eloka-Té, Achokoi, Akradio and Opoyounem) were investigated.

A State of Knowledge (SoK) study was also performed for WP1. It was focused on 3 areas (demand, gender and food science) in order to identified attributes that are important for a good cassava that make good Attiéké and important descriptors for a good Attiéké and desagregate the.data. Leader Interview, Focus Group of men and women, Market Interview, Individual Interview and Transect in these locations were realized.

We also made the WP2 SoK. The main objective of WP2 is to translate the user traits captured in the Food Product Profiles from WP1 into laboratory based quantitative assessments of biophysical and functional properties that can be used as reference values for developing high-throughput product. CNRA provided the inventory of material and equipments existing at the institution and method of analysis that are used.

CNRA participated also in the kick-off meeting in Buéa and the training sections in Benin.

4.13.2 CNRA activities

PARTNER participation in the different WPs & cross-WP interactions

(Describe activities, collaborations between teams within the institution, project implementation)

After the kick-off meeting, the local actors organized a workshop to decline the activities to be conducted and the PI explained how he will lead the project locally. The informations concerning the financial aspect were also delivered.

In which WPs is the PARTNER team involved? For which activities conducted in Period 1?

CNRA activities for yea1 concerned WP1, WP2, WP4 and WP5.

WP1

SoK for WP1 was focused on 3 areas (demand, gender and food science) in order to identified attributes that are important for a good cassava that make good Attiéké and important descriptors for a good attiéké and desagregate the.datas. The surveys were conducted in one location in the south were attiéké is a traditional stapple dish (Bingerville: Bregbo, Eloka-Té, Achokoi). We also did Dabou location (Akradio, Opoyounem)but we did not finish the report.

We did leader interview, Focus group to men and women, market interview, individual interview and transect in this different locations.

Mission were made also in the center part of the country to select the one more indicated for the survey (Lolobo, Yamoussoukro, Sakiaré, Molonoublé)

WP2

We also made the WP2 SoK. The main objective of WP2 is to translate the user traits captured in the Food Product Profiles from WP1 into laboratory based quantitative assessments of biophysical and functional properties that can be used as reference values for developing high-throughput product. We participated in the training section on sensory in Kampala (Ouganda). We provided the inventory material and equipments existing at CNRA and method of analysis that are used here.

WP4

188 samples of the germplasm of *D. alata* were collected. They will be sent for finger printing by SNPs technics genotyping by sequencing (GBS) to DarT in Australia.

WP5

Breeding material of cassava, yam, sweetpotato and plantain were tested participatively. The trials concerning cassava, yam and plantain are still going on. The one of sweetpotato has been harvested. The trials were conducted at Bouaké and Korhogo. Using the agronomic and quality traits such as the shape of the root, the color of the flesh, the aspect of the cooked flesh and the taste of sweetpotato varieties. Variety TIB-440060 was the most appreciated, followed by Irene.

4.13.3 CNRA geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

CNRA is in Côte d'Ivoire, West Africa.

The trials are conducted in the regions of Korhogo (North) for sweetpotato, Bouaké and Tiébissou (Center) for cassava, Bouaké (Center) and gagnoa (Center-Ouest) for Yam. For plantain Aidjan region is chosen for the importance of this crops in that region.

Figure 1: Plot of the FHIA 21 variety at 5 months after planting

4.13.4 CNRA Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

CNRA is working on pounded and boiled yam, Attiéké (cassava), fried sweetpotato and fried plantain

(Alloko). But the main product is Attiéké on which WP1 is focusing. The output from WP1 on this product will be used during the next years for the other work packages.

4.13.5 CNRA Personnel involved & Students activities

*List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab "**3a) PERSONNEL COSTS" of Partner Financial Report)***

Except the personnel mentioned in the agreement many other scientists and technicians, staff of CNRA are involved in the project. They are listed in the table. The driver and the Technician will be recruited in year2.

NAME Surname	***Domain***	***WP***
Dr Kouakou Amani	Plant breeders (Yam breeder)	WP4 WP5
Dr N'Zué Boni	Plant breeders (cassava breeder)	WP5
Dr Koffi Kouablan Edmond	Plant breeders (Tissue culture specialist)	WP4
Dr Ebah-Djedji Bomoh Catherine	Food scientist	WP1
Dr Dibi Konan	Physiologist (sweetpotato, cassava and yam)	WP5
Dr Traoré Siaka	Pathologist (plantain)	WP5
Dr Essis Brice	Pathologist (Yam, cassava, sweetpotato and plantain)	WP5
Kanon Landry Alban	Agro-Economist	WP1
Diby Affoué Sylvie	Food scientist	WP2
Mahyao Adolphe	Agro-Economist	WP1
Depieu Ernest	Agro-Economist	WP1
Pokou Désiré	Plant breeders (Molecular geneticist)	WP4
Kouadio Krah	Technician	WP5

List of Students involved in RTBfoods activities in Period 1:

Two students worked for the project in year1. The other students will be recruited in 2019.

NAME Surname	***Master Student or PhD or Post-Doc***	***Subject Title***	***University of affiliation***	***Fellowship Starting Date***	***Fellowship Ending date***	***Tutor(s) in RTBfoods project***
Ehounou Adou Emmanuel	PhD	Selecting *D. alata* for resistance to anthracnose and quality traits	University Felix Houphouet Boigny, Abidjan	2014 on Africayam	2019	Kouakou Amani Michel
Guehayibi Gouleble Linda Syntiche Gougnan	Master	Study of the plantain development in nursery and in the field at Anguédédou	Institut Polytechnique Rural de Formation et de Recherche Appliquée (IPR/IFRA)	July 2018	December 2018	TRAORE Siaka

NAME Surname	Master Student or PhD or Post-Doc	Subject Title	University of affiliation	Fellowship Starting Date	Fellowship Ending date	Tutor(s) in RTBfoods project
		(South Côte d'Ivoire)	KATIBOUGOU (MALI)			

4.13.6 CNRA Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

*(For more accuracy you can refer to: Tab "**3b) TRAVEL COSTS" of Partner Financial Report)***

Number of People or List of NAMES	RTBfoods meetings	International / Regional Conferences	Dates
C. Djedji - Ebah Deless Thiemele Michel Kouakou Siaka Traore Désiré Pokou	Participation to the Kick off Meeting	Buéa, Cameroon	23rd – 28th January 2018
KANON Alban Landry EBAH Djedji B. C.	participation in a training organized by the actors of theWP1	Cotonou, Benin	16th – 25th April 2018
EBAH Djedji B. C. DIBY Affoue Sylvie	WP2 training	Kampala, uganda	16th - 22nd September 2018

4.13.7 CNRA Capital Equipment or investment (co-investments)

*List of equipment acquired on RTBfoods budget (e.g?. texturometer, RVA, pHmeter, etc.) (For more accuracy you can refer to: Tab "**3d) EQUIPMENT COSTS" of Partner Financial Report)***

One vehicle Mitsubishi L200 pick up bought the 04/06/2018.

4.13.8 CNRA Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	WP concerned (if training within RTBfoods framework)	Country	Dates	List of Participants NAMES
Determination of *D. alata* quality traits by phenotyping and using NIRs	WP3	CIRAD Guadeloupe	31st January – 31st July 2018	Ehounou Adou Emmanuel

4.13.9 CNRA Sub-awards & Consultants

*List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab **3c) CONSULTANT COSTS** and "**3f) SUB AWARDS COSTS" of Partner Financial Report)***

4.13.10 CNRA Other Sources of Support for RTBfoods activities

The costs of the activities on yam (WP4 and WP5) have been supported partially by the AfricaYam Project.

4.13.11 CNRA List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

None

4.13.12 CNRA Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution?

For this first year of the project, the main challenge is the quantity of activities in WP1. To cover all these works, we involved 4 other scientists (Agro economists) not registered on the list of participants of the project. For the year2, the number of team members will be strengthen by adding students.

Risks identified & Risk mitigation proposed?

The lack of funds for indirect costs is also a limiting factor. Some laboratories need equipments such as Air conditioner or repairing for an efficient work.

4.13.13 CNRA Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 accross WPs, Product profiles (& countries)? For year2, Côte d'Ivoire team will continue and finalize WP1 works. The other activities will be deepened. We will participate in all the project meetings. A PhD student will travel to Guadeloupe to finalize his works on yam quality. The leave sample collected will be genotyped for WP4. The participatory assessment of the quality traits will continue for cassava, sweetpotato, plantain and yam.

For (04) PhD students will be recruited: one for WP2, 01 for WP1 and 1 for WP5. Two other master student will be engaged.

4.14 Annex 14: IITA Synthesis Report for Period 1

IITA achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s):

- MAZYIA-DIXON, Busie, IITA, Nigeria
- ALAMU, Emmanuel, IITA, Zambia
- AMELE, Asrat, IITA, Nigeria
- TEEKEN, Béla, IITA, Nigeria
- UWIMANA, Brigitte, IITA, Nigeria

Collaborator(s):

- NRCRI
- Université d'Abomey-Calavi
- Bowen University
- NARL/NARO
- NaCRRI/NARO

4.14.1 IITA Summary

(10 to 15 lines of Partner achievement for Period 1)

Within the WP1 scope IITA has produced State of Knowledge reports for *gari* (Benin, Nigeria, and Cameroon) as well as for yam (boiled yam) product (Nigeria). Furthermore, staff has been trained on the WP1 methodology in Cotonou Benin. Following a standardized sampling frame for WP1, IITA carried out fieldwork including questionnaires and focus group discussions in Nigeria and Benin for all the products separately. In addition, yam advanced clones under on-farm evaluation for commercial deployment were profiled for boiled and pounded yam food product quality characteristics. This was done in collaboration with WP5 and the cassava team.

In WP2 and WP3, 200 clones of yam (Dioscorea rotundata and Dioscorea alata) from two growing environments (Ibadan and Ubiaja) were provided by the AfricaYam project and 200 genotypes of cassava roots from NextGEN diversity trials also from two growing environments (Ibadan and Ikenne) were collected. The samples were analyzed for dry matter (DM), starch, color and protein for yam and cassava to generate reference data for the calibration profile development for NIRS in connection with WP3 deliverables. Cyanogenic potential (CNP) was included for cassava.

Within the scope of the WP5 (evaluation of varieties with stakeholders) IITA has developed a methodology for evaluating and has evaluated promising clones with stakeholders in Nigeria for Cassava and Yam based on existing Yam and cassava trials.

In the first period of RTBfoods, IITA Banana and Plantains team was scheduled to work on cooking bananas (matooke) under WP4 and to conduct a survey to study the impact of the released plantain hybrids in West Africa. Under WP4, on cooking bananas (matooke), IITA has produced a report on State of knowledge (SoK) for quality traits in matooke at IITA" (WP4 period 1 deliverable M1.1). IITA has made an inventory of the available material to be used by different WPs working on matooke quality. Based on this information, we have populated the result tracker for WP4 (WP4, M2.1).

IITA has also collaborated with NaCRRI and NARL to set up the stage in defining matooke quality in sensory and physico-chemical (WP2 by NARL) and NIRS analyses (WP3, NaCRRI). An

impact/adoption study on plantain hybrids (PITAs) was planned to be started in Period 1 of the project. However, the budget was too small for such a study. Meetings were held to device a way forward, and it was decided to replace the study with a plantain consumer preference study based in Nigeria. This will be conducted in Period 2 of the project.

4.14.2 IITA activities

IITA participation in the different WPs & cross-WP interactions

(Describe activities, collaborations between teams within the institution, project implementation)

In which WPs is the PARTNER team involved?

For the reporting period, the IITA team is involved in WPs 1, 2, and 3 with collaboration with WPs 4 and 5.

For which activities conducted in Period 1?

IITA participated in the project kick off and planning meeting in Buea, Cameroon. Representatives from the different work packages participated in more than only their own work package meetings, which facilitated good communication and interaction between the work packages.

Within WP1 the following activities were conducted: State of knowledge reports (activity 1) for the cassava product *gari* in Nigeria and Cameroon; for boiled yam in Benin. Furthermore, staff selected to carry out activity 3, 4 and 5 in Nigeria, Cameroon and Benin were trained during the capacity building workshop (activity 2) in Cotonou (14-25 April 2018) on social science (including practical fieldwork exercises); sensory evaluation methodologies and statistical analysis of social and sensory data using XcelStat. Subsequently fieldwork (activity 3) was carried out using the sampling frame and methodology developed during activity 2 and during an extra meeting with Lora Forsythe focused on finetuning to the local conditions in Nigeria and Benin. Fieldwork was carried out within the 3 senatorial districts of Benue and Osun state and these datasets will be merged with fieldwork carried out by NRCRI in the three senatorial districts in Imo state. For Banana we are assembling an interdisciplinary team and developing an adjusted protocol of WP1 activities as to incorporate initial research on the adoption and use of PITA hybrids.

After development of the protocol, evaluation was carried out with 3 champion farmer-processors in Each state. This was done in two states in Nigeria (Osun and Imo) and was a cooperation between IITA and NRCRI. Nexgen trials comprising a mixture of local varieties, commonly grown varieties as grown by smallholder farmers in Nigeria and new promising IITA clones, were used as a basis for this WP5 clone evaluation with the farmer-processors. Special attention was given to the relation between the clones, the agronomic evaluation by farmer-processors as well as the food product quality. In addition,

a similar protocol was developed, and an evaluation conducted for boiled and pounded yam with yam champion processors using 3 existing trials one in Oyo State and two near Ubiaja, Edo State. Each trial contained both water and white yam groups, the local preferred variety, and a breeder improved check that is widely grown by farmers and three promising candidate varieties.

Within WP2 activities, IITA collected 200 clones of yam species (Dioscorea rotundata and Dioscorea alata) from two locations (Ibadan and Ubiaja) and 200 fresh cassava genotypes from diversity trials. These yam clones and fresh cassava genotypes were provided by WP4 and NextGen, while WP2 did the sampling and analyses. Three fresh yam tubers and cassava roots for each clone (big, medium and small) were prepared for analysis using standard sampling and sample preparation methods (chopped, grated or blended) and analyzed for dry matter, starch, color and protein for yam while cyanide was included for cassava to generate reference data for the calibration of NIRS for WP3 deliverables. Within WP3, a portion of each sample was scanned on the NIRS for spectra data collection. A total 2400 spectra were generated for yam and cassava; and collected within the range of 400 to 2498 nm, using a NIRS monochromator (model FOSS XDS). The usage of reference data

generated for calibration development under WP3 is in progress.

The WP4 yam team received the RTBfoods project management team and WP4 leader at Abuja and was involved in a travel workshop to NRCRI and IITA that facilitated full interaction and communication with WP1, WP2, WP3 and WP5 members. In addition, yam breeding population nomination and tracker report had been developed.

IITA banana and plantains program is involved in WP4 under the product “matooke”. It was also scheduled to conduct an impact study on hybrid plantains.

WP4 activities on matooke are due to start in the second period of the project, hence no funding was provided for those WP. However, IITA produced a report on the state of knowledge on breeding for quality matooke improvement (Activity 1). Moreover, an inventory was conducted on the available populations under banana breeding, and the most suitable one was identified to be used in the future by WP4 and the information was used to populate the result tracker file (activity 2).

We also identified material to be used by WP2 to quantify “matookeness” in laboratory-based physico-chemical analysis, and by WP3 to develop a highthrouput method for quantifying “matookeness”. Because of the nature of banana of around-the-year production, banana bunches are delivered to NARL/NARO (Kawanda – Uganda) and to NaCRRI/NARO (Namulonge) for wet-lab chemistry (WP2) and NIRS (WP3) analyses respectively. So far, 192 bunches, representing 99 genotypes, in 1 to 5 bunches per genotypes, have been analysed by WP2 for physico-chemical content. Eighty-one of these genotypes (129 bunches) have been used by WP3 to generate banana NIRS spectra. The activity will continue through Period 2 of the project to complete 250 genotypes to be analysed, each in 5 replicates.

An impact study on IITA plantain hybrids (PITAs) was planned to be conducted in West Africa. However, due to the limited budget, this study could not take place. Through discussions held in several meetings, it was decided that this activity would be replaced by a consumer preference study on plantains (WP1). The study will cover the use of plantain products, including “fried plantains”. It will also include questions to find out whether PITAs are still grown by the farmers, and the results will pave a future adoption and impact study of those hybrids. A State of Knowledge (SoK) will be conducted to understand what has already been done in this area. For the success of this study, it will be important to have the funds for Period 1 and Period 2 available in the 2nd period of the project.

How is internally organized communication/coordination between WPs?

Communication between work package 1, 2, 3 and 4 have been very good. This has been achieved through emails, phone calls, virtual (skype) and in person meetings. Also, initiatives within the Nextgen project, like the gender trials in Osun and Imo and the processing evaluation done on station in IITA under Ismail Rabbi has very well brought WP1 and WP4 together.

4.14.3 IITA geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

For WP1 activities, IITA is carrying out activities in Nigeria, Benin and Cameroon and Uganda. WP5 activities are only carried out in Nigeria.

For WP1 and WP2 activities, IITA is carrying out these activities in Nigeria and Uganda. There is also interaction between Nigeria and Uganda team. In addition, IITA is working with NRCRI and BOWEN University teams especially in WPs 2 and 3.

4.14.4 IITA Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

IITA has been involved in the product profiles for: *gari-eba*, boiled yam and pounded yam; In addition,

Uganda for banana – matooke, and Nigeria for plantains.

4.14.5 IITA Personnel involved & Students activities

List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab "3a) PERSONNEL COSTS" of Partner Financial Report)

The following IITA personal are involved in the project:

Name	***Activity***
Richard Offei Oladeji Emmanuel Alamu Peter Kulakow Asrat Amele Béla Teeken Brigitte Uwimana Busie Maziya-Dixon Delphine Amah Rony Swennen Violet Akech	Inception RTBfoods kick off and planning meeting in Cameroon; WPs 1, 2, 3, 4, and 5 activities.
Durodola Owoade Bello Abolore Adebowale Osunbade Bussie Maziya-Dixon Béla Teeken Hubert Noel Takam Tchuente Adetonah Sounkoura	WP1 Capacity strengthening Training in Cotonou, Benin
Adebowale Osunbade Nwaoliwe Gregory Liticia Effah-Manu	WP 2 Training Workshop on Sensory Evaluation held at NARL, Uganda
Durodola Owoade Bello Abolore Adebowale Osunbade Amiebhor Blessings	Meeting with Lora Forsythe to review Survey tools and WP1.
Michael Adesokan	WPs 2 and 3
Alex Edemudo Tunde Adeosun	WP4 (Yam Breeding)

List of Students involved in RTBfoods activities in Period 1:

NAME Surname	*Master Student or PhD or Post-Doc*	*Subject Title*	*University of affiliation*	*Fellowship Starting Date*	*Fellowship Ending date*	*Tutor(s) in RTBfoods project*
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A

4.14.6 IITA Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

*(For more accuracy you can refer to: Tab "**3b) TRAVEL COSTS" of Partner Financial Report)***

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
6	Kick-off and planning meeting in Cameroon	GCP 21 Conference; ISTRC	22-28 Jan, 2018
5	WP 1 capacity strengthening workshop in Cotonou Benin		15-26 April, 2018
4	Meeting with Lora Forsythe to review Survey tools		7-9 August, 2018

4.14.7 IITA Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
Capacity strengthening workshop (field data collection tools and analysis, sampling frame, sensory evaluation methodologies and analysis)	WP1	Benin	15-26 April 2018	Durodola Owoade Bello Abolore Adebowale Osunbade Busie Maziya-Dixon Béla Teeken Floriane Nguembou Hubert Noel Takam Tchuente Adetonah Sounkoura
Fine tuning and field testing of the WP1 activity 3 tools with Lora Forsyth (NRI)	Wp1	Nigeria	6-9 August	Durodola Owoade Bello Abolore Adebowale Osunbade Amiebhor Blessings
Sensory panel training (sensory	WP2	Uganda	16-22	Adebowale osunbade

Training Title / Topic	*WP concerned (if training within RTBfoods framework)*	*Country*	*Dates*	*List of Participants NAMES*
evaluation protocol and analysis)			September	
NIRS training (working with and operating NIRS machines)	WP3	Nigeria	12-14 June 2018	Micheal Adesokan Toyin Olaniyan Adedapo Folorunsho Osunbade Adebowale Ogunpaimo Kayode Uba Ezewanyi Enobong Udo Olaniyo Esther
Use of NIRS	WP4	Uganda		Brigitte Uwimana

4.14.8 IITA Sub-awards & Consultants

*List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab **3c) CONSULTANT COSTS** and "**3f) SUB AWARDS COSTS" of Partner Financial Report)***

4.14.9 IITA Other Sources of Support for RTBfoods activities

Which complementary / partner projects (other sources of funding) contributed to RTBfoods activities in Period 1?

The Nextgen funds contributed significantly to the WP5 work as Nextgen trials were used for WP5 work. Next to that AfricaYam project money contributed to Yam WPs 4 and 5 work in setting trials and breeding population and personnel cost for the staff implemented the activities. Also, salary costs of staff under Nextgen was covered by Nextgen funding.

BBB contributed to RTBfoods activities through the in-kind contribution of staff time (see section on personel), maintenance of fields for the population and other accessions to be used by RTBfoods, providing and transporting banana bunches to Kawanda (WP2) and NaCRRI (WP3) every Monday.

4.14.10 IITA List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

No publications on RTBfoods data yet. State of Knowledge reports for Gari in Nigeria and Cameroon and boiled yam in Benin. Methodologies for WP5 variety evaluation with stakeholders for Cassava and Yam in Nigeria focusing on the cassava products gari and fufu and the Yam food products boiled and pounded yam.

4.14.11 IITA Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution?

Risks identified & Risk mitigation proposed?

- Constraints faced were lack of personnel to carry out the work and therefore we had to stretch out to use people who have their salary under other projects.
- Lack of vehicle for the project to execute the project activities
- No funds were allocated for the yam team for the period 1 and the amount allocated starting from period was so small to efficiently implement the project activities.
- Limited funds to carry out the impact study on plantains, which resulted in restructuring the study.
- Funds for the first period took long to be released.

4.14.12 IITA Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 across WPs, Product profiles (& countries)?

For WP1 planification for activities 4 and 5 are well laid out for the cassava product gari in Nigeria and good cooperation with NRCRI is planned. For the gari work in Cameroon, we must set a clear cooperation with ENSAI and the University of Dschang in relation to the planned PhD student's work. WP4: Execution of field trials on nominated breeding population for quality analysis (*gari*, boiled and pounded yam products)

For Banana WP4, recruitment of a field assistance; maintenance of the banana fields for the lines to be used by WP2, WP3 and WP4; continue providing banana bunches for WP2 and WP3 work on matooke; work with WP2 and WP3 to analyze the data on physical-chemical analysis for matookeness (WP2) and NIRS data (WP3) and associating the two; and conducting the plantain consumer preference study under WP1 to completion.

4.15 Annex 15: INRA Synthesis Report for Period 1

INRA achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s):

- ROLLAND-SABATE, Agnès, INRA, France
- DESFONTAINES, Lucienne, INRA, France

Collaborator(s):

- BUREAU Sylvie
- LE BOURVELLEC Carine
- TOULOUMET Line
- GARCIA Caroline
- BOTT Romain
- BOGE Marielle
- PAVIS Claudie
- UMBER Marie
- LANGE David
- GELABALE Suzia
- LEINSTER Jocelyne
- IREP Jean-Luc
- MARIE-MAGDELEINE Carine
- CALIF Valerius
- FAURE Yoana
- BADE Pascale, INRA, France
- CORNET Denis
- CORMIER Fabien
- ARNAU Gemma
- NUDOL Elie; CIRAD, France

4.15.1 INRA Summary

For INRA PACA UMR SQPOV Avignon, this first period was employed to define and organize the future activities to be conducted on yam and banana products in Avignon in light of analyzing the linked bibliography and the protocols. Preliminary tests were done for the extraction of cell wall polysaccharides from raw banana and partners were consulted in order to set the conditions to obtain materials, to define samples, experiments.

For INRA ASTRO-URZ and CIRAD Guadeloupe, this first period was employed to organize the differents activities to be conducted on yam. The objective is quantifying the phenotypic and genetic relationships between yam (D. alata) vegetative growth and tuber quality (dry matter, starches, proteins, sugars, amylose, amylopectin, browning, shape and size of starch granules, and textures parameters, etc) in contrasted environments. Two types of plant material have been assessed: (i) a varietal panel representative of D. alata genetic diversity from 12 (in 2017) and 40 (in 2018) accessions for GxE interaction study, (ii) a biparental population (300 accessions from AfricaYam project) aiming at QTL identification.

4.15.2 INRA Activities

In the frame of WP2, in period 1, INRA PACA UMR SQPOV Avignon team consulted partners (INRA and CIRAD in Guadeloupe, CIRAD in Montpellier France, UAC in Benin, NARO in Uganda, CARBAP in Cameroon) to define the varieties that will be analyzed, how they will be obtained (grown and

delivery), define the form of the samples (raw, boiled, pounded; fresh and/or freeze-dried) and the experiments (who does what).

INRA PACA UMR SQPOV Avignon analyzed the bibliography and compiled the various analytic procedures for cell wall polysaccharides and polyphenol analysis in RTB and did first experimental trials to extract cell wall polysaccharides from raw banana (plantain at 3 different maturation stages: green, mature and over-mature). Bibliography was done with a particular focus on yam and banana cell wall polysaccharides and polyphenols, in relation to the texture and astringency of yam and banana products. INRA PACA UMR SQPOV Avignon participated to the produced SoKs on boiled yam and boiled banana. The future activities to be conducted on yam and banana products in Avignon were organized.

In the frame of WP3, in period 1, at CIRAD Guadeloupe, a study was conducted to assess the feasibility of use NIRS as a tool for predicting different textural attributes in yam *Dioscorea alata*. This work was conducted in collaboration with CNRA (Bouaké) with the hosting of Emmanuel EHOUNOU, PhD student from CNRA, during six months (February to July 2018) at CIRAD Guadeloupe and with INRA-Guadeloupe (ASTRO, URZ) for spectral NIRS acquisition and development of calibration. Nine physico-chemical and textural characteristics (dry matter content, starches, proteins, sugars, hardness, adhesiveness, cohesiveness, springiness and extensibility) were analyzed on a panel of twenty-seven *D. alata* accessions which represent a large genetic diversity of this species. These accessions were selected from molecular and quality data previously obtained (Arnau et al. 2017; Final report Cavalbio 2015-2017). The varieties Florido and Bete-Bete, which are the two most cultivated varieties in Côte d'Ivoire, were used as reference. Accessions were planted together on the same plot and harvested at maturity. At harvest, three tubers by genotype were used. Tubers were peeled with a knife, and washed. The head and the tail were removed and then tuber was cut longitudinally. Half was used for textural analysis and the other half for chemical analyses.

Texture evaluation was conducted on pounded samples using texture profile analyses (TPA, Stable Micro Systems) with two compression cycles. Samples of 200 g were sliced at 5 mm thick and cooked with 1.5 L of water in a pressure cooker JVO. Three pressure cookers JVO were used for cooking the three samples of each accession at the same time. The time of cooking was regularly checked by prodding the yam pieces with the fingers and a fork to evaluate when were well cooked. After cooking, the pieces were cooled during 3 minutes before proceeding to pounded yam with a mechanical pounder (Model Bluesky, NIF A-2842270). The mechanical pound was used in order to ensure uniformity in the conditions of sample preparation that could not be guaranteed with the traditional practice of manual kneading in a mortar with a pestle. Texture properties were characterized on yam pastes samples formed within moulds (diameter 25 mm height 18 mm). Nine different pounded yam samples were analyzed for each accession (three replicates per tuber).

Samples of about 300 g were used for the preparation of chips (5/10mm) for chemical analysis. Tuber pieces were dried at 60°C for 48 h and milled into flour using a stainless steel grinder. The granules size was homogenized using on sieve of diameter 200 µm. Fifty grams of each sample were sent to Teyssier Laboratory for chemical analysis. NIRS measurements were carried on at Food processing Laboratory of INRA in Guadeloupe, and each sample was scanned in duplicate. Calibration is in process.

In WP2, in period 1, INRA ASTRO and CIRAD Guadeloupe team consulted CIRAD Montpellier France and INRA PACA UMR SQPOV to define a protocol to evaluate amylose content in yam flour tuber. Bibliography was done on amylose content in various species and in relation to the texture of yam products. We proceed to a methodological development on amylose estimation from iodine color method and achieved the validation of this protocol. It was applied in the first panel of 95 tuber yam flours from CIRAD Roujol (2017).

Futhermore, in WP2/WP3, at INRA Guadeloupe, we proceeded to the sampling and measurements protocols on 12 genotypes from 2 contrasted environments, planted in 2017. The main activities were:

-Flour preparation of yam tubers for chemicals analysis at INRA-ASTRO Laboratory;

-Spectral NIRS acquisition in yam flour at INRA-URZ Laboratory;

-Sampling Flour for chemicals analysis (Starches, proteins, Sugars) by Teyssier Laboratory;

-Physico-Chemical analysis (amylose, amylopectin) by INRA-ASTRO Laboratory;

-Start the collect and building spectral data base from NIRS spectral and chemicals data (INRA-Guadeloupe/CIRAD Guadeloupe);

-Devolpment of a calibration model for Chemicals and texture parameters are in course.

In the frame of WP4, the selection of 40 accessions to introduce in the experimentation for the Genotype x Environment was conducted and field preparation and planting was achieved in three contrasted places (Godet, Duclos, Roujol).

References

Arnau G., Bhattacharjee P., MN S., Chaïr H., Malapa R., Lebot V., K. A., Perrier X., Petro D., Penet L., Pavis C. 2017. Understanding the genetic diversity and population structure of yam (Dioscorea alata L.) using microsatellite markers. PloS One, 12 (3) : e0174150 (17 p.).

Arnau G., Nudol E., Maledon E. , Desfontaines L ., Marie-Magdeleine C. 2017. Qualité physico-chimique des ignames. In mi -term report of Project PO-Feder-Cavalbio "Caractérisation et valorisation de la biodiversité végétale tropicale d'intérêt agronomique", 44-47.

CAVALBIO Project (2014-2020): Characterization and valuation of tropical plant biodiversity of agronomic interest. Caractérisation et valorisation de la biodiversité végétale tropicale d'intérêt agronomique « CAVALBIO », Research project presented to the Guadeloupe Operational Program 2014 - 2020.

4.15.3 INRA geographic implementation / strategy

INRA PACA UMR SQPOV Avignon team conducted its activities in Avignon, France.

INRA ASTRO and CIRAD team conducted its activities in Guadeloupe, France.

4.15.4 INRA Product Profile participation

INRA PACA UMR SQPOV Avignon team participated to boiled and pounded yam, and boiled banana product profiles by analyzing the linked bibliography and first trials on cell wall extractions in Avignon, France.

INRA and CIRAD Guadeloupe team participated to boiled and pounded yam, and flour yam product profiles by analyzing the linked between starch, amylose and texture properties.

4.15.5 INRA Personnel involved & Students activities

In INRA PACA UMR SQPOV Avignon team the personnel involved for WP2 were: Agnès Rolland Sabaté (Engineer, phD) and Line Touloumet (Technician for the laboratory) in Period 1. They all participated in WP2 in Avignon, France. Agnès Rolland Sabaté is the INRA coordinator in RTBfoods project and expert in physico-chemical, biochemical and biopolymers analyses. She participated to boiled and pounded yam, and boiled banana product profiles by analyzing the linked bibliography and the protocols linked to biopolymers characterizations in relation with textural properties, and by defining and organizing the future activities to be conducted on yam and banana products in Avignon. Agnès Rolland Sabaté and Line Touloumet participated to boiled banana product profiles by analyzing the protocols and doing the first trials on cell wall extractions.

In period 1, the permanent personnel from INRA Guadeloupe involved in the project were for UR-ASTRO: Lucienne Desfontaines (Engineer, Lab manager), Claudie Pavis (Scientist), Yoana Faure (Engineer), Marie Umber (Engineer, phD), David Lange (Technician for the field), Suzia Gélabale (Technician for the laboratory), Jean-Luc Irep (Technician for the field), Jocelyne Leinster (Technician for the laboratory), and Pascale Bade (Technician for the laboratory) and for URZ:

Carine Marie-Magdeleine (Engineer, phD) and Valerius Calif (Technician for the laboratory).

Jean-Luc Irep and David Lange are involved in field experimentation (WP4) (field preparation/planting) and sampling of 12 accessions (in Colziyanm collection in 2017) and 40 accessions (in Colziyanm collection in 2018) on two target environment at INRA (Godet et Duclos) in Guadeloupe.

Claudie Pavis (WP3 and WP4) was head of theTropical Plant Biological Resource Center and yam collection manager. She was replaced by Yoana Faure (Engineer) on September 2018 for the management of the yam collection. The main purpose is to coordinate the protocol of sanitation of accessions from the BRC needed by the experimentation and to provide accessions for multiplication in Colziyanm collection.

Marie Umber is an expert on virology and germplasm sanitation process and viral diagnostics (WP4).

Lucienne Desfontaines is the lab manager and expert in physico-chemical, biochemical and NIRS analysis and calibration (WP2 and WP3). Carine Marie-Magdeleine is the lab manager and expert in phytochemistry, pharmacognosy and NIRS analysis and calibration (WP3).

Lucienne Desfontaines collaborated with CIRAD Montpellier France for analysis of a panel of 21 accessions in order to obtain amylose content by DSC method. Then with 2 students and 1 non-permanent staff, she has proceeded to the development and validation of amylose content in yam flour by iodine color method and applied it on a first panel of 25 genotypes from CIRAD Roujol (Gemma Arnau). Furthermore, Lucienne Desfontaines assured the NIRS acquisition on 12 genotypes from Godet, Duclos and 25 genotypes from Roujol, and transmitted spectra to CIRAD-Montpellier partner for constitution of spectral database (Denis Cornet) and for NIRS calibration on texture and starch properties (Carine Marie-Magdeleine, INRA-URZ). Lucienne Desfontaines, Carine Marie-Magdeleine and Denis Cornet (CIRAD-Montpellier) initiated the calibration on the panel of 285 spectra + chemical analysis (starch, proteins, sugars and texture parameters) in order to evaluate yam properties of a biparental population (Gemma Arnau, CIRAD-Guadeloupe).

Jocelyne Leinster and Pascale Bade were involved in the NIRS acquisition on flour tuber yam on 300 of the biparental population (from Africayam project) for prediction of physico-chemical properties (starches, protein, sugars and texture) (WP3).

INRA Guadeloupe UR ASTRO has not enough technical staff to manage the sampling and preparation of chemical analyses, and the different field trials scheduled in the project. So, we require non-permanent technical staff, to take these tasks in charge (2 months in 2018 owing to the lately date of the budget, and the number of month will growth in 2019 to nine months).

List of Students involved in RTBfoods activities in Period 1:

NAME Surname	***Master Student or PhD or Post-Doc***	***Subject Title***	***University of affiliation***	***Fellowship Starting Date***	***Fellowship Ending date***	***Tutor(s) in RTBfoods project***
Emmanuel EHOUNOU	PhD	Developpement of NIRS for prediction of textural quality attributes	Felix Houphouet-Boigny	31/01/2018	31/07/2018	Gemma ARNAU

No students involved in RTBfoods activities in INRA Avignon and in INRA Guadeloupe in period 1.

4.15.6 INRA Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
Agnès Rolland-Sabaté	RTBfoods kick-off meeting in Buéa, Cameroon		21-30 January 2018
Agnès Rolland-Sabaté	WP2 meeting in Cotonou, Benin	IVth International Cassava Conference – GCP21, Cotonou, Benin	11-15 June 2018
Gemma ARNAU	RTB Annual Meeting 2018	18th Triennial Symposium of ISTRC	20-28 October, 2018

4.15.7 INRA Capital Equipment or investment (co-investments)

No equipment acquired for INRA Avignon and for INRA Guadeloupe in period 1.

4.15.8 INRA Training participations (within RTBfoods framework and other trainings)

No training participation for INRA Avignon and INRA Guadeloupe in period 1.

4.15.9 INRA Sub-awards & Consultants

No Sub-awards & Consultants for INRA Avignon and INRA Guadeloupe in period 1.

4.15.10 INRA Other Sources of Support for RTBfoods activities

INRA participated in funding RTBfoods activities via the personnel employment, material (devices), building and fluids resources and environment.

CIRAD contributed to the travel and accommodation of Agnès Rolland-Sabaté (INRA Avignon) for her participation to the IVth International Cassava Conference in Cotonou, Benin (June 2018).

4.15.11 INRA List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

Agnès Rolland-Sabaté. The structural characterization of starches: a key to understand cassava starch functionalities [Plenary invited lecture]. IVth International Cassava Conference – GCP21, Cotonou, Benin, 11-15 June 2018.

Ehounou E., Maledon E., Cormier F., Cornet D., Nudol E., Kouakou A., Chair H., Arnau G. 2018. Breeding for improved tuber quality in yam *Dioscorea alata* L [Poster]. 18th Triennial Symposium of ISTRC, Cali, Colombia, 22-25 October 2018.

4.15.12 INRA Gaps & Constraints faced

The experimental challenge identified by INRA PACA UMR SQPOV Avignon is to succeed in extracting and analyzing pure cell wall polysaccharides in banana products (but also in yams) as they are tightly linked to polyphenols, in addition removing all the starch is a challenge in bananas because of the inhibition action of polyphenols on amylases.

The risks identified by INRA PACA UMR SQPOV Avignon are the quality of the crops supplied. In fact, fresh crops (yam, banana) need to travel from Africa and/or Guadeloupe to France before their analysis in Avignon. This implies they will be exposed to storage time at various temperatures which might change their physiological state. In order to limit this effect some assays will be done in Africa and in Avignon for a cross-check.

For INRA Guadeloupe, the experimental challenge would be the yam flour preparation of 40 accessions in three local places in 2019, then 72 in 2020, and after the estimation of amylose content by a iodine color method which need three replicates for good accuracy with a 0.8% of repeatability. Furthermore, we would try to make spectral NIRS acquisition in fresh yam tuber with the Help of Fabrice DAVRIEUX (CIRAD-Montpellier), and test the possibility to adapt a module on the Foos NIRS system used in the URZ-Laboratory.

We will also be able to make some measurement of texture parameters in boiled and pounded yam, or in polyphenols contents to add them in our panel of parameters to evaluate quality traits in accordance to WP2 expertises.

So, we require non-permanent technical staff, to take these tasks in charge and we estimate the need in 2019 to nine months.

4.15.13 INRA Perspective & Internal organization for Period 2

In Period two, for the first 6 months, INRA PACA UMR SQPOV Avignon will focus efforts on raw, boiled and pounded yam products in WP2. Fresh yam tubers coming from about ten varieties will be received from two other RTBfoods partners (CIRAD Guadeloupe and UAC Benin). These yams will be chosen for their contrasting cooking abilities and characterized for functional and some physico-chemical properties (including cooking ability) by the suppliers. They will be processed into boiled and/or pounded yam using standardized procedures in CIRAD Montpellier and/or INRA PACA UMR SQPOV Avignon. Textural and microscopic analyses will be carried on by CIRAD in Montpellier. Cell wall polysaccharides will be extracted from raw and processed tubers and deeply analyzed in order to link cell wall structure and composition to cooking ability and texture of pounded yam. To do so, it will be necessary to adapt protocols generally used for cell wall extraction and analysis to yam products. Main enzymatic activities linked to cell wall polysaccharides and polyphenols (PME, PG, PPO) will be tested on raw tubers as well. A close collaboration with CIRAD Montpellier will also be carried on for the development of procedures for cell wall extraction from RTBs in general. These activities will involve mainly a master's thesis student (January to July 2019), and permanent personnel: three technical people (Line Touloumet, Marielle Bogé and Caroline Garcia) and Agnès Rolland Sabaté, Sylvie Bureau and Carine Le Bourvellec.

The second part of the Period two will be partly devoted to banana product analysis in the frame of WP2. INRA PACA UMR SQPOV Avignon will work first on the development of a new protocol for the cell wall extraction from banana products. Banana will probably be supplied by NARO in Uganda and CARBAP in Cameroon. These activities will involve mainly a PhD student (to hire in October-november 2019), and permanent personnel: three technical people (Line Touloumet, Marielle Bogé and Caroline Garcia) and Agnès Rolland Sabaté, Sylvie Bureau and Carine Le Bourvellec.

All INRA PACA UMR SQPOV Avignon activities will need supplies for biochemical, chemical and physico-chemical analyses which imply the use high tech devices, the consumables, maintenance

operations and supplies costs as well as the fees for using technical platforms, and will need supplies for travel and subsistence costs to attend project meetings.

For INRA Guadeloupe, the first period (january-march 2019) will be devoted to the preparation of a panel 40 genotypes planted in 3 target environments in order to follow phenotyping and chemicals properties of yam tuber (flour, boiled, pounded …) in the frame of WP3. Then, the period from april to july 2019 will be devoted to: (i) Flour preparation of yam tubers for chemicals analysis at INRA-ASTRO Laboratory, (ii) Spectral NIRS acquisition in yam flour or fresh tuber at INRA-URZ Laboratory, (iii) Sampling Flour for chemicals analysis (Starches, proteins, Sugars) by Teyssier Laboratory, (iv) Physico-Chemical analysis (amylose, amylopectin) on 360 flours (3 tubers from 3 sites from 40 accessions) by INRA-ASTRO Laboratory, (v) Poursue of the collect and building spectral data base from NIRS spectral and chemicals data (INRA-Guadeloupe/CIRAD Guadeloupe), (vi) Development of a calibration model for Chemicals and texture parameters.

Furthermore, during the same period, NIRS acquisition on the second panel and on biparental population from CIRAD Guadeloupe will be continued, as well as the building of the database of physico-chemical and spectrum of all the experiments. Development of a preliminary calibration model for textures and starches properties will be achieved for the prediction on biparental population quality for germplasm breeding.

In WP4, Selection of 72 accessions to introduce in the experimentation for the Genotype x Environment will be conducted, and field preparation and planting are planned for may 2019 and will be achieved in three contrasted places (Godet, Duclos, Roujol). These steps will be time consuming and will need a daily car for management.

All these activities will need supplies for field sampling and experimentation, for sanitation process of the plant material and for in vitro material conservation and multiplication, and supplies for NIRS and chemicals analyses.

These activities will involve permanent personnel. For INRA-Guadeloupe: technical people (Jocelyne Leinster, Valerius Calif, Pascale Bade, Jean-Luc IREP, David Lange, Suzia Gelabale) and Marie Umber, Yoana Faure, Lucienne Desfontaines, Carine Marie Magdeleine and non-permanent staff (9 months planified) for field preparation, planting, sampling, sanitation, NIRS acquisition, calibration development and chemical analysis.

For CIRAD-Guadeloupe: Gemma Arnau, Fabien Cormier, Elie Ludol for sample preparation of yam flour, texture profile acquisition, and providing plants materials to INRA PACA UMR SQPOV Avignon: Fresh yam tubers from ten varieties chosen for their contrasting cooking abilities and characterized for functional and some physico-chemical properties (including cooking ability) by the suppliers.

For CIRAD Montpellier: Denis Cornet for database building and calibration development.

4.16 Annex 16: JHI Synthesis Report for Period 1

JHI achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s): TAYLOR, Mark, JHI, UK

Collaborator(s):

- MC DOUGALL, Gordon, JHI, UK
- DUCREUX, Laurence, JHI, UK
- STEWART, Derek, JHI, UK
- FOITO, Alexandre, JHI, UK
- AUSTIN, Ceri, JHI, UK
- MUZHINGI, Tawanda, CIP, Kenya
- KYALO, Gerald, CIP, Uganda

4.16.1 JHI Summary

(10 to 15 lines of Partner achievement for Period 1)

Research at the James Hutton Institute has focused on boiled sweetpotato texture. In order to compare different genotypes and to accurately characterise differences between genotypes an accurate and reproducible method was required. Appropriate instruments for measuring sweetpotato texture were investigated and it was established that the QTS25 texture analyser (Brookfield Engineering, Harlow, UK) using an acrylic wedge (Pat TA7, approx. 8, 3mm wide x 60mmlong and angle 40) met the criteria for throughput, accuracy and reproducibility. An important aspect was the cooking method and several approaches were assessed. The most successful method involves cooking the sweetpotato tuber in a vacuum sealed bag at 80^0C. The method development was carried out on test tubers purchased in the UK. In order to investigate the variability in cooking time/texture, samples were obtained from CIP partners in Kenya and Uganda. Seven genotypes were analysed that showed a wide-range in cooking time/textural properties. The dry matter contents of tubers were measured and an important finding was that there was no correlation between cooking time, texture parameters and dry matter content within these seven genotypes.

4.16.2 JHI Activities

PARTNERPartner participation in the different WPs & cross-WP interactions

(Describe activities, collaborations between teams within the institution, project implementation)

In which WPs is the PARTNER team involved? For which activities conducted in Period 1? How is internally organized communication/coordination between WPs?

The JHI team is involved in WP2. The main activity has been in establishing methods for sweetpotato texture analysis, sharing protocols for methods relevant to cooking time/texture measurements and contributing to “SoK” documents on sweetpotato and potato sensory analysis. Regular meetings of the JHI team working on this project (3 researchers and 3 technicians) have ensured the activities are well coordinated.

4.16.3 JHI geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

JHI operates in the UK and has collaborated with CIP Kenya and Uganda who have provided sweetpotato genotypes.

4.16.4 JHI Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

JHI research has focused on boiled sweetpotato texture. JHI has also discussed boiled potato texture with CIP Kenya and a training visit by a PhD student from Kenya to JHI is planned.

4.16.5 JHI Personnel involved & Students activities

*List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab "**3a) PERSONNEL COSTS" of Partner Financial Report)***

Mark Taylor
Derek Stewart
Gordon McDougall
Ceri Austin
Alexandre Foito
Laurence Ducreux

List of Students involved in RTBfoods activities in Period 1:

None

4.16.6 JHI Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

*(For more accuracy you can refer to: Tab "**3b) TRAVEL COSTS" of Partner Financial Report)***

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
Taylor	Cameroon		22-28 Jan 2018

4.16.7 JHI Capital Equipment or investment (co-investments)

*List of equipment acquired on RTBfoods budget (e.g?. texturometer, RVA, pHmeter, etc.) (For more accuracy you can refer to: Tab "**3d) EQUIPMENT COSTS" of Partner Financial Report)***

None

4.16.8 JHI Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
Boiled potato texture	2	UK/Kenya	Various (at discussion stage)	JHI (Taylor) CIP Kenya (Muzhingi)

4.16.9 JHI Sub-awards & Consultants

*List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab **3c) CONSULTANT COSTS** and "**3f) SUB AWARDS COSTS" of Partner Financial Report)***

None

4.16.10 JHI Other Sources of Support for RTBfoods activities

Which complementary / partner projects (other sources of fundings) contributed to RTBfoods activities in Period 1?

None

4.16.11 JHI List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

None

4.16.12 JHI Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution?

Risks identified & Risk mitigation proposed?

Supply routes for sweetpotato genotypes have been established and so far have worked well although we may need to receive a wider range of material.

4.16.13 JHI Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 accross WPs, Product profiles (& countries)?

We shall expand our analysis of sweetpotato texture by collaboration – characterizing a wider range of sweetpotato germplasm provided by CIP Kenya/Uganda

We shall develop relevant enzymes assays

We shall initiate cell wall analysis

We shall host a training visit from CIP Kenya PhD student.

4.17 Annex 17: NaCRRI Synthesis Report for Period 1

NaCRRI achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s):

- KAWUKI, Robert, National Agricultural Research Organization (NARO) - National Crops Resources Research Institute (NaCRRI), Uganda
- NUWAMANYA Ephraim, NARO-NaCRRI, Uganda
- ESUMA Williams, NARO-NaCRRI, Uganda
- NANYONJO Rita, NARO-NaCRRI, Uganda

Collaborator(s): NARL, Uganda

4.17.1 NaCRRI Summary

During the past one year (November 2017 to November 2018), NaCRRI participated in implementation of five major activities. First, compilation of state on knowledge report for work packet one (WP1) "*State of knowledge report for boiled cassava. A case of Uganda*" This report highlighted: a) product variations notable boiled cassava, mashed cassava and "katogo"; b) segments for demand of boiled cassava in rural and urban communities; and c) provided profitability estimates for boiled cassava.

Second major activity was conduction of an end-user survey on boiled cassava in two locations: Luwero (central region) and Apac (northern region). Data were collected using individual interviews, focus group discussions and key informant interviews; this survey was conducted following harmonization of tools and sampling methodologies as guided by WP1 leadership. Third, was compilation of state of knowledge report for WP2 and participation in the sensory panel trainings at NARL.

The fourth major activity was under WP3; for this, NaCRRI hosted a five-day training workshop on "*Near infrared Spectroscopy: Theory and Application*" A total of 19 participants attended this training that was conducted by Dr. Davrieux Fabrice. Consequently, it was agreed that the NIRS instrument and competencies at NaCRRI be used by partners to develop HTPPs for the different RTB crops. To kick start this, NaCRRI, through the Nutrition and Bioanalytical Lab partnered with the IITA banana breeding team to provide NIRS services.

Finally, under WP4 NaCRRI compiled and submitted the state on knowledge report "*Cassava State of Art on Breeding Quality Traits in Uganda*" In addition, NaCRRI established two field trials at Namulonge (central region) and Serere (eastern region) for purposes of identifying RTB varieties that meet users' needs, with a focus on variety (V); user (U); socio-economic environment (E). These trials comprised of both elite and popular landraces. Relevant documents associated with the above-mentioned activities, have all been submitted to respective WP leaders.

It also suffices to note that both RTBfoods and the NextGen Cassava Breeding Projects being implemented by NaCRRI, offer excellent opportunities for sharing lessons, techniques and knowledge. In fact, we have, and continue, to optimally exploit this project partnership for the benefit of stakeholders involved in the cassava production-processing-marketing-consumption continuum.

4.17.2 NaCRRI activities

RTBfoods project focusses on boiled cassava, as its flagship product. Accordingly, we are involved

in activities associated with WP1, WP2, WP3 and WP4. This project interconnects well with the NextGen Cassava Breeding Project, which has three major divisions, Research, Breeding and Survey.

Major WP1 activities include: 1) compilation of state of knowledge (SoK); and 2) documentation of trait preferences and processes associated with boiled cassava. These activities have largely been implemented; what remains is the processing and/or analysis of data generated by the end-user survey. Additional planned activities to be implemented under WP 1 include capacity strengthening and learning workshops.

Major WP2 and WP3 activities include: 1) conducting sensory characterization of boiled cassava following standardized approaches; and 2) biophysical and chemical analysis of defined traits. Spectra data will also be taken on samples; using both spectra and phenotype data, NIRS will be calibrated. Most of this work will commence during the 2nd year of the project. It also suffices to note that NaCRRI is providing research services to both NARL and IITA-Uganda that focus on banana. So far, we have scanned ~120 banana samples using the NaCRRI NIRS platform. The physicochemical characterization of these samples is being done at NARL and at an appropriate time, the physicochemical data will be shared and used for model development.

Major activities under WP4 have involved establishment of field trials at Namulonge (central region) and Serere (eastern region) for identifying RTB varieties that meet users' needs, with a focus on variety (V); user (U); socio-economic environment (E). These trials comprised of both elite and popular landraces. Further, using selected NextGen Cassava Breeding Project trials, we also plan to undertake studies to examine genetic architecture and heritability of selected end-user traits. Most of this work will commence during the 2nd year of the project.

4.17.3 NaCRRI geographic implementation / strategy

The bulk of the RTBfoods project activities will be implemented in central, eastern and northern Uganda. These regions represent major cassava growing and consumption areas in Uganda, and thus where most project impact will be witnessed.

4.17.4 NaCRRI Product Profile participation

NaCRRI identified boiled cassava, as its flagship product profile.

4.17.5 NaCRRI Personnel involved &Students activities

During period 1, the following persons were involved in the meetings and training activities supported under RTBfoods project:

Name	***Activity***
(1) Ms. AnnRita Nanyonjo, (2) Dr. Nuwamanya Emphraim (3) Mr. Julius Baguma	Inception meeting in Cameroon
(1)) Ms. AnnRita Nanyonjo,	WP1 Training in Benin
(1) Ms. AnnRita Nanyonjo (2) Ms. Hamba Sophia	Sensory Panel Training at NARL

Name	*Activity*
(3) Mr. Micheal Kanaabi	
(1) Ms. AnnRita Nanyonjo (2) Ms. Hamba Sophia (3) Mr. Micheal Kanaabi (4) Mr. Amenet Justin	Meeting with Lora Forsythe to review Survey tools
(5) Dr. Robert Kawuki (6) Dr. Esuma Williams (7) Dr. Nuwamanya Emphraim (8) Mr. Enock Wembabazi (9) Mr. Katungisa Arnold (10) Mukasa Yusuf	NIRS Training at NaCRRI

Following the approval of both NextGen and RTBfoods project, interviews had to be conducted to identify personnel to attach and/or appoint to the respective projects. Consequently, AnnRita Nanyonjo (M.Sc. Plant Breeding) and Julius Baguma (M.Sc. Plant Breeding) were appointed as Research Assistants under the NextGen Project. On the other hand, Micheal Kanaabi (M.Sc. Plant Breeding) and Hamba Sophia (M.Sc. Agriculture Economics) were appointed as Research Assistants under RTBfoods. Drs. Robert Kawuki, Nuwamanya Emphraim and Esuma Williams, provide technical support to the RTBfoods.

Despite AnnRita being attached to the NextGen project, she does provide support to RTBfoods project as witnessed by the activities she has implemented under WP1. Further, NextGen PhD students (Enock Wembabazi and Leah Nandudu) also provided significant technical support towards RTBfoods's, particularly in taking spectra data.

It does suffice to note that whenever demand for more technical support is needed, other experienced personnel notably Amenet Justin and Stephen Angudubo, are invited to participate. We do not have any students associated with RTBfoods.

4.17.6 NaCRRI Travels: Participation to RTBfoods meetings& International Eventson RTBfoods budget

*(For more accuracy you can refer to: Tab "**3b) TRAVEL COSTS" of Partner Financial Report)***

Number of People orList of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
3	Kick-off meeting in Cameroon		22-28 Jan, 2018
1	WP1 Training in Benin		15-26 April, 2018

4.17.7 NaCRRI Capital Equipment or investment (co-investments)

No capital equipment was purchased

4.17.8 NaCRRI Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
Field data collection tools and methodologies	WP1	Benin	15-26 April, 2018	Ms. AnnRita Nanyonjo,
Sensory Panel Training	WP 1 and 2	Uganda	16-22 September, 2019	Ms. AnnRita Nanyonjo Ms. Hamba Sophia Mr. Micheal Kanaabi

4.17.9 NaCRRI Sub-awards& Consultants

No sub-awards have been made.

4.17.10 NaCRRI Other Sources of Support for RTBfoods activities

Next Generation Cassava Breeding Project

4.17.11 NaCRRI List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

No publicity has yet been made

4.17.12 NaCRRI Gaps & Constraints faced

Two major constraints; delay in transfer of funds and the limited funds to implement planned activities

4.17.13 NaCRRI Perspective &Internal organization for Period 2

To cope with limited financial resource, we as one of the options, plan to reduce on the scope of work to be implemented. For this we shall notify the leadership in advance.

4.18 Annex 18: NARL Synthesis Report for Period 1

NARL achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s): NOWAKUNDA Kephas, National Agricultural Research Organization (NARO) - National Agricultural Research Laboratories (NARL), Uganda

Collaborator(s):

- IITA, Uganda
- CIP
- Bioversity International

4.18.1 NARL Summary

During the period November, 2017 to November 2018, NARL participated in project inception and planning meetings in Cameroon, WP1methodology development training in Benin aimed at harmonizing sampling approaches, pretesting tools, role plays for focus groups, data analysis and final report writing. NARL together with Bioversity also completed the review of state of knowledge for WP1 and WP2 (Reports are uploaded on the RTBfoods platform). NARL also successfully hosted and participated in the sensory panel training workshop, led by CIRAD. The training equipped NARL together with Diversity have also completed farm-level end-user preference profiling surveys under WP1(summary table submitted to work package leader) and are in process of scanning and uploading questionnaires and FGD reports to RTBfoods platform). NARL has also recruited a socio-economics Msc student (Ms Moreen Asasira), attached to Makerere University, whose thesis will contribute to the understanding of traits preferred by market and urban based value chain actors such as retail traders, restaurant operators and consumers. The student has completed her research proposal and is currently working on data collection tools. Also, an Msc student (Mr. Nelson Willy Kisenyi) attacked to Kyambogo University will contribute to the laboratory characterization and quantification of consumer preferred traits under WP2. He is shared between NARL and Bioversity International. NARL has successfully coordinated with IITA-Uganda, NaCRRI, Boiversity International and CIP to implement RTBfoods activities, through sharing personnel and equipment such as the NIRS, which has helped us to cope with budget limitations. During the period 2, NARL will continue to work closely with IIT-NARO Breeding better bananas project, Bioversity International, CIP and NaCRRI. All the activities planned for period 1 were completed.

4.18.2 NARL activities

The RTBfoods NARL-Uganda team focuses on cooking banana (matooke) and contributes to activities under WP1,WP2 and WP5. WP1 activities include(1) state of knowledge (SoK) review, (2) participating in joint capacity strengthening and building common methodologies development, (3) generating gendered knowledge of food consumption habits and preferences by user group, (4) community-based RTBfoods processing and/or preparation diagnosis and (5) consumer taste tests in rural and urban market segments. Activities 1 and 2 were completed and activities 3 and 4 are on-going while activity five is planned for next year. In Uganda, CIP, NARL and Bioversity teams operate jointly as one project implementation team.

WP2 activities include (1) constituting sensory panel and conducting sensory characterization of matooke (2) biophysical and chemical analysis of selected components. These activities will be conducted in collaboration with NaCRRI-Uganda, IITA-Uganda and the Melinda and Bill Gates

supported Breeding Better bananas project in East Africa. Data generated will be used to calibrate NIRS and tested on ability to screen matooke genotypes (WP5) for end-user acceptable hybrids.

WP5 involves on-farm participatory evaluation of promising genotypes using tools developed in above WPs. All the activities under WP5 will be implemented in collaboration with the IITA-NARO Breeding better bananas project and the National Bananas Research Programme.

NARL also supports CIP with Food Science expertise in Uganda while CIP supports also supports NARL with gender expertise. The RTBfoods team also serves as the post harvest team for the Melinda and Bill Gates supported Breeding Better bananas project in East Africa.

During period 1, NARL organized and hosted the sensory panel training workshop in Uganda. The training workshop was conducted by CIRAD and attended by participants from RTBfoods project partners – CIP, IITA, NRCRI,CNRA, CARBAP, Bowen University, UAC-FSA-Benin, NaCRRI, Bioversity International and NARL-Uganda. The training equipped partners with skills in sensory panels recruitment, training and conducting various types of sensory evaluation experiments.

4.18.3 NARL geographic implementation / strategy

The RTBfoods (cooking banana) activities will be implemented in North (Gulu), Central (Luwero) and Western (Mbarara) regions of Uganda. The sites for implementation were selected to take advantage and link into on-going IITA-NARO, Bioversity International and the National Banana Research Programmes' activities on breeding, germplasm evaluation and promotion of new hybrids in the county.

4.18.4 NARL Product Profile participation

NARL is involved in matooke and Sweet potatoes product profile. The NARL team provides the food science expertise to both CIP and Bioversity International in Uganda.

4.18.5 NARL Personnel involved &Students activities

During period 1, the following persons were involved in the meetings and training activities supported under RTBfoods project:

Name	***Activity***
(1) Moses Matovu, (2) Kenneth Akankwasa (3) Kephas Nowakunda	Inception meeting in Cameroon
(1) Edgar Tinyiro (2)Kenneth Akankwasa	WP1 Training in Benin
(1) Edgar Tinyiro (2) Elizabeth Khakasa (3) Mose Matovu (4) Gloria Aguti (5) Moreen Asasira	Sensory Panel training in Uganda
(1) Kenneth Akankwasa (2) Kephas Nowakunda	Breeding Better Bananas Collaboration meeting in Arusha
(1) Kephas Nowakunda	Collaboration meeting in Moscow:

The following persons were involved in various project activities including WP1 tools development, tools pre-testing, data correction, cleaning and entry.

A group of scientists and research assistants led by a socio-economist, Dr. Kenneth Akankwasa is

implementing WP1 activities in collaboration with Bioversity International and CIP. The CIP team provides gender backstopping to the Bioversity and NARL teams while the NARL teams provide Food science and socio-economic backstopping to the group. The groups includes David Serunjogi, Prossy Namuli, Sarah Kisakye, Marion Byonanebye, Ronald katwaaza, Loyce Twikirize, Jane Bagoya, Lakeris Nabigaba, Mpiriwe Innocent all participating in field data correction. These assistants work in the field together with senior staff and members of the NARL RTBfoods teams including Dr. Kenneth Akankwasa (Socio-economist), Elizabeth Khakasa (Food Scientist) and Gloria Aguti (Post harvest), Kephas Nowakunda (Food Scientist and overall coordinator).

The following persons were involved in state of knowledge review for WP1 and WP2. Kenneth Akankwasa, Priscilla Maremo and Moreen Asasira (WP1 SoK), While Kephas Nowakunda reviewed WP2 SoK.

List of Students involved in RTBfoods activities in Period 1:

NAME Surname	***Master Student or PhD or Post-Doc***	***Subject Title***	***University of affiliation***	***Fellowship Starting Date***	***Fellowship Ending date***	***Tutor(s) in RTBfoods project***
Moureen Asasira	Master student	Consumer preference for cooking banana traits in Uganda. A case of urban consumers.	Makerere University	September, 2018	September, 2019	K. Akankwasa K. Nowakunda
Nelson Willy Kisenyi	Master Student		Kyambogo University	Jan, 2019	Jan, 2020	Kephas Nowakunda Moses matovu Priscilla Maremo

4.18.6 NARL Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

*(For more accuracy you can refer to: Tab "**3b) TRAVEL COSTS" of Partner Financial Report)***

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
3	Kick-off meeting in Cameroon		22-28 Jan, 2018
2	WP1 training in Benin		15-26 April, 2018
2		Breeding Better Bananas	23-25 April, 2018

4.18.7 NARL Capital Equipment or investment (co-investments)

During period 1, NARL purchased a pick truck (delivered) and is currently being used to facilitate field activities under WP1. NARL has also procured a texture analyzer (delivered) and a Fume hood (to be delivered in January, 2019), both key in biophysical and chemical analyses.

4.18.8 NARL Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
Field data collection tools and methodologies	WP1	Bénini	15-26 April, 2018	1. Edgar Tinyiro 2. K. Akankwasa
Sensory Panel Training	WP 1 and 2	Uganda	16-22 September, 2019	1. E. Khakasa 2. G. Aguti 3. M. Asasira 4. E. Tinyiro 5. M. Matovu

4.18.9 NARL Sub-awards& Consultants

N/A

4.18.10 NARL Other Sources of Support for RTBfoods activities

Breeding Better Bananas supported a WP1 team member to participate in the BBB meeting.

4.18.11 NARL List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

None yet

4.18.12 NARL Gaps & Constraints faced

The budgets are limited. It is difficult to remain within stipulated budget lines or else activities cannot be implemented to completion. We shall try to cope by linking the RTBfoods activities with the Bill and Melinda Gates supported activities under NARO and IITA plus collaboration with partner institutions, IITA, Bioversity and CIP wherever possible.

4.18.13 NARL Perspective &Internal organization for Period 2

During period 2, NARL team will continue to work with CIP, Bioversity, IITA and NaCRRI to cope with limited financial resource. The partners try to implement activities together wherever possible. We envisage and recommend more streamed coordination between WPs and product champions.

4.19 Annex 19: NRCRI Synthesis Report for Period 1

NRCRI achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s):

- CHIJIOKE Ugo, NRCRI, Nigeria
- EGESI Chiedozi, NRCRI, Nigeria
- MADU Tessy, NRCRI, Nigeria
- OBEDIEGWU, Jude, NRCRI, Nigeria
- NJOKU, Damian, NRCRI, Nigeria
- OFOEZE Miriam, NRCRI, Nigeria

Collaborator(s): IITA, Nigeria

4.19.1 NRCRI Summary

(10 to 15 lines of Partner achievement for Period 1)

NRCRI, Umudike within period 1 produced the State of knowledge (SoK) report on the demand, preferred sensory characteristics and socio-cultural context of gari, boiled and pounded yam in South-East Nigeria (WP1 actitivty1). The institute also documented and delivered the state of knowledge report on biophysical and sensory characterization of fresh cassava and fufu (WP2 period 1 deliverable) WE also collaborated with IITA Ibadan and Bowen University to prepare a draft of the Protocol for determining the cooking, pounding ability, sensory, textural and biophysical properties of some yam varieties

NRCRI conducted and delivered the report of the survey on Gender Product mapping and User profile survey for gari, eba, fufu, boiled and pounded yam. The study was carried out in eight villages within six senatorial zones of two State (Imo and Ebonyi) in the South-Geo-political region of Nigeria (WP1 activity 3).

The Institute in collaboration with IITA Ibadan used twenty-three NextGen cassava varieties planted in the Mother trial at Imo State Nigeria to conduct and develop the protocol and methodology for participatory evaluation of new hybrids WP5. The NextGen cassava mother trial was replanted in Imo State for validation of the WP5 protocol. Samples of fresh cassava roots and gari from the NextGen cassava Mother trial were analyzed using wet lab methods and table top NIRS (WP2 activity) in collaboration with IITA Ibadan. An inventory of state of art within the yam breeding population was undertaken and submitted the WP4 leader

The Institute organized training for NRCRI and IITA staff on use of hand-held NIRS for high throughput analysis of fresh cassava roots. NRCRI participated in capacity strengthening workshop organized by wp1 in Benin, sensory evaluation training in Uganda by wp2 and the in-country co-ordination meeting held at IITA Ibadan.

4.19.2 NRCRI activities

PARTNER participation in the different WPs & cross-WP interactions

(Describe activities, collaborations between teams within the institution, project implementation)

NRCRI WP1,WP2 and WP3 members were involved during the workshop on Harmonizing tool for gender food mapping and user profiling study for cassava and yam conducted by WP1 leader at NRCRI, Umudike .The WP1,2 and 4 member breeders, Food scientists, Gender specialist and Socio economists) participated in the WP5 activity on yam and cassava. WP 2 and 3 members in the Institute also participated in NIRs training organized in the institute. An in-country co-ordination meeting was held at IITA Ibadan for harmonizing

activities conducted by RTBfoods team Nigeria for all the work packages.

In which WPs is the PARTNER team involved? For which activities conducted in Period 1?

NRCRI Umudike was involved WP1; **Activity 1**: State of knowledge report for yam, cassava, gari, fufu, boiled and pounded yam. **Activity 2**: Capacity strengthening workshop and **Activity 3:** Gender Product mapping and User profile survey

For WP2 we were involved in **activity 1**: State of knowledge report on biophysical and sensory characteristics of fresh cassava and *fufu*. **Activity 2:** Setting up of sensory laboratory and Development of protocol for determining the cooking, pounding ability, sensory, textural and biophysical properties of some yam varieties in collaboration with IITA Ibadan and Bowen University. We also collaborated with IITA Ibadan to analyze biophysical properties of fresh cassava root and *gari* samples processed from the Next Gen cassava Mother trial planted in Imo state South-East Nigeria using the wet laboratory method. Parameters evaluated include starch, dry matter, swelling power, solubility, color, cyanide, bulk density, dispersibility, and water absorption capacity.

WP3; Samples of fresh cassava roots and gari collected from NEXTGen cassava Mother trail in Imo State were also sent to IITA for NIRS calibration of starch, dry matter, colour and cyanide .

WP5: Participatory studies were conducted to develop protocol for future use WP5. The material were sourced from the Next Gen cassava Mother trial, champion processors within the locality were used to process and evaluate the gari samples.

How is internally organized communication/coordination between WPs?

Communication was maintained internally between WPs through exchange of mails, periodic meetings and workshops.

4.19.3 NRCRI geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

NRCRI, Umudike activities covered two states within the South-East geo-political region of Nigeria; Imo and Ebonyi states.

4.19.4 NRCRI Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

NRCRI Umudike was involved in product profile activities for gari, fufu, eba, boiled and pounded yam

The Institute conducted activities for cassava and cassava products (gari, Eba and fufu) in 4 villages in Imo state (Uzoagba, Akwakuma, Amandugba and Isinweke Ihitte). Yam activities were carried out in 4 villages in Ebonyi State (Onueke Ezza, Amagu Izzi, Umuebe Ezza Ohaukwu, Obinagu Ishiagu). The activities were carried out under wp1 activity 3: Gender product Mapping and user profile survey

4.19.5 NRCRI Personnel involved & Students activities

NRCRI Umudike staff that were involved in the activities for period 1 include

Name	***Activity***
Chedozie Egesi—	Cassava Breeder
Damian Njoke---	Cassava Breeder
Jude Obidegwu---	Yam Breeder
Ugo Chijioke ----	Food Scientists
Miriam Ofeze—	Food Scientist
Amaka Onyenwe –	Food Scientists
Chukwudi Ernest Ogbenta—	Food Scientists
Tessy Madu---	Gender / socio economist
Emeka Benjamin Okoye---	Socio-economist
Justice Ewuziem -----	Socio-economist
Confidence Kanu—	Socio-economist
Mercy Ejechi----	Agic Extensio
Maria Okoro----	Agric Technician

*List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab "**3a) PERSONNEL COSTS" of Partner Financial Report)***

The following are the list of personnel as captured in RTBfoods project in period 1

Name	***Activity***
Chiedozi Egesi (WP4 & 5)	South-east Nigeria Cassava
Tessy Madu (WP 1& 5)	South-east Nigeria Cassava and yam
Ugo Chijioke (WP1, 2, 3 & 5)	South-east Nigeria Cassava and Yam
Damian Njoku (WP4 & 5)	South-east Nigeria Cassava
Jude Obidiegwu (WP4 & 5)	South-east Nigeria Yam
Miriam Ofoeze (WP 1& 2)	South-east Nigeria Cassava and Yam
Ugochukwu Ikeorgu (WP 3)	South-east Nigeria Cassava and Yam

List of Students involved in RTBfoods activities in Period 1:

None.

4.19.6 NRCRI Travels:

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
Jude Obidiegwu, Tessy Madu,Ugo Chijioke	RTBfoods inception meeting Buea Cameroon		22nd -28th January 2018
Chiedozie Egesi, Ugo Chijioke, Confidence Kanu Benjamin Emeka Okoye	In-country Country meeting at IITA, Ibadan		20th-21st November 2018

4.19.7 NRCRI Capital Equipment or investment (co-investments)

*List of equipment acquired on RTBfoods budget (e.g?. texturometer, RVA, pHmeter, etc.) (For more accuracy you can refer to: Tab "**3d) EQUIPMENT COSTS" of Partner Financial Report)***

2 Hp Pavilion intel core i7 laptops for NIRS

4.19.8 NRCRI Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
Breeding RTB products for end user preference Capacity strengthening workshop	WP1	Cotonu Benin	16th -22nd April 2018	Tessy Madu, Ugo Chijioke
Sensory Panel Training Workshop	WP2	Kampala-Uganda	17th -21st September 2018	Ugo Chijioke, Nwamaka Ogunka
Harmonizing and Piloting tools for survey on Gender product mapping and user profile on gari,eba, fufu, boiled and pounded yam	WP 1	NRCRI, Umudike, Nigeria	6th -8th August 2018	Tessy Madu, Ugo Chijioke, Benjamin Okoye, Confidence Kanu, Mercy Ejechi, Miriam Ofoeze, Amaka Ogunka, Chukwu Ernest Ogenta.

4.19.9 NRCRI Sub-awards & Consultants

*List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab **3c) CONSULTANT COSTS** and "**3f) SUB AWARDS COSTS" of Partner Financial Report)***

4.19.10 NRCRI Other Sources of Support for RTBfoods activities

Which complementary / partner projects (other sources of fundings) contributed to RTBfoods activities in Period 1?

The NextGen cassava and African yam projects complimented RTBfoods activities during the period under review. In conjunction with IITA, NRCRI Umudike provided 600 samples (fresh root and gari samples) from NextGen cassava mother baby trials for biochemical analysis and NIRS calibration of . These samples are to also to be used calibrate NIRS for end user quality triats (RTBfoods Wp 3 and 5 activites). African yam project to nominate candidates from MLT trials for wp5 activity. Activity to be conducted within first quarter of 2nd period. (The trial was delayed due to plant harvesting period for yam).

4.19.11 NRCRI List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

None.

4.19.12 NRCRI Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution? Risks identified & Risk mitigation proposed?

Lack of project vehicle was a major limitation

Limited funds allocated to some work package and travel affected project activities and participation in international conferences for project personnel.

4.19.13 NRCRI Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 accross WPs, Product profiles (& countries)?

WP1 (a): Community-based RTBfoods processing/preparation diagnosis on *gari, fufu*, boiled and pounded yam in 4 villages within two states in South-East geo-political region in Nigeria

WP1 (b): Consumer taste tests in rural and urban market segments on *gari, fufu*, boiled and pounded yam in 2 selected locations within two states in South-East geo-political region in Nigeria

WP 2(a): Recruitment and training of panelist for sensory profiling of gari/ebai,fufu, boiled and pounded yam.

WP 2 (b): Sensory Profiling of gari/eba, fufu, boiled and pound yam

WP 2(C): Biophysical analysis of yam, cassava and processed product

WP 3: NIRS activities will be conducted on fresh and processed products of selected yam and cassava varieties

WP4: Establishment of advanced yam breeding lines establishment of field trails, maintenance and data collection for Cassava and yam varieties in selected locations within the south-east agro-ecological zones

WP5: Development of protocol for adoption study of user preferred cassava and yam varieties in 2states (Imo and Ebonyi) in the South-east agro-ecological zones of Nigeria.

4.20 Annex 20: NRI Synthesis Report for Period 1

NRI achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s): FOSYTHE, Lora, NRI - University of Greenwich, UK

Collaborator(s):

- KLEIH, Ulrich, NRI, UK
- BECHOFF, Aurelie, NRI, UK
- SHEE, Apurba, NRI, UK
- TROY, Caroline, NRI, UK
- TOMLINS, Keith, NRI, UK
- MARTIN, Adrienne, NRI, UK

4.20.1 NRI Achievement Summary

(10 to 15 lines of Partner achievement for Period 1)

NRI is responsible for the overall coordination of WP1 and contributing to WP5. Achievements for Year 1 are mainly in WP1 due to activity sequencing. In collaboration with CIRAD and Cornell University, NRI has led the achievement of the following project outputs: the development of WP1 interdisciplinary methodology, resulting in four manuals used by all 11 implementing partners and shared with external projects and stakeholders; the organization, development and delivery of Capacity Strengthening and Sharing Workshop on WP1 methodology for WP1 partners, with resources made public at project end; development of the interdisciplinary WP1 State of Knowledge (SoK) guidance document that has structured and informed the development of 10 product-based SoK reports to identify key evidence-based research gaps to be addressed by RTBfoods; development and dissemination of the WP1 Data management plan for WP1 partners, and WP1 data analysis guidance for Activity 3, aimed to strengthening qualitative skillsets among the teams. NRI has also provided continual, timely and tailored in-country and virtual support to WP1 partners and led in pro-active communication with other workpackages, particularly WP2. NRI has been involved in strategic partnerships external to the project, including participation in Excellence in Breeding; CGIAR Gender Breeding Initiative-GBI; NextGen Cassava, Global Cassava Partnership 21 Conference.

4.20.2 NRI activities

PARTNER participation in the different WPs & cross-WP interactions

(Describe activities, collaborations between teams within the institution, project implementation)

In which WPs is the PARTNER team involved? For which activities conducted in Period 1?

How is internally organized communication/coordination between WPs?

In RTBfoods, NRI is responsible for the overall coordination of WP1, and contributing to WP5. This work involves the following:

- Led the overall development of WP1 interdisciplinary methodology (food science, gender and economics), in collaboration with the WP1 Coordination team (CIRAD and Cornell

University). This aimed to collect evidence on RTB product preferences for different user groups along the product chain, how the gender and socio-economic factors that influence preferences for consumer segments, and how preferences are prioritized. This methodology has been synthesized into four manuals available on the project platform and was the basis of the Capacity Strengthening and Sharing workshop (see below). The manuals are live documents and are updated with learning from and with 11 implementing partners.

- Led the overall organization and content development of Capacity Strengthening and Sharing (training) Workshop on WP1 methodology for all partners involved in WP1, in collaboration with the WP1 Coordination team. The workshop was held from 16-25 April, 2018 at the Chant d'Oiseau in Cotonou, Benin with considerable logistical support from Université d'Abomey Calavi (UAC). The objectives of the WP1 workshop were twofold: 1) Design robust interdisciplinary methodology bridging economics, food science and gender, employing participatory approaches to identify trait preferences in RTBfood products. 2) Foster a co-creative environment to ensure the diverse group of researchers input into, understand and own the methodology. There were 31 participants at the workshop from six countries.
- Led the collaborative development of the WP1 State of Knowledge (SoK) methodology in collaboration with the WP1 Coordination team, and provided support to implementing partners on SoK research and report development and finalization. This activity has resulted in the production of SoK guidance based on three modules (food science, gender and economics), in addition to reports for each implementing partner for WP1 (11 partners, with each partner completing at least one module).
- Led the development of the WP1 Data management plan, drawing on the RTBfoods Global Access Plan and in partnership with CIRAD staff.
- Provided timely support to implementing partners to deliver on WP1 objectives. This support included:
    - Virtual support by NRI staff to partners via email, Skype, and telephone (all implementing partners) to francophone and anglophone partners
    - In-country support visits by NRI staff to partners for pilots of Gender Food Mapping (Activity 3) fieldwork (Benin, Nigeria, Uganda and Côte d'Ivoire)
- NRI facilitated the collaborative development of the WP1 data analysis plan for Activity 3, with inputs from CIRAD and UAC-FSA Benin during an in-country support visit to Benin.
- Participation in discussions with Excellence in Breeding (EiB) Platform to harmonize RTBfoods and EiB definitions of "product profiles".
- Participation in CGIAR Gender Breeding Initiative (GBI) Workshop November 2018 at Cornell University to:
    - Broadly discuss product profiles and mainstreaming gender in breeding activities
    - Input into a prototype tool specifically on gender responsive product profiles, drawing on RTBfoods experience in WP1
    - Lora Forsythe presented on WP1 during workshop, which was very well received

NRI's work with WP5 in year 1 is at its infancy. To date, materials developed under WP1 have been shared with the WP5 coordination team. Bilateral skype calls with WP5 members were held between WP1 Coordinator/NRI staff Lora Forsythe, and WP1 Co-coordinator/Cornell Hale Tufan.

NRI has made minor contributions to WP2 regarding the application of sensory methodologies.

4.20.3 NRI geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

As NRI is the overall coordinator of WP1 and contributor to WP5, in Year 1 we are ***providing a backstopping role to partners in all countries where WP1 is being implemented. However,***

NRI has also had direct involvement in activities in Benin, Cameroon, Côte d'Ivoire, Uganda and Nigeria. In addition to providing virtual support to partners, the following direct activities have taken place within RTBfoods countries with implementing partners:

Partner Institution(s)	***Products***	***Country***	***NRI direct country activities***
IITA-Benin and UAC	Boiled yam, boiled cassava	Benin	Coordinated the WP1 Capacity Strengthening and Sharing Workshop Support in data analysis for Activity 3
Project-wide	n/a	Cameroon	RTBfoods inception meeting
CNRA, CIRAD	Attiéké	Côte d'Ivoire	Activity 3 fieldwork pilots
NaCRRI, Bioversity/ NARO/NARL, CIP	Boiled cassava, matooke, boiled/ fried sweetpotato	Uganda	Activity 3 fieldwork pilots
NRCRI, IITA-Nigeria	Eba, gari, boiled yam, fufu	Nigeria	Activity 3 fieldwork pilots

4.20.4 NRI Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

As mentioned in the previous section, NRI is the overall coordinator of WP1 and contributor to WP5, in Year 1 we are ***providing a backstopping role to partners for all product profiles under WP1*** (Boiled yam, boiled cassava, Gari, Boiled plantain, Attiéké, matooke, Boiled sweetpotato, Eba, boiled yam, fufu, Eba). NRI has provided direct in-country support for fieldwork relating to Boiled yam, boiled cassava, Attiéké, Boiled cassava, matooke, boiled/ fried sweetpotato, Eba, gari, boiled yam, and fufu.

4.20.5 NRI Personnel involved & Students activities

*List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab "**3a) PERSONNEL COSTS" of Partner Financial Report)***

NRI Personnel	***WP***	***Activities***
Lora Forsythe	WP1, WP5	WP1 Coordinator, Gender focal point, Activity 3 focal point, review and final approval of partner SoKs, responsibility for WP1 folder on RTBfoods platform, chaired gender and youth session for Global Cassava Partnership GCP21 conference, participated and presented at CGIAR Gender Breeding Initiative (GBI) Workshops
Ulrich Kleih	WP1	Markets and methodology /sampling focal point, review of partner SoKs, Activity 3 implementation in Uganda
Aurelie Bechoff	WP1, WP2	Food science support for WP1 methodology, review of partner SoKs, Activity 3 implementation in Côte d'Ivoire. Advisory inputs into WP2 relating to sensory methodology.
Apurba Shee	WP1	Support on sampling methodology
Keith Tomlins	WP1,	Attendance of project inception meeting; WP1 methodology

NRI Personnel	*WP*	*Activities*
	WP2	guidance; Ethics support. Advisory inputs into WP2 relating to sensory methodology.
Adrienne Martin	WP1	WP1 methodology guidance and workshop design, quality assurance role on outputs
Caroline Troy	WP1	Logistical and organizational support for WP1 Workshop activities

List of Students involved in RTBfoods activities in Period 1: Not applicable to NRI.

4.20.6 NRI Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget (For more accuracy you can refer to: Tab "3b) TRAVEL COSTS" of Partner Financial Report)

Name	*Travel Cost Item Description (location and date)*	*Purpose of Trip*
Lora Forsythe, Keith Tomlins	Cameroon, Buéa, January 2018	Participation to the Kick off Meeting
Lora Forsythe	Arusha, Tanzania, February 18	Attendance at the NextGen Cassava Annual Meeting (visa and subsistence covered by RTBfoods)
Lora Forsythe, Ulrich Kleih, Caroline Troy	Benin, April 2018	Deliver capacity strengthening workshop on identifying user preferences for RTBfoods breeding under the RTBfoods project
Lora Forsythe	Benin, June 18	Chaired gender and youth session for Global Cassava Partnership GCP21 conference and RTBfoods support to Benin Team
Lora Forsythe	Nigeria, August 18	Support to IITA/ NRCRI socio-economic fieldwork
Lora Forsythe Ulrich Kleih	Uganda, Sept 18	Support to NaCRRI, CIP and Bioversity teams on RTBfoods fieldwork
Aurelie Bechoff	Côte d'Ivoire Sept 18	Visit partners and conduct fieldwork in Côte d'Ivoire on the RTBfoods project and advise on data collection
Lora Forsythe	Benin, October 2018	Support IITA/ UAC on fieldwork and data analysis for RTBfoods
Lora Forsythe	USA, November 2018	Participation and presentation for the Gender and Breeding Initiative Workshop (costs covered by GBI)

4.20.7 NRI Capital Equipment or investment (co-investments)

*List of equipment acquired on RTBfoods budget (e.g?. texturometer, RVA, pH meter, etc.) (For more accuracy you can refer to: Tab "**3d) EQUIPMENT COSTS" of Partner Financial Report)***

No costs were incurred by NRI for equipment.

4.20.8 NRI Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned***	***Country***	***Dates***	***List of Participants NAMES***
NRI led the Capacity Strengthening and Sharing session with all WP1 teams	1	Benin	April 2018	Lora Forsythe (methodology and coordination); Ulrich Kleih (methodology and coordination); Caroline Troy (coordination); Content contributions from: Aurelie Bechoff (methodology); Keith Tomlins (methodology); Adrienne Martin (methodology)
In-country support visits:	1	Nigeria	August, 2018	Lora Forsythe
In-country support visits	1	Uganda	September, 2018	Lora Forsythe, Ulrich Kleih
In-country support visits:	1	Côte d'Ivoire	September, 2018	Aurelie Bechoff
In-country support visit and sharing for Activity 3 data analysis	1	Benin	October, 2018	Lora Forsythe
Virtual support	1, 2	Benin, Cameroon, Côte d'Ivoire, Uganda, Nigeria	Throughout year 1	Lora Forsythe; Ulrich Kleih; Aurelie Bechoff (sensory); Keith Tomlins (Ethics and sensory)

4.20.9 NRI Sub-awards & Consultants

*List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab **3c) CONSULTANT COSTS** and "**3f) SUB AWARDS COSTS" of Partner Financial Report)***

No costs were incurred by NRI for sub-awards and consultants.

4.20.10 NRI Other Sources of Support for RTBfoods activities

Which complementary / partner projects (other sources of fundings) contributed to RTBfoods activities in Period 1?

Participation and presentation of Lora Forsythe at the Gender and Breeding Initiative Workshop (costs covered by GBI)

Attendance of Lora Forsythe at the NextGen Cassava Annual Meeting (flight and accommodation covered by NextGen)

4.20.11 NRI List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

The following presentations were given by NRI on behalf of WP1 RTBfoods:

- Gender and Breeding Initiative Workshop (USA, October 2018)
- Gender and Youth Keynote Global Cassava Partnership (GCP) 21 (Benin, June 2018)
- Abstract submitted to "Seeds of Change: Gender Equality Through Agricultural Research for Development" conference at University of Canberra (Australia April 2019)

NRI led the collaborative development of the following manuals:

- WP1 guidance (methodology and adaptable tools) is provided in a set of four documents:
  - WP1 Introduction and product profile (this document)
  - Activity 3: Gendered product mapping
  - Activity 4: Community-based RTBfoods processing/preparation diagnosis
  - Activity 5: Consumer taste tests in rural and urban market segments
- State of Knowledge Report
- Data management plan
- Activity 3 data analysis (under review)

NRI has contributed to the review and finalization of all partner WP1 SoK reports (11 partners with at least one module completed).

4.20.12 NRI Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution? Risks identified & Risk mitigation proposed?

WP1 Coordination was successful during this period. A number of challenges such as delays by some partners in meeting deadlines, mainly related to other demands on staff time and resources. . I

The situation created a risk of late or suboptimal delivery of some outputs. Mitigation measures that have successfully addressed these included follow-up communication and monitoring, provision of timely advice and support from the Project Management Unit, and renegotiating of deadlines with partners and PMU where possible. In addition, there is scope and support to improve outputs, such as the state of knowledge reports, in year 2.

There are no constraints within NRI for project outputs.

4.20.13 NRI Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 across WPs, Product profiles (& countries)?

As NRI is the overall coordinator of WP1 and contributor to WP5, in Year 2 we will continue to provide

a ***backstopping role to partners in all countries where WP1 and WP5 are being implemented and therefore have indirect activities in each country*** (Benin, Cameroon, Côte d'Ivoire, Uganda and Nigeria).

Specific roles for NRI staff are as follow:

Name	***Role***	***Country/ Profile***
Lora Forsythe	WP1 Coordinator, Gender focal point, Activity 3 focal point, responsibility for WP1 folder on RTBfoods platform, attendance of annual meeting in Nigeria, data analysis support; report writing support	All
Aurelie Bechoff	Food science support for WP1 methodology, Data analysis support; Report writing support	Côte d'Ivoire + possibly others
Ulrich Kleih	Markets and methodology /sampling focal point, Activity 3 implementation; attendance of annual meeting in Nigeria, data analysis support; report writing support	All
Keith Tomlins	Advisory support relating to ethics and consumer preference	All

4.21 Annex 21: UAC-FSA Synthesis Report for Period 1

UAC-FSA achievements in Period 1

Activities Conducted, & Perspectives

Main Author(s): AKISSOE, Noël, UAC/FSA, Benin

Collaborator(s):

- HOUNHOUIGAN, Joseph, UAC/FSA, Benin
- ADINSI, Laurent, UAC/FSA, Benin
- ADETONAH Sounkoura, IITA, Benin

4.21.1 UAC-FSA Summary

(10 to 15 lines of Partner achievement for Period 1)

During this Period 1, the UAC-FSA team has been working on WP1 and WP2 activities. These activities are related to the field works and capacity strengthening (training). Concerning WP1, we gathered the state of knowledge of boiled yam from literature review and key informant interviews. The report was validated by WP1 coordination team. In addition, the UAC-FSA and IITA-Benin research teams collaborated to carry out the survey (Activity 3) on boiled yam and boiled cassava in 8 rural communities. Regarding WP2, the state of knowledge on the physico-chemical, biophysical and nutritional quality of boiled yam were reported and validated by the WP2 coordination team. The list of laboratory procedures was also provided on RTBfoods website. As far as the training is concerned, we participated to the “Capacity Strengthening and building common methodologies” held at Cotonou-Benin in 16-25 April, 2018. We also attended to the workshop on the sensory panel training at Ouganda. Currently, we are in the process of the activity 3 data analysis.

4.21.2 UAC-FSA activities

PARTNER participation in the different WPs & cross-WP interactions

(Describe activities, collaborations between teams within the institution, project implementation)

In which WPs is the PARTNER team involved? For which activities conducted in Period 1?

How is internally organized communication/coordination between WPs?

The UAC-FSA team is involved in WP1 and WP2. For WP1, we collected information from yam and cassava production, commercialization, processing and consumption, as boiled yam and boiled cassava. In this respect, data were collected from focus group discussion and individual interview with community members and individual interview with leader market and community leader. These activities were conducted in collaboration with Benin IITA team involved in RTBfoods Project. The feedback of the discussion between the two WP1, 2 coordination leaders related to the expectations of **WP2** from WP1 activities is transmitted/conveyed to the UAC-FSA team. So, the best procedure to be adopted to meet these expectations was discussed internally. The UAC-FSA participated to the skype meeting involving all WP.

4.21.3 UAC-FSA geographic implementation / strategy

In which countries (and sub-regions) is the PARTNER team conducting activities?

These activities were conducted in Benin, particularly the survey (activity 3 of WP1) was carried out on yam in 8 rural communities of center Benin, named District of DASSA-ZOUNME and District of DJIDJA. As far as cassava is concerned, the survey was carried out in southern Benin, particularly in the Districts of Dangbo and Bonou. These geographic areas are the gross production and consumption zones of yam and cassava. We hypothesize that all actors involved in food chain approach of yam and cassava can be found in these zones, with the aim of collecting gendered product profile information.

4.21.4 UAC-FSA Product Profile participation

In which product profiles the PARTNER team has been involved in Period 1? How & Where?

The UAC-FSA team has been working on boiled yam and boiled cassava in period 1. The quality profile of these products is discussed through a field survey by using the methodology developed by the WP1 leaders; this methodology focused on food chain approach and gender related questionnaires. The data analysis is in progress. The stakeholders' perception contributed to build boiled yam and boiled cassava quality profile.

4.21.5 UAC-FSA Personnel involved & Students activities

*List of Personnel involved in RTBfoods project in Period 1 (WPs + Country + Product Profiles implication): (For more accuracy you can refer to: Tab "**3a) PERSONNEL COSTS" of Partner Financial Report)***

List of Students involved in RTBfoods activities in Period 1:

NAME Surname	***Master Student or PhD or Post-Doc***	***Subject Title***	***University of affiliation***	***Fellowship Starting Date***	***Fellowship Ending date***	***Tutor(s) in RTBfoods project***
Laurenda HONFOZO	PhD	Structural and biophysical characteristics of cassava and yam determining the quality and preference of derived products	UAC-FSA	September 2018	November 2022	Noël Akissoé
Francis HOTEGNI	Master	Biophysical characteristics of boiled yam	UAC-FSA	September 2018	February 2019	Noël Akissoé

4.21.6 UAC-FSA Travels: Participation to RTBfoods meetings & International Events on RTBfoods budget

*(For more accuracy you can refer to: Tab "**3b) TRAVEL COSTS" of Partner Financial Report)***

Number of People or List of NAMES	***RTBfoods meetings***	***International / Regional Conferences***	***Dates***
Noël Akissoé and Laurent Adinsi	Kick-off meeting	International meeting	22-29 January 2018
Laurent Adinsi and Laurenda Honfozo	Sensory panel training	International meeting	17-21 September 2018

4.21.7 UAC-FSA Capital Equipment or investment (co-investments)

*List of equipment acquired on RTBfoods budget (e.g?. texturometer, RVA, pHmeter, etc.) (For more accuracy you can refer to: Tab "**3d) EQUIPMENT COSTS" of Partner Financial Report)***

The FSA-UAC team is in the process to order a rheometer with RTBfoods budget.

4.21.8 UAC-FSA Training participations (within RTBfoods framework and other trainings)

Training Title / Topic	***WP concerned (if training within RTBfoods framework)***	***Country***	***Dates***	***List of Participants NAMES***
Capacity strengthening and sharing course: Understanding the drivers of trait preferences and the development of multi-user RTB product profiles	WP1	Benin	16-25 April 2018	Noël Akissoe Joseph Hounhouigan Laurent Adinsi
Sensory panel training	WP2	Uganda	17-21 September 2018	Laurent Adinsi Laurenda Honfozo

4.21.9 UAC-FSA Sub-awards & Consultants

*List of Sub-awards + WP concerned + Purpose. (For more accuracy you can refer to: Tab **3c) CONSULTANT COSTS** and "**3f) SUB AWARDS COSTS" of Partner Financial Report)***

Not applicable in period 1

4.21.10 UAC-FSA Other Sources of Support for RTBfoods activities

Which complementary / partner projects (other sources of fundings) contributed to RTBfoods activities in Period 1?

We are starting the procedure to buy a rheometer but the RTBfoods budget was not enough to cover the global bill. Other projects of UAC-FSA (Icowpea project and Lab contribution) participated for the purchase of this equipment.

4.21.11 UAC-FSA List of Publications, Conference communications, Manuals, Leaflets, Posters, etc.

No publication, communication and poster were presented in the period 1.

4.21.12 UAC-FSA Gaps & Constraints faced

Which challenges faced in implementation of RTBfoods project within the PARTNER institution?

Risks identified & Risk mitigation proposed?

Not applicable in period 1

4.21.13 UAC-FSA Perspective & Internal organization for Period 2

Which planification for the PARTNER team in Period 2 accross WPs, Product profiles (& countries)?
The period 1 focused essentially on WP1 activities; We plan to finish the yam data analysis of activity 3 earlier January in order to provide quality attributes for WP2. We intend also to start the activity 4 and activity 5 of WP1. We plan to finish activities 3, 4 and 5 with the second product (boiled cassava). Regarding WP2, the period 2 will be of high priority in the laboratory activities.

4.22 Annex 22: RTBfoods Global Access Strategy

Global Access Strategy

Global Development Grant #: **OPP1178942**

Breeding RTB products for end user preferences (RTBfoods)

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1. BACKGROUND

Breeding RTB products for end user preferences (RTBfoods) is a project co-funded by the Bill and Melinda Gates Foundation (BMGF), CIRAD, INRA, CIAT, JHI to encourage better variety choices in Africa. It will develop high throughput tools that will facilitate the selection of RTB varieties by breeders, meeting users' requirements, in order to ensure better variety adoption. It aims to identify the quality traits that determine the adoption by users of new varieties of roots, tubers and bananas (RTB) developed by breeders. The project will take a novel approach involving consumers, processors and researchers, and will eventually serve to boost food security.

The emergence of new pests and diseases, climate change, soil erosion and depletion, as well as changing consumption patterns from rural to more urban lifestyles, compel breeders of roots, tubers and bananas (RTB crops) to develop new varieties better adapted at the farm level to biotic and abiotic stresses and at the post-harvest level to agro-industrial value chain requirements. Knowledge of the socio-cultural structures linking farmers, middlemen, processors and consumers of RTB crops is scarce in Africa. The understanding of preferences and needs of men and women involved in RTB value chains is incomplete and currently not available to RTB breeders. In this respect, many quality traits that determine user preferences and variety adoption by stakeholders are to date only partially studied, if not unknown. As a result, many new varieties developed by breeding programs encounter significant problems of acceptability by key stakeholders in RTB value chains. The processing ability and quality of end products are a common issue for improved varieties of RTB, hindering their adoption and dissemination.

The proposed investment will improve knowledge of the quality traits essential for a successful RTB variety adoption along the value chain. Multidisciplinary teams of social scientists and food technologists will capture these essential quality traits through surveys conducted with RTB crop users, i.e. processors and consumers, as well as farmers, traders or middlemen.

During the RTBfoods Kick-off meeting (Buea, Cameroon, January 2018), eleven food products of particular importance for RTB-based staple diets (cassava, yam, sweetpotato, highland banana, plantain and tropical potato) were selected for this project, in partnership with several African organizations in five countries: Benin, Cameroon, Côte d'Ivoire, Nigeria and Uganda. Research activities will be organized in five work packages (WP) bringing together the skills and expertise of several world-class laboratories.

The key quality criteria identified through socio-cultural surveys and technological assessments of the selected food processes will be dissected and analyzed in order to understand their underlying biophysical properties, biochemical composition, the food matrix structure, etc. (WP1). To characterize chemical compounds of interest in detail, specific biophysical analysis methods will be adapted or developed as needed (WP2). Based on these primary quantitative analyses, the investment will build databases to establish predictive equations and to calibrate high throughput phenotyping protocols (HTPP) in the different RTB breeding programs in Sub-Saharan Africa (SSA) (WP3). In particular, near-infrared spectroscopy (NIRS) of new hybrids will enable simultaneous prediction of several quality traits, using a single in-situ spectral analysis of fresh RTB materials, to select the varieties most likely to be adopted by end users. These HTPP will also allow genetic association analyses (GWAS: genome wide association study) and study of genes for quality QTLs. The investment will also significantly reduce phenotyping costs and allow low-cost analysis of the contribution of genetic factors, environmental factors, and cultivation and processing practices to the quality traits of RTB-based end products (WP4). The most promising varieties (clones) thus identified will be tested under real conditions with users to

validate the approach in partnership with the various RTB breeding programs in SSA (WP5).

The project is designed to complement the many other investments in breeding programs in SSA, in particular, the NEXTGEN Cassava, BBB, SASHA, GT4SP, AfricaYam, and HarvestPlus projects, in order to improve and/or optimize the impacts of these ongoing investments.

2. PROJECT MANAGEMENT STRUCTURE

Project coordination is led by the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Montpellier, France, with sub-awards to specialized partner organizations that target specific product profiles. Project coordination covers monitoring and evaluation, communications, financial management and technology transfer. It also supports the project Advisory Committee, organizes annual meetings, scientific meetings and prepares overall project plans and reports. An internal CIRAD monitoring committee has been set up to facilitate internal communication within the organization (CIRAD's scientific, financial and administrative departments)

Dr. Dominique Dufour (dominique.dufour@cirad.fr), Food Technologist, is the RTBfoods project coordinator. (**Appendix 1.** lists the RTBfoods project partners.)

3. GLOBAL ACCESS STRATEGY REQUIREMENTS

The funding agreement signed between BMGF and CIRAD for the RTBfoods project includes requirements related to the global accessibility of the research outcomes. In particular, the technologies and information generated by the project must be managed in such a way as to ensure “global access.” Global access requires that all knowledge and information gained through the project will be rapidly and widely disseminated. Global access also requires that resulting products, services, processes, technologies, materials, software, data, and other innovations (collectively, “Funded Developments”) be made available and accessible at affordable prices to intended beneficiaries in developing countries.

4. GLOBAL ACCESS STRATEGY

There are six essential components of the global access strategy, each of which is discussed below.

4.1 Background Intellectual Property Rights

All project participants are required to share pre-existing proprietary technology and information within the project—that is, intellectual property rights (IP)—in accordance with global access requirements. Although the inclusion of proprietary technology in project activities may be subject to restrictions, IP must be identified in advance and must comply with project objectives and, in particular, global access requirements. Where partners introduce their own proprietary technology or access third-party proprietary technology for use in the project, appropriate licenses must be negotiated and agreed. This stipulation aims to protect the legitimate interests of the right holders while achieving the global access objectives.

Similarly, biological material exchanged between partners will be subject to a Material Transfer Agreement (MTA) and may be subject to specific conditions. In particular, partners should respect national legislation on access and fair and equitable benefit-sharing under the Nagoya Protocol. In the absence of national legislation, Parties shall nevertheless

promote the implementation of access and benefit-sharing measures.

4.2 Funded Development Identification

CIRAD and CGIAR centers have an open access policy for knowledge and Information generated by publicly funded projects. There are different avenues for quickly and widely making public the information produced by this project, such as open databases hosted by CIRAD and CGIAR centers, containing the datasets generated.

However, the information contained in these databases, is “raw” and can be difficult to exploit. Each research team working with specific product profiles may analyze further the generated information and publish it in peer-reviewed journals, scientific meetings and conferences, web pages and brochures.

RTBfoods intends to provide access to all publications and documents produced during the project. To this aim, publications and documents will be deposited on the institutional repository of each partner concerned. For example, CIRAD’s open access repositories (http://agritrop.cirad.fr/) and those of the CGIAR centers. For partners with no open access repository, publications and documents will also be uploaded into open access international repositories (e.g. OpenAire/Zenodo, the EU infrastructure) or knowledge platforms (e.g.; FAO Tropical Agriculture Platform, Food & Business Knowledge Platform, SustainabilityXchange, SciDev, etc.). In addition, all these documents will also be available on the RTBfoods website, as indicated below.

The dissemination of digitized information resulting from the analysis of genetic resources should take into account the different national legislations adopted pursuant to the Nagoya Protocol. Moreover, even in the absence of legislation, such dissemination must be conditioned, at a minimum, by profit sharing with the supplying country in the event of commercial development. It is important for CIRAD to integrate dematerialization of research into the benefit-sharing process established by the Convention on Biological Diversity, in order to foster capacity-building in this area. Thus, before any dissemination, participants in projects using such information must provide fair and equitable benefit-sharing arrangements for the benefit of the provider of genetic resources, validated by CIRAD.

The dissemination of digitized information resulting from the analysis of genetic resources will have to take into account the different national regulations enacted in application of the Nagoya Protocol. Moreover, even in the absence of national regulation, such dissemination must be conditioned, as a minimum, by benefit sharing with the supplying country in the event of commercial development. It is important for CIRAD to integrate dematerialization of research into the benefit-sharing process established by the Convention on Biological Diversity, in order to foster capacity building in this area. Thus, before any dissemination, participants in projects using such information must provide fair and equitable benefit-sharing arrangements for the benefit of the genetic resources provider, validated by CIRAD.

RTBfoods funded developments include high-throughput phenotyping protocols (HTPP) to screen large numbers of RTB clones to identify at low cost desirable user traits. These HTPP will be based on knowledge developed during the project, in particular information on user expectations (captured in product profiles) and databases on biophysical and functional properties of RTB crops and products. RTBfoods will also benefit from previous and ongoing research conducted by participating institutions, for instance NIRS-based calibration equations for dry matter and carotenoids developed by CIRAD and CIAT. Given that most of partner institutions are public and non-profit oriented whose research must be publicly accessible, most Background Technology used in the proposed project is already in the public domain, and therefore accessible at an affordable price. If a specific circumstance requires the use of proprietary Background Technology, this will be communicated to the Foundation for consideration.

The ultimate target of the knowledge generated by the project is the scientific community at large and the stakeholders of RTB value chains. Making information accessible to value chains stakeholders is more difficult because there is no pre-established and well-organized structure for many of these value chains. NARs working in each country can contribute to develop brochures in local languages with easy to understand guidelines and information for improving the efficiency of the various value chains.

All datasets in these repositories will be tagged as 'RTBfoods' to facilitate document/material search and allocation. The RTBfoods website, which will be hosted under the CIRAD domain (cirad.fr), will provide an entry point for global access to all Funded Development, increasing the visibility and accessibility of these materials to a broader audience.

4.3 IP Protection and Management

Products, services, processes, technologies, materials, software, data, and other innovations resulting from the project constitute Funded Developments.
In the sub-grant agreements with the project partners, Funded Developments are referred to as "Project IP."

> *Project Intellectual Property* means and includes all technical information first conceived, discovered, developed, or reduced to practice by the participants during the course of the project. The information includes, but is not limited to, inventions, plant cultivars, plant varieties, developments, discoveries, concepts, software, manuscripts, know-how, methods, techniques, test results, studies, analyses, reports formulae, data, processes, logos, and other information or data, whether or not patentable or copyrightable.

All project participants are required to provide CIRAD a full written disclosure of the project's IP as it is being developed. In particular, each sub-grantee contractually agrees to provide CIRAD, in a timely manner and sufficiently in advance of the project's donor reporting deadlines, with the information required and requested by CIRAD for fulfilling its annual IP reporting obligation to the donor. The reporting timelines and format are detailed in **Appendix 2**. In accordance with the BMGF's requirements, each project partner agreed to retain and provide information on the project's IP for five years after the end of the project, at the request of both CIRAD and/or the BMGF.

Unless CIRAD and project participants agree otherwise, ownership of the rights to the project's IP shall belong to the party(ies) that developed it, subject to conditions specified herein. If the party exercising the IP rights intends to restrict its availability in any form to other project parties, it must obtain written authorization from CIRAD prior to the acquisition of IP rights in the project. All costs and fees associated with obtaining and maintaining IP rights protection for the project (e.g., via patents or copyrights) shall be the sole responsibility of the party that developed it and claims ownership.

Furthermore, in order to promote the dissemination of knowledge, the Partners shall not file patents on natural products or their components as such.

In order to facilitate access to project IP, and to preserve the right to use it for non-profit educational purpose, CIRAD and the donor reserve a royalty-free, perpetual, nonexclusive, and irrevocable right to reproduce, publish, or otherwise use the Funded Developments. Each project participant agrees to execute all documents and to perform all acts necessary to further global access and guarantee CIRAD, the donor, or its designee the rights reserved herein.

4.4 Materials and Data Sharing

CIRAD will make its Dataverse repository (https://dataverse.cirad.fr/) available to enable partners to deposit their datasets. CGIAR centers and INRA are also equipped with a

Dataverse repository. All are connected to the international Harvard Dataverse network (https://dataverse.org/) allowing visibility and compliance with the data FAIR principles (findable accessible interoperable reusable).

The main datasets that will be available through Dataverse repositories will be especially dedicated to:

- Socioeconomics Survey Data
- Biophysical analysis
- NIRS data

Several open-access crop databases incorporate phenotypic and molecular information such as BTI RTB databases:

NextGen (https://www.Cassavabase.org/), BBB (https://www.Musabase.org/), Sweetpotatobase and Yambase in addition to the generic RTBbase (http://www.rtbbase.org/), Cassava Genome (https://www.cassavagenome.org/), CIAT Germplasm Bank Database (https://cgspace.cgiar.org/handle/10568/43737), the integrated crop portal for Musa and the Cassava Genome Hub (https://github.com/SouthGreenPlatform). Specifics agreements will be developed for molecular data.

If appropriate, thematic repositories will be selected from the re3data recommended registry (re3data.org) to increase visibility and access to specific datasets.

To facilitate data management, RTBfoods will develop a Data Management Plan (DMP) and train partners in the use of DMP, repositories etc... The DMP will be in line with the project Consortium Agreement and will be monitored by the Advisory Committee. If necessary, a defined period for data embargo or restricted access will be applied to certain datasets. Any restrictions on data sharing due to intellectual property rights of researchers, stakeholders and producers, due to legal obligations including professional confidentiality; protection of persons in compliance with the European regulation (General Data Protection Regulation - GDPR) on the protection of natural persons with regard to the processing of personal data and on the free movement of such data; but also because the data originate from genetic resources analysis (benefit sharing obligations), will be considered by the Advisory Committee.
Where appropriate, data may be marked as “confidential”; some restrictions may be imposed on their use or dissemination, subject to global access requirements.

For the purpose of publishing data that contain elements of personal information (preference survey), firstly prior consent of interviewees will be collected to allow surveys to be carried out and secondly appropriate anonymization techniques will be implemented (k anonymization etc..) before publishing related data. See (Appendix 3. RTBfoods consents).

The dissemination of digitized information resulting from the analysis of genetic resources is also regulated (cf. 4.2). Dissemination of such scientific knowledge must preserve the interests of countries providing the genetic resources. CIRAD is an active member of the Research Data Alliance (RDA) and its French node (https://rd-alliance.org/groups/rda-france) and participates to relevant interest groups (IG) and working groups (WG), e.g. Agricultural Data Interest Group (IGAD) as one of the RDA’s most prominent Thematic Groups

https://www.rd-alliance.org/groups/agriculture-data-interest-group-igad.html.

Therefore, CIRAD will follow recommendations and adopt outputs from IG and WG of RDA such as the IGAD, IG on Privacy Implications of Research Data Sets to align data sharing practices with internationally recognized recommendations of RDA.

4.5 Publication Rights

International public good

Project deliverables will target international public good, particularly for use in developing countries. Project participants will conduct and manage research, technologies, information, and innovations related to the project so that the knowledge gained is promptly and widely disseminated. Moreover, project participants will make them available and accessible at a reasonable cost to developing countries around the world and, where applicable, to the educational system and public libraries in the United States.

RTBfoods Publication policy will be based on the Vancouver/ICMJE recommendations (http://www.icmje.org/icmje-recommendations.pdf, updated December 2016) to identify authorship.

Open Access publication

Publications under the project will be available in accordance with Open Access terms as provided for in the CIRAD Open Access and Data Management Policy and the donor's Open Access Policy.

https://www.cirad.fr/en/publications-resources/cirad-publications
https://agritrop.cirad.fr/mention_legale.html (in French)
https://agritrop.cirad.fr/pdf/Depot_institutionnel.pdf (in French)

Scientific papers will therefore be published in selected journals allowing green or gold open access. To this end, the project will encourage the use of BMGF Chronos service for Open Access publications. All papers will be published under the Creative Commons Attribution license (CC BY 4.0).

If some policies are found incompatible, the stricter conditions of either policy will apply.

Copies of every publication of material based on or developed under this project will be sent to the project coordinator promptly after publication. These publications will be kept in the project repository (Website), clearly labeled with the project's name and number and other appropriate identifying information.

4.6 Post-Project Development

These provisions will ensure that Funded Developments and lessons learned from the project will continue to be used beyond the project's lifetime.

APPENDIX 1 _ LISTS THE RTBFOODS PROJECT PARTNERS.

Partner	Website
AFRICAN REGIONAL & NATIONAL PARTNERS	
CARBAP	http://www.carbapafrica.org/
CNRA	http://cnra.ci/
Bowen University	http://bowenuniversity.edu.ng/
NaCCRI	https://www.naro.go.ug/
NARL	https://www.naro.go.ug/
NRCRI	http://www.nrcri.gov.ng/
Université Abomey Calavi	http://fsa-uac.org/

Partner	Website
EUROPEAN PARTNERS	
CIRAD	https://www.cirad.fr/en/who-are-we/cirad-in-a-nutshell
INRA	http://www.inra.fr/
James Hutton Institute	http://www.hutton.ac.uk/
Natural Research Institute	https://www.nri.org/
CGIAR PARTNERS	
Bioversity International	https://www.bioversityinternational.org/
CIAT	http://ciat.cgiar.org/
CIP	https://cipotato.org/
IITA	http://www.iita.org/

* Boyce Thompson Institute (BTI): https://btiscience.org/

APPENDIX 2 _ REPORTING PERIODS AND FORMAT

Project reporting dates to the BMGF

Name of Report	Date of Submission
Global Access Strategy	may 31th, 2018
Annual IP Report	January 31th, 2019
Annual IP Report	January 31th, 2020
Annual IP Report	January 31th, 2021
Annual IP Report	January 31th, 2022
Final IP Report	September 31th, 2022

Partner reporting dates and format to RTB Project Management Unit (RTB-PMU)

Name of Report	Date of Submission
Annual IP Report	December 31th, 2018
Annual IP Report	December 31th, 2019
Annual IP Report	December 31th, 2020
Annual IP Report	December 31th, 2021
Final IP Report	August 31th, 2022

Partners will annually report to the RTB-PMU the Funded Developments created during that implementation year in accordance with the following format:

Name of Partner			
Reporting Period			
	Title of Funded Developments created during the reporting period	Brief description of the Funded Development (supporting documents may be enclosed)	Conditions which may affect Global Access/Repository where Funded Development may be accessed (including link if available)
1.			
2.			
3.			
4.			
5.			
Add row as required.			

APPENDIX 3_ RTBFOODS INFORMATION & CONSENT PRINCIPLES AND RELATED DOCUMENTS

Principles for Investigators *(version 03-05-2018)*

5 Steps to inform participants about their rights and obtain their consent during any kind of activity.

1- Be sure that the participant is a volunteer.

2- Read, the ***Information Sheet*** to the participant. In case the participant is illiterate or cannot sign, ask the participant to appoint a representative or find a witness person the participant agrees upon and read the ***Information Sheet*** to both of them (participant + representative).

3- Inform the participant she/he has the opportunity to give the project her/his consent to use the data provided during the activity. This form is to protect her/his rights. Fill in the ***Consent Form*** with the participant (and eventually with her/his representative). Provide contact details of the person responsible for the activity.

4- Conduct the activity.

5- After the activity is completed, check that the participant still agrees with the ***Consent Form*** previously signed by her/himself or her/his representative.

Participant Information Sheet *(version 03-05-2018 – Page 1/2)*

Research project title: Breeding RTB products for end user preferences (RTBfoods)
This Project is Supervised by: Dominique DUFOUR (Food Technologist, CIRAD)
Main researchers contact details:
Name of researcher: ……..
Role in the project: ……
Full address: ……
Tel: ……
E-mail: ……

Introduction
(This section should introduce the researcher to the participant, providing their name and CIRAD contact details as well as their status/ role (e.g. staff, undergraduate/ postgraduate/doctoral student). The language used in the Participant Information Sheet and Consent Form should be tailored to the participants.)

The ultimate objective of RTBfoods project is deploying RTB varieties for user-preferred quality traits and increased adoption rates of RTB varieties in Africa. Additional outcomes will be the reduction of breeding costs, increased economic value, widening the range of food products from RTBs and enhanced livelihoods for men and women.
11 food products particularly important for RTB-based staple diets were selected for this project (i.e. boiled cassava, gari, boiled potato, boiled sweetpotato and boiled yam, matoke from cooking banana), in partnership with several African organizations in 5 countries: Benin, Côte d'Ivoire, Nigeria, Cameroon and Uganda.

What is the purpose of the activity/investigation we are leading?
(This section should include the aims of the investigation, the reason for it and what it is trying to achieve.)

The activity is an interview based on a questionnaire prepared by our team of food and social scientists. During this activity we expect from you brief or sometimes more detailed answers concerning your preferences in RTB consumption.
The purpose of our activity is to capture the essential quality traits for successful RTB variety adoption through surveys conducted with users of RTB crops, i.e. processors and consumers, as well as farmers and traders or middlemen**.**

Why have you been invited to take part?
(To be filled by the researcher. This should explain the types of participants that have been chosen to take part in the investigation and the reasons. Should include an explanation of the nature of the participant's sample; any screening procedures necessary; any inclusion/ exclusion criteria; any special skills/ attributes involved.)

Nevertheless, it is a participant's voluntary decision to take part in the activity and the participant can leave the study at any time without any consequences on the way she/he will be treated by the project team and collaborators.

What will you do in the project?
(This should provide participants with information on what they will be required to do for the investigation e.g. completing a questionnaire, interviews, attending meetings etc. Information on payment/ reimbursement should be provided here. This section should also provide the location and duration of the investigation and dates that the participant should be aware of.)

Participation means being interviewed, completing the questionnaire orally, and potentially attending meetings. Information could be recorded. The duration of this activity is about 1h30.

What are the potential risks to you in taking part?
(To be customized in the case of sensory testing. Include a statement regarding any real or perceived risks or potential discomfort that may result from participation in the research. If there is a possibility of harm or discomfort it must be described and the mitigation methods must be indicated)

No risks have been identified for the different actors' participation in the interviews, questionnaires and/or meetings.
Nevertheless, participants who would wish to express any particular or personal issue or concern, are free to ask researchers or any other RTBfoods partner about it.

What happens to the information collected in the project?
(This section should provide information on the confidentiality and anonymity of the participants. If any information provided has to be disclosed, then this should be explained here. Data storage and retention information should also be provided here.)

Data storage and management of information will be secured according to RTBfoods established and specific rules.

Consent Form *(version 03-05-2018 – Page 2/2)*

Research project title: Breeding RTB products for end user preferences (RTBfoods)
This Project is Supervised by: Dominique DUFOUR (Food Scientist, CIRAD)
Contac details
Name of researcher: ……..
Role in the project: ……
Full address: ……
Tel: ……
E-mail: ……

Title of the Study:		
Investigator's name:		
Location of this activity:		
To be completed by the participant 1. Have you understood the information sheet about this activity?		YES / NO
2. If you asked questions did you receive satisfactory answers?		YES / NO / Not applicable
3. Do you understand that you are free to withdraw from this activity and from RTBfoods project at any time and without the need to give a reason?		YES / NO
4. Do you give your agreement for the record of the activity?		YES / NO
5. Do you understand that the information you provide during this activity will be anonymized, no traceable to you and securely stored and managed?		YES / NO
6. Do you give your agreement for the use of your picture and/or video/audio recordings for training or scientific presentation purposes?		YES / NO / Not applicable
7. Do you agree to take part in this activity for RTBfoods project?		YES / NO
Signed:		Date: ……../……../…….
If signed is not possible	**Verbal consent:**	YES / NO
	Representative's name in block letters:	
Participant's name in block letters:		
Signature of investigator:		Date: ……../……../…….

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