Breeding RTB products for end-user preferences (RTBfoods)

Annual Report Period 5 (Jan - Dec 2022)

July 2023

Main Author(s):

- Dominique DUFOUR, Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), Montpellier, France
- Eglantine FAUVELLE, CIRAD, Montpellier, France
- Cathy MÉJEAN, CIRAD, Montpellier, France
- Kanya JIRAJAROENRAT, CIRAD, Montpellier, France
- Delphine MARCIANO, CIRAD, Montpellier, France
- Claire KHOURY, CIRAD, Montpellier, France
- Anne-Laure PERIGNON, CIRAD, Montpellier, France

This report has been written in the framework of the RTBfoods project.

To be cited as:

Dominique DUFOUR, Eglantine FAUVELLE, Cathy MÉJEAN, Kanya JIRAJAROENRAT, Delphine MARCIANO, Claire KHOURY, Anne-Laure PERIGNON (2023). *Breeding RTB products for end-user preferences (RTBfoods). Annual Report Period 5 (Jan - Dec 2022).* Montpellier, France: RTBfoods Annual Report, 151 p. https://doi.org/10.18167/agritrop/00764

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 previously informed about the objective of the activity and informed 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.

Acknowledgments: This work was supported by the RTBfoods project https://rtbfoods.cirad.fr, through a grant OPP1178942: Breeding RTB products for end user preferences (RTBfoods), to the French Agricultural Research Centre for International Development (CIRAD), Montpellier, France, by the Bill & Melinda Gates Foundation (BMGF). The authors acknowledge Vincent Johnson for his editorial support.

CONTENTS

Table of Contents

ABSTRACT

Type of document:

Technical Report

Context

Breeding root, tuber, and banana (RTB) products to meet end-user preferences is a Bill and Melinda Gates Foundation investment. This RTBfoods project reveals user preferences along the RTBfood chains in Benin, Cameroon, Cote d'Ivoire, Nigeria, and Uganda. It has developed specific trait-determination methods for 13 RTB product profiles, derived from five key staple crops: banana/plantain, cassava, potato, sweetpotato and yam. This includes developing high-throughput tools to facilitate selecting new RTB varieties to meet end-users' requirements, thereby contributing to boosting variety adoption and ultimately food and nutrition security.

Content

Five work packages (WPs) bring together skills and expertise of several world-class laboratories. A sixth WP is dedicated to project management, financial and scientific coordination, monitoring, and promoting project achievements. The project has identified the quality traits that drive users' adoption of new RTB varieties, and taken a novel approach by directly involving consumers, processors, social scientists, breeders, and other researchers. The project is now translating 13 RTB product profiles into market-led breeding initiatives that have begun developing new, end-user–focused, RTB varieties in sub-Saharan Africa (SSA). The project is improving genetic insights into quality traits along the RTBfoods value chains, essential for successful RTB breeding and variety adoption, and reducing drudgery for women. Multidisciplinary teams of social scientists and food technologists have captured these essential quality traits through surveys of RTB crop processors and consumers, farmers, merchants, and traders. A highly positive project outcome assessment recommends consolidating and scaling the innovative, participatory RTB breeding approaches for the next phase. Advisory committee recommendations provide the basis for phase 2 project design.

Objectives:

The work will boost RTB improved variety adoption in SSA, and associated food/nutrition security.

Key Words: RTBfoods; gendered trait preferences; improved variety adoption; high-throughput phenotyping; food and nutrition security.

ACRONYMS

ABI	Accelerated Breeding initiative
ADH	Adhesiveness
AR4D	Agricultural Research for Development
BMGF	Bill and Melinda Gates Foundation
BTI	Boyce Thompson Institute
CARBAP	Centre Africain de Recherche sur Bananiers et Plantains
CATA (test)	Check all that apply testing
CIAT	International Tropical Agricultural Research Centre
CIP	the International Potato Center
CIRAD	the French Agricultural Research Centre for International Development
CNN	Convolutional Neural Network
CNRA	Centre National de Recherche Agronomique
CO	Crop Ontology
CoP	Community of Practice
COSCA	Collaborative Study of Cassava in Africa
CRP	CGIAR (global) Research program
DArT	Diversity Arrays Technology
DI	Deviation from the ideal (or optimum)
DM(C)	Dry matter (content)
EiB	(One-CGIAR) Excellence in Breeding (platform)
FAO	(UN) Food and Agriculture Organization
GEI	Genotype and environment interactions (see also GXE)
GS	Genomic selection
G(T)FPP	Gendered (Target) Food Product Profile
GWAS	Genome-wide association study
GWG	Gender working group
GXE	Genotype by Environment
HCN	Hydrogen cyanide
HSI	Hyper-spectral imaging
HTPP	High-throughput phenotyping protocols
IITA	the International Institute of Tropical Agriculture
IFST	the Institute of Food Science & Technology
IJFST	the International Journal of Food Science & Technology
INRAe	the French National Institute for Agricultural Research
ITPA	Instrumental texture profile analysis
JAR (test)	Just about right testing
JFSA	Journal of the Science of Food and Agriculture
JHI	the James Hutton Institute
KASP	Kompetitive (Competitive) Allele Specific PCR (see PCR below)
KQTs	Key quality traits
MAP	Months after planting
MAS	Marker-assisted selection
MDP	Mwanga Diversity Panel
MEL(IA)	Monitoring, evaluation, and learning (& impact assessment)
MIPPI	Market Intelligence and product profile
MTPP	Medium-throughput phenotyping protocols
NaCRRI	National Crops Resources Research Institute
NARL	National Agricultural Research Laboratories, Uganda
NARO	National Agricultural Research Organisation
NIRS	Near Infrared Spectroscopy Spectra

NRI	the Natural Resources Institute (University of Greenwich)
NSPs	Non-starch polysaccharides
OFSP	Orange-fleshed sweetpotato
One CGIAR	The restructured CGIAR global research network
OxB	Oxidative browning
PCR	Polymerase chain reaction
PLS	Partial Least Square
PME	Pectin-methyl-esterase
PMU	Program Management Unit
PPO	Polyphenol oxidase
PVS	Participatory varietal selection
QDA	Quantitative descriptive analysis
QTLs	Quantitative trait loci
QTNs	Quantitative Trait Loci/Nucleotides
RMSEs	Root mean square errors
RTB	Roots, Tubers, and Bananas
SEL	Standard Error of Laboratory (method)
SNPs	Single nucleotide polymorphisms
SOP	Standard Operating Procedures
SSA	Sub-Saharan Africa
STPA	Sensory Texture Profile Analysis
TDs	Trait dictionaries
TRICOT	Triadic comparison of technologies
UAC/FSA	Abomey-Calavi University- Faculty of Agronomic Sciences
VUE	Variety (V); user (U); and socio-economic environment (E)
WAB	Water absorption
WP	Work package

PREFACE

This period 5 (2022) report outlines the activities, outputs and outcomes from the Bill and Melinda Gates Foundation (BMGF) supported project *Breeding root, tuber, and banana (RTB) products to meet end-user preferences*. The work has revealed user preferences along the RTB food chains in Benin, Cameroon, Cote d'Ivoire, Nigeria, and Uganda. It has developed specific trait-determination methods for 13 RTB product profiles, derived from five key staple crops: banana/plantain, cassava, potato, sweetpotato and yam. This includes developing standard trait-measurement lab operating procedures (SOPs), and high-throughput tools to facilitate developing and selecting new RTB varieties to meet end-users' requirements, thereby contributing to boosting variety adoption and ultimately food and nutrition security.

Section 1 introduces the program context. **Section 2** outlines the RTBfood product profiles development, through i) new trait discovery linked to end-users' preferences; ii) determining trait acceptability thresholds, considering processors' and consumers' gendered preferences; and iii) linking with the One CGIAR's excellence in breeding (EiB) product profiles. **Section 3** describes developing the laboratory protocols (SOPs) for quality trait evaluation, including for i) starch and parietal compounds; ii) color, texture (boiled & dough/paste products), taste; and trait prediction. **Section 4** covers RTB crop genotypes' population screening and genetics, including: i) Genotype extraction, and promoting and assessing released varieties assessed for end-user quality traits; ii) Database management and ontologies on quality traits for breeders' use; and iii) Identifying QTLs for quality traits (texture, color and end-product yield). **Section 5** shows how the program management unit (CIRAD) has promoted RTBfoods results and project impacts, including through i) Talent development; ii) Animating the RTB scientific community (via website, social media, and webinars; iii) Publications, and iv) an RTBfoods outcome assessment. **Section 6** presents the report's conclusions and recommendation for further work. This includes the RTBfoods advisory committee feedback and recommendations and some proposed cross-cutting activities for future RTB Breeding project work. **Section 7** (the report's 6 **annexes**) include summaries of work package's (WP) and partner's scientific achievements; associated trainings and workshops; Lists of RTBfoods students and publications, and an outline of the RTBfoods dashboard open-access deliverables.

1 INTRODUCTION

Breeding Root, Tuber, and Banana (RTB) products for end-user preferences (RTBfoods) is a Bill and Melinda Gates Foundation (BMGF) investment, co-funded mainly by CIRAD & INRAe, to encourage increased improved variety adoption of root, tuber, and banana (RTB) crops in sub-Saharan Africa (SSA). It has developed specific trait determination methods for each product profile, and when possible: high-throughput tools that will facilitate the selection of new RTB varieties by breeders to meet end-users' requirements, thereby contributing to boosting variety adoption and food and nutrition security. The investment aims to identify the quality traits that drive users' adoption of new RTB varieties, and takes a novel approach by directly involving consumers, processors, social scientists, breeders, and other 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 is improving 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 are capturing these essential quality traits through surveys of RTB crop users (i.e., processors and consumers), farmers, traders, and middlemen.

From the outset, in order to compare the understanding and perspectives of the various specialists, the project was designed based on multi-disciplinary scientific teams across the different crops and product profiles. (See figure 1)

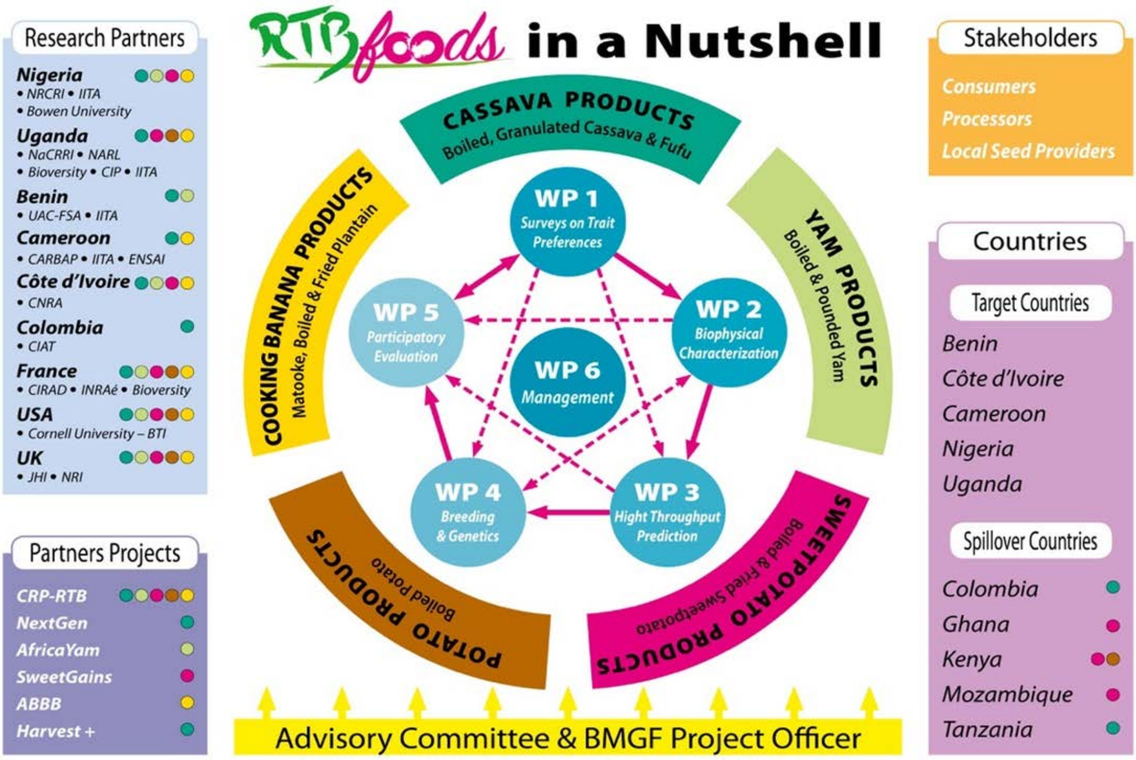

Figure 1 RTBfoods project design

Research activities have been 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 promotion of the project achievements.

Each WP has a specific objective in the project and is in constant interaction with the other WPs.

WP1: Understanding the drivers of trait preferences and the development of multi-user RTB product profiles. The evidence base for user preferences for RTB products is being identified through the use of interdisciplinary methods and lines of inquiry (food science, gender, and socioeconomics). This examines preferences for different user groups in the product chain and identifies the factors that influence these preferences for men, women, and other social segments, including how they are prioritized.

WP2: Biophysical characterization of quality traits (Smart Laboratories). To characterize chemical compounds of interest in detail, specific biophysical analysis, and sensory profiling protocols are being adapted or developed as needed.

WP3: High-throughput phenotyping protocols (HTPPs). Based on these primary quantitative analyses, the investment is building databases to establish predictive equations based on near-infrared spectroscopy (NIRS) data to calibrate HTPP in the different RTB breeding programs in SSA. NIRS of new, elite breeding lines is enabling 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.

WP4: 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 studies (GWAS) and study of genes for quality quantitative trait loci (QTLs). The investment is also significantly reducing phenotyping costs and allowing low-cost analysis of how genetic factors, environmental factors, and cultivation and processing practices contribute to the quality traits of RTB-based end products.

WP5: Gender-equitable positioning, promotion, and performance. The most promising varieties (VUE) thus identified are being 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.

As indicated in the project's infographics the most-consumed RTB food products in sub-Saharan Africa (SSA) have been identified with the project partners. Thirteen food products of particular importance for RTB-based staple diets (cassava, yam, sweetpotato, cooking bananas, and tropical potato) have been selected and are featured in the discontinuous circle surrounding the WPs, with a color code specific to each crop, in the graphical design (Figure 1).

Each product has relative importance in the diet of the selected countries as reported by crop in Dufour *et al.*, (2021) https://doi.org/10.1111/ijfs.14911

For each product profile, a multidisciplinary team has been constituted within the project under the responsibility of the product champion who ensures the continuity of activities between WP and countries for the same product profile. The project is being implemented in partnership with several SSA organizations in five SSA countries: Benin, Cameroon, Côte d'Ivoire, Nigeria, and Uganda. Specific deliverables have been assigned to and accepted by project partners that enable RTBfoods product profiles to be developed and thus map activities between the different WPs and product profiles. Each partner contributes to the establishment of 13 product profiles and the scientific coherence of the different WPs.

RTBfoods project partners

CGIAR Partners Bioversity International, Rome, Italy (now Alliance Bioversity-CIAT) International Center for Tropical Agriculture (CIAT), Cali, Colombia (now Alliance Bioversity-CIAT 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 (INRAe), 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 Recherche Agronomique (CNRA), Abidjan, Côte d'Ivoire. National Agricultural Research Organisation (NARO) (NaCRRI, NARL, Kazardi), Kampala, Uganda. National Crops Resources Research Institute (NRCRI), Kampala, Uganda Université d'Abomey-Calavi (UAC/FSA), Cotonou, Benin.
Consultants and Subcontractors Boyce Thompson Institute (BTI), Ithaca, New York, USA. Cornell University, Ithaca, New York, USA. Ecole Nationale Supérieure des Sciences Agro-Industrielles, ENSAI, Ngaoundéré, Cameroon

The four preliminary annual reports are available in Table 1 RTBfoods annual reports.

2 FOOD PRODUCT PROFILE DEVELOPMENT

2.1 New trait discovery linked to end-users' preferences:

2.1.1 Preliminary studies on consumption habits & preferences

Root, tuber, and banana (RTB) crops play a vital role in household food and income security across sub-Saharan Africa (SSA). As such, breeding programs have worked for decades for genetically improving these crops, particularly in terms of yield and pest and disease resistance, to increase the food and nutrition security they provide to millions of people. Despite the progress made in these areas, there remains a gap in understanding of varietal traits and preferences for RTB varieties in terms of processing and consumption characteristics for a range of RTB products. This has contributed to low levels of adoption of new varieties and thus enjoyment of their potential benefits.

There is also limited understanding of the socio-cultural influences on RTB product preferences, and the differentiated needs of men, women, and other social groups involved in RTB food chains in SSA.

To address these challenges, an interdisciplinary and participatory five-step methodology was developed to identify demand for quality characteristics among diverse user groups along RTB food chains. This initiative aims to link local consumer preferences with breeders' selection criteria to ensure adoption along the value-chains of cassava, yam, sweetpotato, potato and cooking banana products.

The methodology includes an evidence review, consultations with key informants and rural communities, processing diagnosis with experienced processors and consumer testing in urban and rural areas. Forsythe *et al.* (2021) https://doi.org/10.1111/ijfs.14680

Quality characteristics are then prioritized into a Food Product Profile by user group to inform further work of biochemists and breeder in developing improved selection tools. Importantly, the methodology incorporates a sampling and conceptual foundation to enable analysis by gender and other factors of social difference, to help crop breeders identify and prioritize specific traits in their breeding programs.

This initiative presents a new basis for understanding consumer preferences for RTB crops. The methodology is currently being applied, adapted and – importantly - improved by 12 interdisciplinary teams of food technologists, economists, and gender specialists in five project countries: Benin, Ivory Coast, Cameroon, Nigeria, and Uganda.

Part of the results from the studies have been synthesized and published in the 11 publications in the same special issue. It is expected that the results from profiling the preferences of value chain actors with their gender-differentiated trait and product preferences will support breeding programs to improve adoption of new varieties and impact on food and income security in SSA.

The project focuses its efforts on the acceptability of the 11 RTB staple foods, the most consumed in sub-Saharan Africa from cooking bananas (boiled and fried plantain, matooke), cassava (boiled cassava, gari and fufu), potato (boiled), sweetpotato (boiled and fried), yam (boiled and pounded).

Surveys and diagnostics were carried out among men and women, farmers, middlemen, users, and consumers of RTB in order to better understand the importance of the quality characteristics preferred by the value-chain actors.

National partners in collaboration with the international institutions of the project consolidated the information collected from users and consumers in Benin, Côte d'Ivoire, Nigeria, Cameroon, and Uganda to generate new knowledge on the preferences and acceptability of each staple product in relation to the locally processed RTB varieties and genotypes.

Key findings of this work have been published in the special RTB issue of the *International Journal of Food Science and Technology*: "Consumers have their say: Assessing preferred quality traits of roots, tubers and cooking bananas, and implications for breeding", IJFST special issue is online

Step 1: State of Knowledge

Step 1 was to establish what is currently known about the product and gaps in knowledge. For this activity the Coordination team developed guidance for building a knowledge base from a disciplinary perspective, to identify gaps in knowledge to be addressed by the project.**)** https://doi.org/10.18167/agritrop/00568

13 Product-based SoK reports and summaries were delivered with support from the WP1 Coordinator team and other collaborators. Table 2 Reports from preliminary studies on RTB consumption habits & preferences, Step 1

Step 2: Gendered food mapping

Step 2 was to take a food chain approach to identify and understand preferences for crop and food characteristics by gender and other factors of social difference. 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. The guidance was updated based on lessons learned from pilots in Uganda and Nigeria. https://doi.org/10.18167/agritrop/00569

The Coordination team also provided support to implementing partners on research and report development and finalization. This activity has resulted in the production of 20 partner reports for Step 2 Gendered Food Mapping reports. Table 3 Reports from preliminary studies on RTB consumption habits & preferences, Step 2

Tables 2 and 3 report the analysis of the data collected and the publications accepted in the RTBfoods special issue published in International Journal of Food Science and Technology: Consumers have their say: assessing preferred quality traits of roots, tubers and cooking bananas, and implications for breeding, Volume 56, Issue 3, 1071-1501, March 2021. https://ifst.onlinelibrary.wiley.com/toc/13652621/2021/56/3

Step 3: Participatory Processing Diagnosis and Quality

This Step 3 involves a Food scientist-led team to evaluate the processing ability of different RTB varieties with a group of processors in the community during processing of the RTB crop into the different end-products. Several parameters have been measured at each step of the process to assess the technological properties of each variety. This has involved participatory demonstrations and consultation with the processors to collect their opinions and views on the different quality characteristics of varieties, associated with the different processing steps or practices. In order to produce comparable data, Step 3 guidance has been developed and applied by all partners: https://doi.org/10.18167/agritrop/00570

In order to identify the quality characteristics of the crop required at the processing level, it has been necessary to have the greatest variability of raw materials (crops) to get final products with a large range of sensory characteristics. This variability has been obtained by processing local varieties known for their ability (or unsuitability) to render a high-quality product. To increase the variability between sensory properties of the products, processors have been asked to process new genotypes with very different characteristics, comparing them with local varieties but hitherto unknown by the processors.

The objective was not specifically to compare new genotypes and local varieties regarding their technological properties. Rather the objective was to propose a large variability of products to invite processors (Step 3) and consumers (Step 4), to tell us what their sensory preferences are – that may or may not include new genotypes. Comparison among a broad variability made it easier for people to perceive and talk about their sensory preferences. Table 4 Reports on participatory processing diagnosis with RTB processors, Step 3

This step of the methodology has been an opportunity through the collection of quantitative and qualitative data to describe in detail the processes in each product profile according to the implementation and use of standardized tools. Thus, it allowed to reach the initially fixed objectives by the integration of processors evaluation based on their in-depth knowledge of traditional products. It has been possible to describe processes but also to identify the main unit operations requiring work force and impacting production yields, with both of these parameters impacting productivity. In this way, some specific processing criteria have also been highlighted for some crops. The evaluation of end-products by processors themselves allowed collecting several quality descriptors useful for building the step 4 questionnaires.

At the end of the project, all the work reported in Table 4 Reports on participatory processing diagnosis with RTB processors, Step 3 was compiled and analyzed jointly, and a review-type publication was produced (**Success Story Box n°1:)** and accepted for the new RTB special issue in *Journal of the Science of Food and Agriculture*: ***Tropical roots, tubers and bananas: New breeding tools and methods to meet consumer preferences***.

Success Story Box n°1: ***Varietal impact on women's labor, workload, and related drudgery in processing root, tuber, and banana crops. Focus on cassava in sub-Saharan Africa.***

Roots, tubers, and bananas are bulky and highly perishable. In Africa, except for yams, their consumption is mainly after transport, peeling and cooking in the form of boiled pieces or dough, a few days after harvest. To stabilize, better preserve the products and, in the case of cassava, release toxic cyanogenic glucosides, a range of intermediate products have been developed, mainly for cassava, related to fermentation and drying after numerous processing operations. This review highlights, for the first time, the impact of genotypes on labor requirements, productivity, and the associated drudgery in processing operations primarily carried out by women processors. Peeling, soaking/grinding/fermentation, dewatering, sieving, and toasting steps were evaluated on a wide range of new hybrids and traditional landraces. The review highlights case studies of gari production from cassava. Results show that, depending on the genotypes used, women's required labor can be more than doubled and even the sum of the weights transported along the process can be up to four times higher for the same quantity of end product. Productivity and loads carried between each processing operation are highly influenced by root shape, ease of peeling, dry matter content and/or fiber content. Productivity and the often-related experienced drudgery are key factors to be considered for a better acceptance of new genotypes by actors in the value-addition chain, leading to enhanced adoption, and ultimately to improved livelihoods for women processors.

Step 4: Consumer Testing in Rural and Urban Areas

The objective of this step 4 is to understand the consumers' demands for quality characteristics of the product under study, i.e., to understand the nature of a high-quality product as demanded by local consumers. The sensory characteristics of several products with very different sensory properties will be related to the overall liking by many consumers. The products were made from local varieties and/or genotypes that were selected by processors and the research team for their different quality characteristics (in Step 3). Consumer testing was conducted in rural and urban areas previously identified in Steps 2 and 3. *Step 4 Guidance: Consumer testing in rural and urban areas*, was produced and applied by all the project partners: https://doi.org/10.18167/agritrop/00571. This Guidance is associated with the data analysis & reporting report that gives a step-by-step description of the different analyses that should be included for consumer testing data analysis and reporting https://doi.org/10.18167/agritrop/00660.

This step 4 was conducted on boiled cassava (Uganda and Benin), gari-eba, fufu, pounded yam (Nigeria), boiled yam (Benin and Nigeria), attiéké (Côte d'Ivoire), matooke, boiled potato, boiled and steamed sweetpotato (Uganda), fried sweetpotato (Ghana and Nigeria) and boiled plantain (Cameroon). It consisted of of individual interviews with rural and urban consumers where consumers were invited firstly to complete a small questionnaire on demographic information and consumption habits. They then tasted each product, one after the other, in a specific random order, and scored the overall liking using a nine-point hedonic scale. They also scored the intensity of 2–4 specific characteristics identified as important in Steps 2 and 3, using the 3-point JAR "Just About Right" scale, and described the product using a CATA "Check-All-That-Apply" table including sensory and perception characteristics collected during Steps 2 and 3. Sensory characteristics collected from CATA test constituted a reference for conducting a Quantitative Descriptive Analysis (QDA) in WP2. Consumer test results have generally contributed to high throughput phenotyping platform development. Table 5 Reports on consumer testing with RTB consumers, Step 4

Step 5: Product Profile Consolidation. Understanding the Drivers of Trait Preferences

In order to develop the methodology for producing the expected RTB gendered food product profiles (GFPP), a working group was formed within the RTBfoods project. The Gender working (GWG) group included Lora Forsythe (lead - NRI); Pricilla Marimo, Bioversity (formerly); Gérard Ngoh, CARBAP; Alexandre Bouniol, CIRAD; Béla Teeken and Olamide Olaosebikan, IITA; Benjamin Okoye and Tessy Madu, NRCRI; Aurélie Bechoff, NRI; Laurent Adinsi and Noel Akissoe, FSA-UAC. GWG led the development of RTBfoods Product Profile gender assessment document and template and adapted G+ tool. This was adapted from the G+ tool to fit the focus of the RTBfoods project and approach to gender equity. The aim of the G+ Foods Product Profile tool is to assess the potential gender impact for RTB crop and food product related characteristics (or expressed as traits if established) to inform what is included and prioritized in the final version of the WP1 Food Product Profile. A guidance and template were produced and applied by all the partners to develop the GFPP: *Finalization of the food product profile. Understanding the drivers of trait preferences and the development of multi-user RTB product profiles:* https://doi.org/10.18167/agritrop/00661. This was presented and validated by the RTBfoods Advisory Committee in May 2021.

The GWG also provided a review and inclusion of gender and social difference aspects into the Food Product Profile Methodology and the WP1 G+ RTBfoods Product Profile Assessment (adapted from G+ Product Profile Tool) and calculator.

The GWG and NRI's Lora Forsythe contributed to and led to (respectively) the publication of the WP1 Gendered Food Product Profile (GFPP) methodology (Forsythe) in a Special Issue of the Journal of the Science of Food and Agriculture.

Table 6 reports the list of preferred quality characteristics generated for Raw product, during processing and Final / ready-to-eat product. Table 6 Preferred quality characteristics per RTB food products at the 3 stages of processing, Step 2 to Step 4

Table 7 shows the RTB-GFPPs produced by the various project teams. Table 7 Gendered Food Product Profiles, Step 5

The GWG also provided a review and inclusion of gender and social difference aspects into the Food Product Profile Methodology and the WP1 G+ RTBfoods Product Profile Assessment (adapted from G+ Product Profile Tool) and calculator.

The GWG and NRI's Lora Forsythe contributed to and led (respectively) the writing for the publication of the WP1 Gendered Food Product Profile (GFPP) methodology (Forsythe) in a Special Issue of the Journal of the Science of Food and Agriculture (JFSA).

Success Story Box n°2: ***A case of inter/trans-disciplinarity and collaborative decision making: the co-construction of Gendered Food Product Profiles***

Crop breeding has made considerable gains in crop improvement; however, post-harvest characteristics, characteristics that reduce drudgery, consumer preferences and social differences in preferences, have been overlooked. This has the consequence of reducing varietal adoption along with their potential development impact. This context is changing as more holistic food-chain approaches, informed by gender, social difference, and place, are informing breeding programs through innovative inter/trans-disciplinary approaches. The effectiveness of these approaches depends on the use of inter/trans-disciplinary efforts and the power dynamics within these contexts, which privilege certain types of knowledge, academic disciplines, institutions, and individuals that represent them. For this reason, a working group of breeders, food technologists, economists and gender specialists designed a conversational, qualitative method to facilitate the decision-making process for product profile development. This paper presents the learning of a cross-disciplinary team on co-developing a 'Gendered Food Product Profile' to support breeders in varietal development for key food staples in five sub-Saharan African countries. The paper provides a description of the process of developing the product profile with an illustrative case study, and a collection of lessons learned from participating researchers.

2.2 Determination of trait acceptability thresholds

2.2.1 Processing: productivity, drudgery, end-product yield

Drudgery in processing of root, tuber, and banana crops (RTBs) has been recognized as a major, complex social, economic and health problem. However, little attention has been paid to the influence of varietal differences on drudgery, and the potential to exploit breeding of appropriate varieties (genotypes) as a partial solution. Although it can have a significant impact on the livelihoods and wellbeing of women (who perform the majority of processing labour), addressing labour requirements, productivity and related drudgery in food processing is often ignored in the development of improved RTB genotypes. Throughout sub-Saharan Africa, women play a vitally important role in agriculture and post-harvest activities, 50% of agricultural work is done by women, with significant variations within and among regions and countries. Agri-food processing at artisanal or small scale is mainly carried out by women with the help of family labour (often young and/or elderly people and neighbors). For processing of RTB products, these operations are often carried out entirely by women -- from the peeling to the elaboration of the end-products ready to be marketed or consumed at the household level. The Collaborative Study of Cassava in Africa (COSCA), conducted in six African countries, showed that women lead in root transportation (68%) and processing operations (76%). On average, cassava processing was carried out mostly by women in about 75% of the surveyed villages, mostly by men in less than 5%, and by both equally in about 20%. Women in sub-Saharan Africa have the highest average agricultural labour-force participation rates in the world.

Figure 2 Peeling cassava roots. **A.** Illustration of the occurrence of constrictions (left) and variation of root shape and size (right). **B.** Traditional peeling by slashing in Africa. **C.** Illustration of roots where the peel can be easily removed.

RTBs have several important features of note in relation to labour input. They tend to be bulky and perishable, making them difficult to transport, and as a result most are often eaten fresh, after cooking, soon after harvest. Cassava is by far the most widely grown and consumed root in sub-Saharan Africa.

Assessment of processing productivity and the drudgery associated with processing RTB-based foods is limited. Genotype acceptability and drudgery in processing appear to be strongly linked, i.e., women are more likely to prefer RTB varieties with traits that reduce the drudgery of processing. Furthermore, cassava processing, for example, is associated with challenging working conditions and serious health hazards which increase the likelihood that such operations are perceived as drudgery. Prolonged labour associated with all the operations significantly impinges on the productivity and wellbeing of the (mostly) women operators. An SOP to assess peeling ease of cassava roots was developed https://doi.org/10.18167/agritrop/00736. Drudgery has been defined as the dissatisfying experiences that constrain work performance in any activity and is often related to time-consuming, repetitive, and menial work. Physical and mental strain, agony, monotony, and hardship have been linked to the drudgery often experienced in farm operations.

15 processing diagnostics are reported in Table 4 Reports on participatory processing diagnosis with RTB processors, Step 3. These were produced following a standardized participatory processing diagnosis procedure common to all RTBs and mainly published in 2021 in the special issue of the IJFST: Consumers have their say: assessing preferred quality traits of roots, tubers and cooking bananas, and implications for breeding https://ifst.onlinelibrary.wiley.com/toc/13652621/2021/56/3.

The main objectives of the study were to:

i) dissect the individual processing steps involved in different RTB food products;

ii) evaluate effects of genetic differences among varieties on processor workload, particularly comparing improved and traditional varieties; and

iii) guide breeders by highlighting the traits responsible for varietal differences in required labour inputs, which in turn influence acceptability of new varieties

The review, therefore, does not directly evaluate the level of drudgery experienced based on different genotypes, but rather examines the impact of varieties on productivity and the associated labour requirements in processing operations. Regardless of how an operation is perceived, a decrease in productivity or an increase in labour requirements can potentially contribute to the drudgery experienced by processors. Therefore, this review examined the influence of different varieties on the productivity of processors individually for various processing operations. The study measured processing operator productivity by the amount of mass produced per unit of time per operator within each operation. Additionally, as a secondary measure related to productivity, we evaluated the weights of products that processors had to transport between operations. This assessment served as an indicator, albeit productivity-related, to quantify the labour involved in processing different varieties.

Key findings

This study shows a strong genetic influence on processing yield, operators' efficiency, workload, and fatigue of RTB processors (mainly women, young children, and elderly). Processing yield depends not only on varieties but also on the level of complexity of the processes. Indeed, low processing yields are the result of complicated operations with many steps to reduce water content, enhance the shelf-life of products and, in the case of cassava, detoxify it if necessary. Thus, more complex processes tend to increase the likelihood of perceived drudgery, reduce global processing yields but, on the other hand, lengthen the shelf life of food products. In that sense, complexity, and concomitantly some degree of drudgery, is the trade-off for increasing the shelf life of the end-product coming from the same raw material.

Reduced processing yields do not only have a direct negative economic impact on the value addition, but also have an indirect (but strongly-correlated) effect on the accumulated weight carried through the process. By combining all the datasets for the different food product profiles, Figure 3 illustrates the clear association between weights carried out and processing yields.

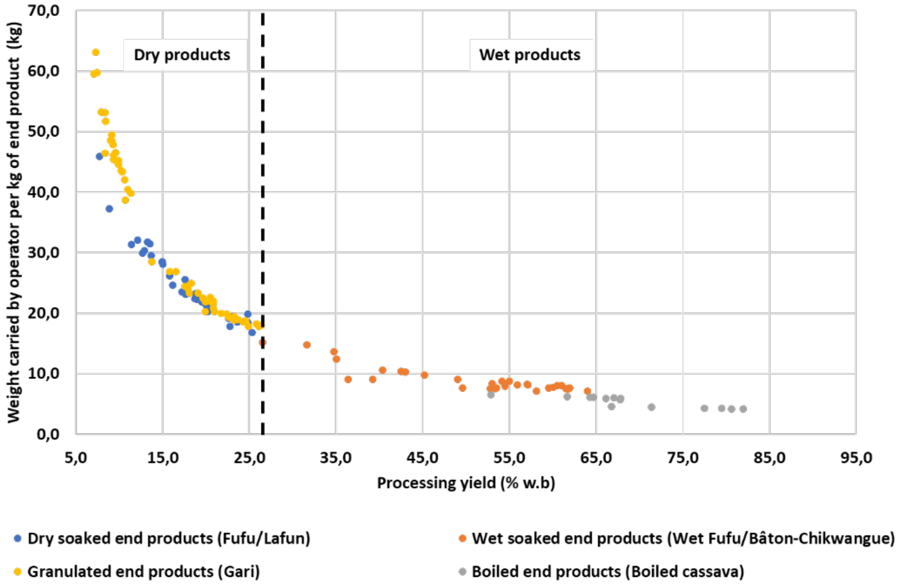

Figure 3 Weight (kg) carried out by operator per kg of end product according processing yield (% w.b). Based on Gari CIRAD/UAC-FSA, Gari IITA, Dry fufu CIRAD/UAC-FSA, Dry fufu CIRAD/IITA, Bâton CIRAD/IITA, Wet Fufu IITA and Boiled cassava UAC/FSA data.

Furthermore, this review addressed a clear gender dimension as processing work is often dominated by women because of existing norms that often push women into monotonous and drudgery-related tasks. As social impact through social and gender inclusiveness is a particular intended outcome by RTB breeding, and part of the sustainable development goals, increasing productivity and limiting perceived drudgery in RTB processing, is therefore crucial within the empowerment of women from below. Gender transformative approaches that aim to change gender roles are important but often slow to work. Also, they do not always address concrete working conditions, or livelihoods and their contexts (including the existing norms) upon which women are largely dependent to make a living and increase their income and independence.

A special effort should be made by RTB breeders to evaluate the yields of the final product and this can influence fatigue levels associated with new genotypes. This is particularly necessary for the more complex processed products, especially those from cassava, because of the additional need to detoxify them, reduce weight of the marketable product by removing water and the need to increase shelf life. Moreover, addressing labour requirements and associated drudgery related to processing is not enough because breeders must also consider consumer preferences as well. There is a large diversity of requirements for granulated and soaked products on the one hand, and paste and dough products such as pounded yam and matooke, on the other. All these products are obtained after complex processing steps.

The processing efficiency or productivity that determines the amount of labour required from processors and the related drudgery are key factors for varietal adoption. The processors, who are often the decisionmakers for purchasing raw materials, strongly contribute to creating a market segment for new genotypes or to their rejection depending on the difficulty of processing and/or the food product yields obtained. The views of consumers, traders and growers have already been incorporated into the definition of breeding goals. This review highlights, however, the critical importance of processors in the final varietal adoption. Their perception of each genotype provides relevant information that must be integrated upstream in the breeding pipeline to increase the chances of success of new varieties. *

***Bouniol, A., Ceballos, H., Bello A., Teeken B., Olaosebikan, D.O., Owoade, D., Afolabi, A., Fotso Kuate, A., Madu, T., Okoye, B., Ofoeze, M., Nwafor, S., Onyemauwa, N., Adinsi, L., Fliedel, G., Forsythe, L. and Dufour, D.** (2023). Varietal impact on women's labour, workload, and related drudgery in processing root, tuber, and banana crops. Focus on cassava in sub-Saharan Africa. *J Sci Food Agric.* Accepted Author Manuscript.

2.2.2 Consumption: color, texture, taste, aroma

The objective of assessment of acceptability thresholds for the main quality traits is to enable sensory qualities to be considered earlier in the assessment of new clones in the breeding pipeline.

The methodology for evaluating acceptability thresholds was presented in 2 workshops, one during the RTBfoods Annual Meeting (April 2021) and one during the AfricaYam / RTBfoods workshop on Yam Quality evaluation in Benin (November 2021), and an RTBfoods Webinar.

The principle is to assess acceptability thresholds by linking intensity of sensory attributes (Quantitative Descriptive Analysis (QDA), biophysical parameters) to their “satisfaction” level (JAR test). The CIRAD Sensory team made aware the RTBfoods project partners of the conditions and constraints to be respected with regards to sampling and sample preparation, in order to identify acceptability thresholds.

This methodology was used to identify acceptability thresholds for the main sensory attributes in boiled yam (easy to break, crumbly and sweet taste) and for hardness in boiled sweetpotato (Figure 4).

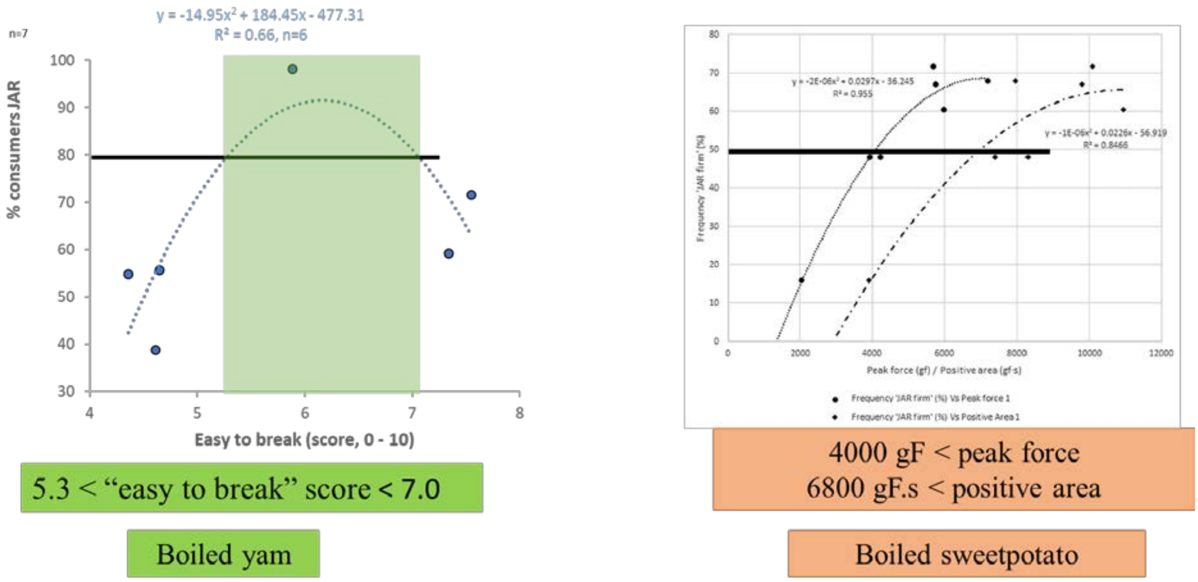

Figure 4 *Acceptability thresholds identified for easy-to-break in boiled yam (UAC-FSA) and peak force in boiled sweetpotato (CIP)*

These thresholds are calculated on the basis of a percentage of satisfied consumers. This percentage is chosen arbitrarily by the team in charge of evaluating these thresholds. A high percentage (80% for 'easy-to-break' in boiled yam) will make it possible to tend towards the thresholds of the ideal product but with the risk of being too restrictive and of not identifying promising clones. Conversely, too low a percentage (less than 60%) of satisfied consumers can lead to the selection of too many "just acceptable" clones. For crumbly and sweet taste, the product is assessed beyond an intensity with no maximum threshold.

Firmness / hardness was the main sensory attribute, for which acceptability threshold has been calculated on different products (boiled yam, sweetpotato, and plantain).

In the case of boiled cassava, thresholds of acceptability of Hardness and Mealiness were defined based on a NaCRRI (Uganda) study of consumer preferences (liking scores instead of JAR) (Figure 5 b). Liking scores collected by NaCRRI (Uganda) correlated well with QDA scores collected by both NaCRRI and CIAT (Colombia), with consumers preferring mealy and less hard samples (Figure 5 a; R^2 = 0.80 and 0.70, respectively).

The linear regression equations between liking scores and QDA scores were as follows:

Mealiness liking = 0.73 x Mealiness QDA + 2.30

Hardness liking = -0.73 x Hardness QDA + 9.90

We defined thresholds of acceptability as 'the mean of the minimum and maximum scores used by consumers'.

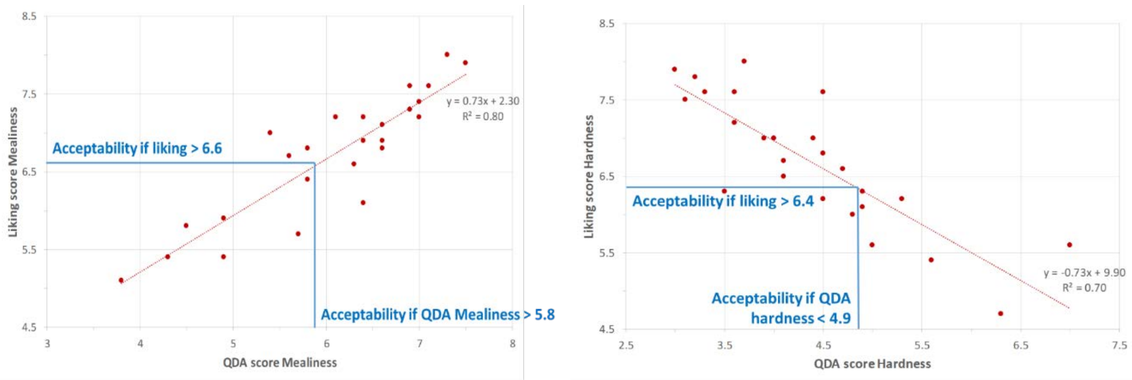

Figure 5 a) Linear regression between Liking score (NaCRRI) and QDA score (CIAT) of boiled cassava, in the case of hardness and mealiness sensory attributes. Thresholds of acceptability are shown in blue.

Figure 5 b) Translation of overall liking scores for Mealiness and Hardness into sensory and instrumental thresholds of acceptability

	Mealiness	**Hardness**
Minimum overall liking score used by consumers	5.1	4.7
Maximum overall liking score used by consumers	8	8
Range of overall liking scores	2.9	3.3
Threshold of acceptability at 50% of the range of liking scores	≥ 6.6	≤ 6.4
Threshold of acceptability in terms of QDA scores	≥ 5.8	≤ 4.9
Threshold of acceptability in terms of WA30 (%)	≥ 36	-
Threshold of acceptability in terms of Gradient (g/mm)	≤ 302	≤ 794

Using the linear regression equations above, the corresponding ranges of acceptability on the QDA scale were 5.8 to 10 for Mealiness, and 0 to 4.9 for Hardness (figure 5).

Among the 15 cassava genotypes analyzed by QDA in Colombia, two met the thresholds of acceptability for mealiness and hardness (COL1516, VEN77) and two nearly met them (CR63, PER368), based on the average QDA scores over the three 2022 harvests (9, 10 and 12 months after planting (MAP)). Younger plants tended to cook better than older ones, with 6, 5 and 0 genotypes meeting the two thresholds of acceptability at 9, 10 and 12 MAP respectively. Thus, under the growing conditions in Colombia, 9–11 MAP seems to be optimum harvest time for cooking quality, after which roots became less desirable. The main change was in mealiness, with all genotypes failing to meet the 5.8 acceptability threshold at 12 MAP, while some genotypes remained below the 4.9 threshold for hardness.

Success Story Box n°3: **Acceptability threshold determination.**

By completing sensory profiles (through Quantitative Descriptive Analysis (QDA)) of all RTB products, the RTBfoods project has met one of the stated challenges. SOPs and the mapping of sensory diversity are now available for all the thirteen products. It is now possible to extract sensory attributes, which are common between similar products (boiled structured, pasty, and other products) and on which to focus our attention, in terms of instrumental predictors research and SMART development: firmness/hardness, stickiness, color, smoothness, moldability and sweetness / sourness, fibrousness, moisture/mealiness, stretchability and bitterness. In order to integrate sensory traits earlier in the selection schemes, partners were sensibilized to assess acceptability thresholds for the main quality traits. Firmness / hardness was the main sensory attribute, for which acceptability threshold has been calculated on different products (boiled yam, sweetpotato, and plantain).

2.3 Linkages with EiB product profiles (MIPPI-WP2)

RTBfoods Gendered Target Food Product Profiles (GTFPP) for each commodity are now available. Deployment of the RTBfoods methods on the target RTB populations and strengthening of the collaborations of the breeding programs with quality analysis laboratories as well as consumer scientists will allow the identification of new promising genotypes.

The link between consumer perception with biophysical analyses and trained sensory panels characterizing color, texture, and sensory aspects (taste, aroma, mouthfeel) is crucial, including shelf-life studies. The approach allows producing the threshold values acceptable by consumers (acceptability threshold) and transforming this acceptability into laboratory measurement units (L, a, b for color; Newtons for hardness and stickiness; sugar content for sweetness, etc.).

For some traits, laboratory measurements are not available or only weakly correlated with the results of trained sensory panels. In this case, the evaluation scale of the panels will be used to establish thresholds of acceptability (aromas, texture in mouth, bitterness, post-harvest physiological deterioration ...).

Market Intelligence and product profile (MIPPI WP2) validates product profiles for the Accelerated Breeding initiative (ABI). The new traits related to quality and consumer perception need threshold values to be included in the product profile. These thresholds will be used to define selection indexes specific to consumer preferences.

We are working closely with MIPPI to produce these Product Profiles, including quality traits and their respective thresholds, to improve the breed adoption chances of new clones proposed for release.

Example: Boiled Yam Preferences and Thresholds determination:

Acceptance thresholds and deviation from optimum for boiled yam assessed through the instrumental measurements are promising tools for yam breeders.

Understanding sensory attributes through robust and objective instrumental parameters with clearly defined thresholds is critical for efficient (rapid and early) screening of germplasm to ensure the adoption of new varieties.

The study established robust relations between sensory attributes and biophysical/instrumental variables and to determine the acceptance thresholds and deviation from optimum for screening and selecting yam germplasm.

The results show for the first time that the acceptability thresholds for boiled yam have been determined and used for yam genotype screening. However, the values calculated for the thresholds present two situations.

- ✓ First, for the optimal product (80% of satisfied consumers), the ranges obtained for some biophysical parameters exclude each other, thus making impossible the simultaneous satisfaction of the relevant traits. This is the case for the penetration force associated with a crumbly texture and easiness to break or raw dry matter related to sweet taste and easiness to break.
- ✓ Second, at 60% of satisfied consumers, most thresholds widen and therefore expand the range of parameter variation. As a result, the number of yam varieties that pass through the screening is high. As a solution, using 'deviation (DI) from the ideal/optimum' on the overall liking scale is promising and helpful for selecting and ranking yam varieties that are close to optimal levels of overall liking simultaneously across a set of relevant traits. Consequently, the DI is highly appropriate to screen yam varieties.

The effect of harvest locations observed on the DI demonstrates that it is sensitive to growing environmental conditions. Breeders generally use several selection tools to allow ranking of top varieties. The use of DI, along with regression coefficients as weights in our study should give consistent results*.

***Adinsi, L., Djibri-Moussa, I., Honfozo, L., Bouniol, A., Meghar, K., Alamu, E.O., Adesokan, M., Arufe, S., Ofoeze, M., Okoye, B., Madu, T., Hotègni, F., Chijioke, U., Otegbayo, B., Dufour, D., Hounhouigan, J.D., Ceballos, H., Mestres, C. and Akissoé, N.H.** (2023), Characterizing quality traits of boiled yam: texture and taste for enhanced breeding efficiency and impact. *J Sci Food Agric.* https://doi.org/10.1002/jsfa.12589

3 SMART LABORATORY PROTOCOLS FOR QUALITY TRAIT EVALUATION

3.1 Deciphering the role of starch and parietal compounds in end-product quality

3.1.1 Processing/retting ability

Retting is a key step during cassava processing into widely-consumed foods (fufu, chikwangue, miondo, and bobolo) in SSA. Softening ability of roots during fermentation and textural attributes of cooked *fufu* are key quality traits for cassava that drive the adoption of new cassava varieties. Retting cassava is a complex process whereby soaking in water results in tissue breakdown, release of starch, and softening of the fermented roots. The rate at which different traits associated with it evolve during *fufu* processing varies considerably. There is no formal procedure to determine retting ability. Manual and instrumental methods were developed and employed to measure varieties' retting index (https://doi.org/10.18167/agritrop/00734; https://doi.org/10.18167/agritrop/00736) and textural attributes of *fufu* (https://doi.org/10.18167/agritrop/00612).

In Nigeria different protocols effectively characterized 135 cassava genotypes into distinct groups regarding retting ability and textural properties, respectively.

In Cameroon, eight cassava varieties contrasting in retting ability were used in this study. Roots and soaking water were sampled during retting and characterized at both histological and biochemical levels.

Histological data highlighted the degradation of root cell wall during retting. The average pH of soaking water decreased from 5.94 to 4.31, the average simple sugars from 0.18 to 0 g/l while the organic acids increased up to 5.61 g/l. In roots tissue, simple sugars and organic acid contents decreased from 2.29 to 0 g/100g and from 8 to 0 g/100g, respectively.

The total root pectin content among varieties at harvest was similar, and decreased during the retting process. Overall, there was a negative correlation between total pectin content and root softening, but not statistically significant.

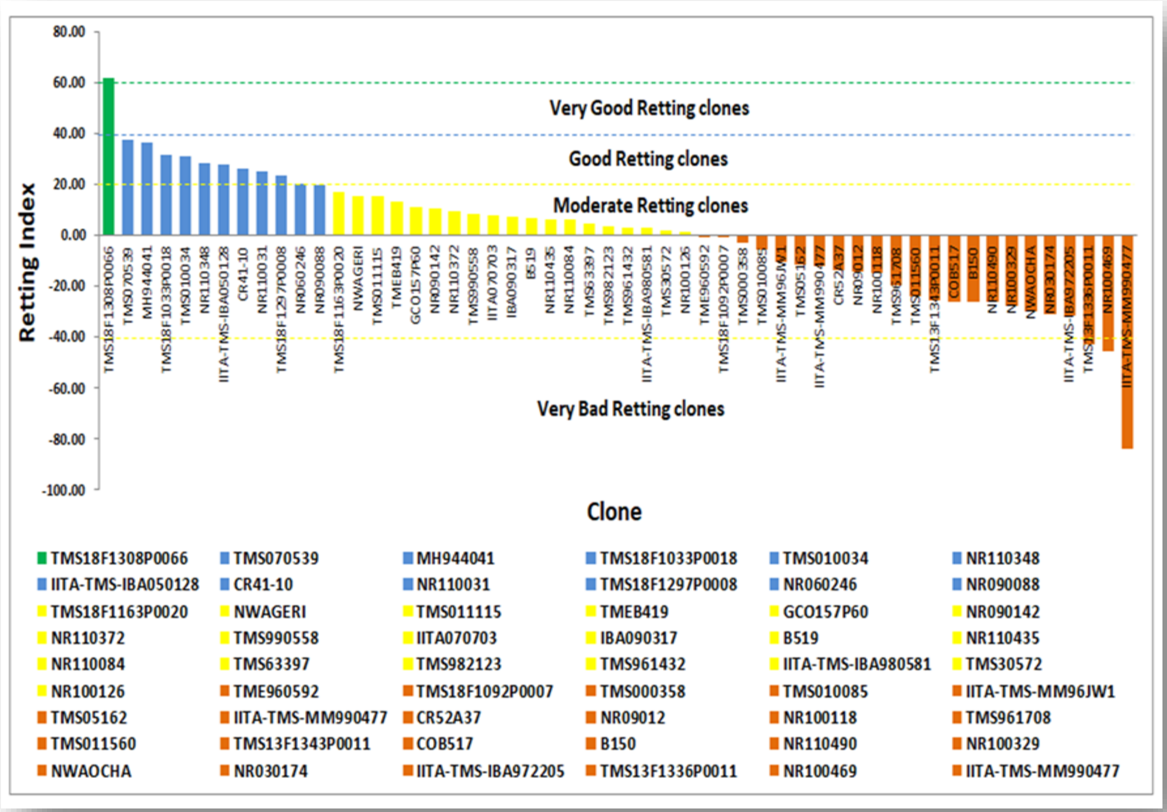

Figure 6 Classification of genotypes in Nigeria for different levels of retting traits (Slow, intermediate, and fast retting ability)

In Nigeria, there were significant genetic differences for most traits. Foaming ability and water clarity should be taken at 24 hours, and penetrometer, and hardness data at 48 hours. Turbidity, pH, and total titratable acidity provided better results even after 48 hours of retting. A handheld penetrometer could predict the retting ability of cassava roots. The stepwise regression analysis showed that the best multivariate model (highest R_2) for prediction of cassava retting involved pH-value, foaming ability, and dry matter content. The predictors were used to develop a retting index to assess retting ability.

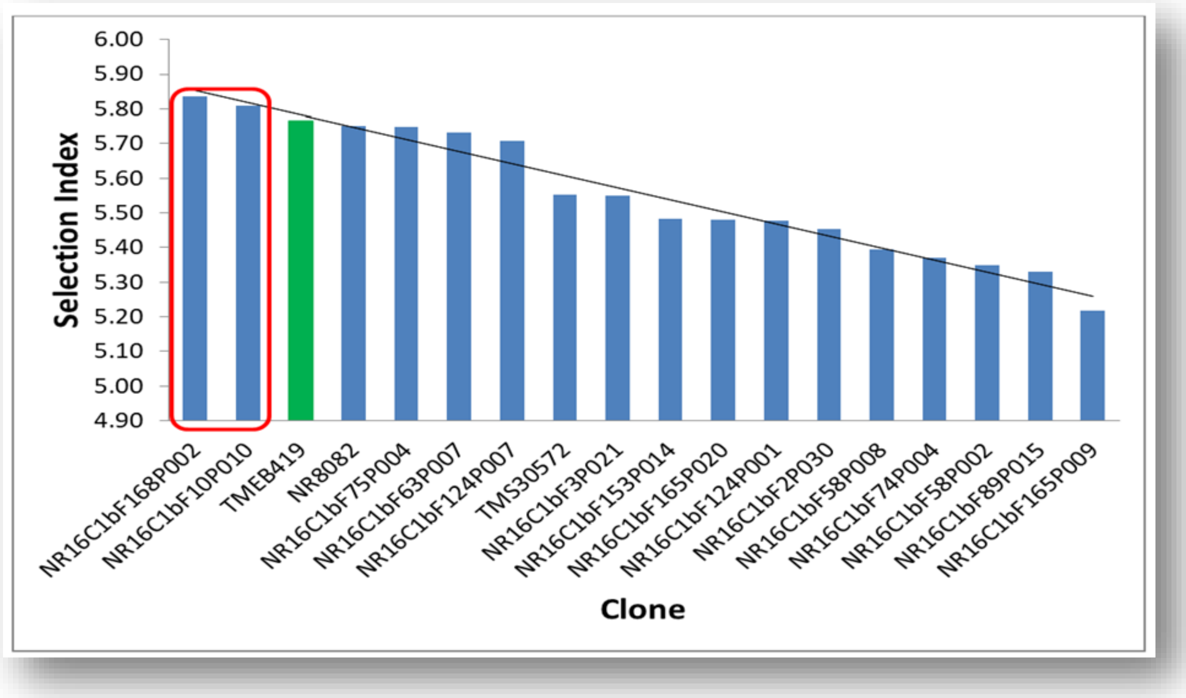

Figure 7 Mainstreaming retting selection index traits into the breeding pipeline

Significant relationships were observed between the retting index, biophysical parameters and fufu yield of different genotypes. Significant correlations were also found between instrumental cohesiveness and sensory smoothness (r = -0.75), moldability (r = -0.62), and stretchability (r = 0.78). Instrumental cohesiveness can correctly estimate *fufu* smoothness (R2 = 0.56, P = 0.008) and stretchability (R2 = 0.60, P = 0.005). Although several mid- and high-throughput protocols can serve as selection tools for key consumer *fufu* quality traits, the regression of pH value, foaming ability and the dry matter content gives a better discrimination among the genotypes. Major histological and biochemical changes occurred during cassava root retting, some of them associated with the process. Retting affected starch pasting properties more than starch content. Although this process is characterized by root softening and degradation of cell wall structure, our study strongly suggested that pectin is not the only cell-wall component involved in these changes. This still needs demonstrating across a larger number of genotypes.

3.1.2 Cooking ability/softening/mealiness

Consumer preferences for boiled or fried pieces of RTB foodstuffs are mainly related to their texture. Different raw and cooked RTBs were physiochemically characterized to determine the effect of biochemical components on their cooking properties. A number of biochemical analysis methods and proofs of concept have been developed to gain a better understanding of the physicochemical mechanisms at work during RTB cooking (Tables 8 & 9) Table 8 Standard Operating Procedures developed for Biophysical & Biochemical characterization of RTB crops and Table 9 Biophysical & Biochemical Proofs of Concepts to decipher the role of starch and parietal compounds in end-product quality,

Biochemical proof-of-concept studies to elucidate the molecular mechanisms underpinning the sensory and textural quality of RTB products focused mainly on pectins and cell walls (CIRAD, JHI, INRAe, CIAT). A medium-throughput manual or automated chemical colorimetric procedure (20 or 50 samples/day, respectively) for assessing total pectin content and branched pectins was developed, as well as a procedure to extract cell walls from yam, plantain and sweetpotato. Concerning the role of pectins, contradictory results were obtained, and studies will be further developed in period 5:

- ✓ **Total pectin content,** evaluated as total galacturonic acid content of fresh yam and fresh cassava, was significantly and positively correlated with texture (hardness) of steamed yam and steamed cassava (seven genotypes). In addition, the softening during yam cooking also appeared linked to pectin degradation. However total pectin content was not a good predictor of steamed yam and sweetpotato cooking times,

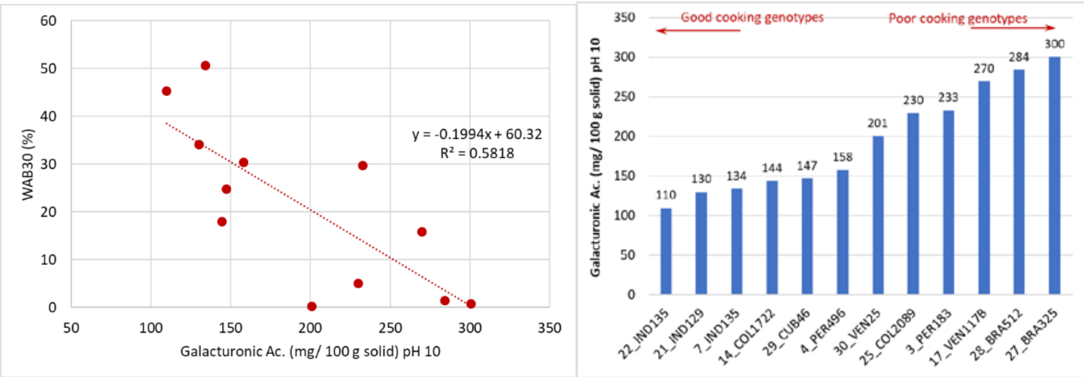

Figure 8 Cassava cooking quality in relation to water absorption at 30 min and pectin content evaluated as galacturonic acid content (pH10 extraction).

- ✓ **Degree of methylation** appeared negatively correlated with cooking time of steamed yam, and with firmness of cooked plantain, but not in the raw material, suggesting a putative action of pectin-methylesterase (PME) during the cooking process.

Furthermore, in green vegetables, pectins are known to complex with calcium ions (Ca^{2+}) to form a sample-wide network that strengthens texture and reduces water absorption. Experiments of boiling cassava in water in presence of Ca^{2+} demonstrated that same effect, with water absorption decreasing with increasing Ca^{2+} concentration up to 4 g/L, thus further confirming that pectins play a key role in determining cooking quality. In addition, mouldability of pounded ywas negatively correlated with yam ash content which may also be linked to the interaction of pectins with cations. The role of other components of RTB was also investigated:

- ✓ **Starch content and dry matter** content had no direct effect on the cooking quality (texture, water absorption) of boiled cassava, but may play a role in determining texture. On the contrary, dry matter of raw sweetpotato played a key role in determining the texture of boiled sweetpotato, as evidenced by significant correlations with sensory firmness (r = 0.500) and mealiness (r = 0.717), Amylose content was negatively correlated with the firmness of boiled yam
- ✓ As hypothesized and already observed with previous experiments, **cyanogenic compounds** content was highly significantly correlated with bitterness.
- ✓ The evaluation of the role of **polyphenols** on the color of RTB products and their interaction with texture has just begun, and will continue in the next phase of the project.

3.2 SOPs for trait measurement: color, texture (boiled & dough/paste products), taste

Implementation of the RTBfoods project brought together food scientist teams from various universities and research organizations in Africa, Europe, and Latin America. A first key achievement was the establishment of standard operating protocols (SOPs) common to RTBfoods partners, enabling the production of post-harvest quality phenotyping data of similar scientific quality, and under similar database format.

The majority of activities consisted in collecting datasets of sensory, biophysical, and functional characterizations of the 11 RTB product profiles included in RTBfoods. These datasets demonstrated the range of phenotypic diversity among RTB crops in terms of postharvest quality traits, and the importance of screening for such traits. Moreover, genotypes with particularly desirable quality traits were identified for the 13 product profiles and selected as potential progenitors for breeding. Correlations were identified between instrumental measurements, e.g., texturometer or water absorption, and sensory attributes, e.g., hardness, mealiness, stretchability, etc. These confirm that instrumental measurements are relevant to describe sensory perception of RTB products, and can be used for medium-throughput phenotyping of RTB quality traits.

3.2.1 Color measurement

The color of the ready-to-eat end-product is a criterion intrinsically linked to consumer preferences. This color is linked to the biochemical compounds present in the different RTB genotypes (carotenoids, anthocyanins, …). The brightness and greyness of the raw and ready-to-eat product have a major influence on its acceptability, and indirectly on the varietal adoption of RTB genotypes. Chlorogenic acid and Polyphenol oxidase (PPO), are largely responsible for enzymatic browning and after-cooking darkening during storage. Different SOPs has been developed by the partners for color analysis (Chromameter, DigiEyes, Image analysis, even NIRS). The methods reported in Table 10 are used routinely for population screening on raw RTBs and finished ready-to-eat products. Table 10 Standard Operating Procedures developed for Color characterization of RTB crops.

Success Story Box n°4: The use of image analysis in CNRA to characterize the color of RTB products in Côte d'Ivoire.

The characterization of color is an essential criterion for the majority of RTB product profiles. The heterogeneity of the color and the rough aspect of the studied surfaces make the use of the chromameter difficult. This is why CIRAD has developed a method for monitoring color and oxidation by image analysis. In order to appropriate this method, CNRA participated in the AfricaYam / RTBfoods Training on Yam Quality Evaluation from 22 to 26 November 2021. At the same time, a CNRA researcher was hosted at CIRAD Montpellier from September 15 to November 15, 2021, in order to learn about the various phenotyping techniques. This stay allowed reviewing the different steps of the method described in the 3 SOPs. After this visit, CNRA Bouaké built a photo studio equipped for image acquisition and created its own custom reference color chart. At the beginning of 2022, the first series of images was acquired by the CNRA on the yam collections of Bouake. A support mission from CIRAD in June 2022 made it possible to work on these images and to improve their acquisition method. A technician was dedicated to this specific task. CNRA Bouake is now operational for characterizing the color of the various RTB products! https://doi.org/10.18167/agritrop/00672

3.2.2 Textural evaluation of cooked products

The adoption of RTB genotypes relies on the interplay among agronomic traits, ease of processing and consumer preference. In breeding RTBs, until recently, little attention was paid to key textural traits preferred by consumers. Moreover, a lack of standardized discriminant and repeatable protocols, able to measure these textural traits, has constrained developing pragmatic linkages between breeding better RTB genotypes and end-use/consumer preferences.

Product texture i.e., behavior under unique deformations, such as disintegration and the flow of a food under force - is one of the most critical components of these preferences. Textural characterization of RTBs using standard operating procedures (SOPs) is important in ensuring the regularization of texture measurement conditions, predictability of RTBs' textural quality, and ultimately definition of RTB food product profiles (FPPs). Table 11 Standard Operating Procedures developed for Textural characterization of RTB food products. It is important to develop standardized protocols that can be used by breeders and food scientists as medium-throughput tools to study the texture diversity of RTB genotypes. This should provide means of identifying which genotypes are associated with key discriminant textural attributes and which textural protocols will enhance rapid discrimination of those promising genotypes that will lead to development of breeds that will be preferred by consumers.

The texture of the various products could be analyzed by unique or a range of instrumental protocols that provide information on the suitability of the protocol vis-à-vis reproducibility of measurements, discriminability and relatability with sensory assessment and consumer preferences.

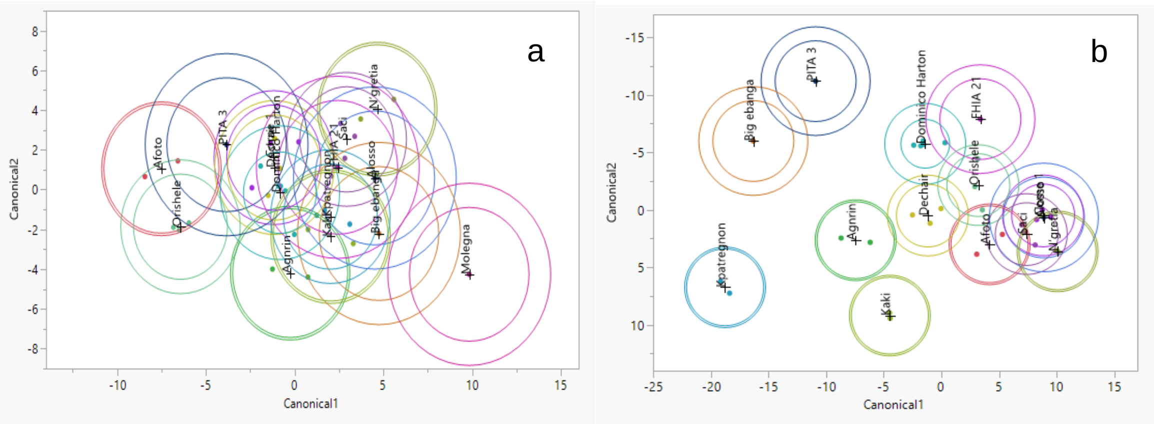

Figure 9 Example of canonical analysis showing discrimination between texture of cooked banana from 16 cooking and dessert banana genotypes by TPA (a) and penetration (b).

Global outlook on RTB food product texture: hardness as an exemplary attribute

To categorize the global RTB food product instrumental texture data, discriminant and partitioning analyses were carried out considering the hardness attribute as response, while product profile, crop, and texture protocol were regarded as categories. Hardness was selected because all the textural protocols measure hardness/max force, it is a common key discriminant attribute for RTB food products, and it correlates with most sensory attributes. Partitioning was conducted on 675 hardness values across the categories until the optimum number of splits that produced the highest explained variation (R^2) was reached. Discriminant analysis showed that hardness of boiled cassava is discriminant from other food products. Hardness of boiled yam, boiled plantain, and pounded yam are closely related, but are also slightly discriminant from boiled sweetpotato. On the other hand, the hardness of fufu, eba, matooke, fried sweetpotato and boiled potato are not discriminant.

With regard to the textural protocols, the extrusion protocol records more highly discriminant hardness values compared to hardness of other protocols (TPA, penetration and extensibility, probably due to the higher load resistance to deformation caused by the extruder blade.

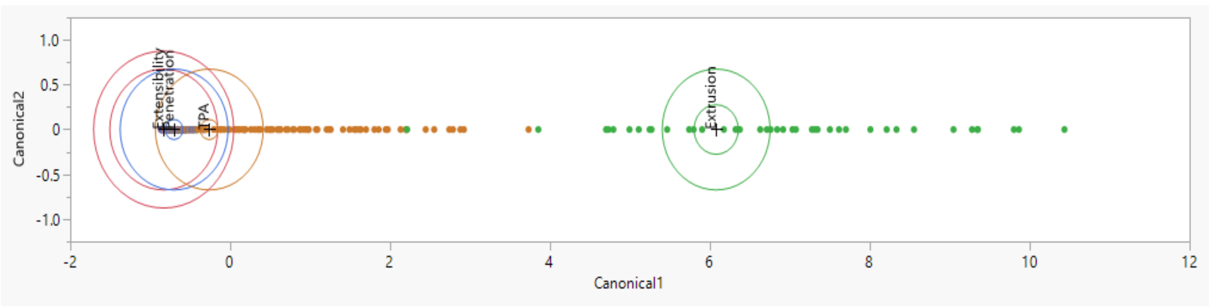

Figure 10 Discriminant analysis of hardness texture of RTBs by textural protocol

Based on the RTB crops considered, cassava seems quite discriminant in hardness from other crops. Yam and plantain are closely related in hardness, just as potato, sweetpotato and banana are also closely related in hardness.

There is no doubt that encouraging the inclusion of texture as inheritable traits into breeding pipelines for RTB programs will play a significant role in improving adoption of new breeds that will be appreciated by consumers.

3.2.3 Sensory evaluation of ready-to-eat RTB products

The assessment of user acceptability in relation to crop quality traits should be a full part of breeding selection programs. Our methodology is based on a combination of sensory approaches aiming to evaluate the sensory characteristics and user acceptability of root, tuber, and banana (RTB) varieties.

The four-stepped approach links sensory characteristics to physicochemical properties and end-user acceptance. It starts with the development of key quality traits using qualitative approaches (surveys and ranking) and it applies a range of sensory tests such as Quantitative Descriptive Analysis with a trained panel, Check-All-That-apply, nine-point hedonic scale and Just-About-Right with consumers. Results obtained on the same samples from the consumer acceptance, sensory testing and physicochemical testing are combined to explore correlations and develop acceptability thresholds.

More information in: **Béchoff A., Adinsi L., Ngoh Newilah G., Nakitto M., Deuscher Z., Saali R., Chijioke U., Khakasa E., Nowakunda K., Bouniol A., Dufour D., Bugaud C.** (2023). Combined use of sensory methods for the selection of root, tuber, and banana varieties acceptable to end-users. *J Sci Food Agric.* Early view. https://doi.org/10.1002/jsfa.12723

Step 1: Identification of the key quality traits (KQTs).

This is achieved through qualitative surveys with different stakeholders of the crop value chain, on RTB products that have contrasting sensory properties, aiming to develop a lexicon. Triangulation of results from the different surveys is carried out to select KQTs that drive end-user preferences.

Step 2: Assessment of the sensory profile, consumer acceptance, and physicochemical properties of various RTB products.

Numerous RTB products derived from highly-contrasting clones (in terms of sensory properties), including new hybrids from breeding programs and common/local landraces, are characterized using KQTs from Step 1. Sensory testing is conducted on the ready-to-eat RTB products using QDA with a trained panel. Consumer testing is performed on the same prepared products using hedonic testing (i.e., nine-point hedonic scale and JAR) or a triadic comparison of technologies (TRICOT)[1] with consumers recruited *ad hoc*. Physicochemical (biophysical and biochemical) properties are measured on raw material and/or ready-to-eat products using laboratory methods. To develop meaningful correlations (translatable to measurable criteria that could be used by breeders), it is critical to ensure that the same samples are tested by the sensory panel, consumers, and physicochemical means. All tests should be on edible (processed) products. However, some instrumental analyses (e.g., DMC, sugars, and starch) and visual observations (e.g., color, absence of pests and diseases) can additionally be carried out on raw materials because these could generate more discriminating indicators and eliminate time allocated to product processing. In addition, high throughput methods such as near-infrared spectroscopy (NIRS) and hyperspectral imaging have been applied to develop correlations with physicochemical characteristics of RTB products (e.g., for DMC, pectin, starch, and texture).

[1] See https://cgspace.cgiar.org/handle/10568/109942 for explanation of this approach

Step 3: Establishing correlations between sensory, consumer and instrumental measurements to determine thresholds.

Once all the data are collected, relationships between the sensory profile, consumer acceptance, and instrumental properties are explored. Non-linear (e.g., bell-shaped curve) or linear relationships could be obtained, and acceptability thresholds linked to sensory and instrumental measurements can be obtained.

Step 4: Validation and scaling up of the method.

The thresholds defined in Step 3 are then used to screen new RTB clones using instrumental measurements (if sensory traits can be predicted by physicochemical parameters) or a trained panel (for sensory traits that are not easily predicted by instrumental measurements, such as aroma). The clones that are above the acceptability thresholds are then validated using consumer testing (Overall Liking or JAR).

To generalize the findings, the consumer tests should be performed in different regions or countries and new hybrids compared to local and preferred landraces.

The steps of the approach are summarized in Figure 11. In theory, the methodology is a linear approach from Steps 1 to 4. However, in practice, it is often a feedback loop process. Although steady forward progress is most desirable, sometimes there may be a need to go back a step to improve data collected earlier.

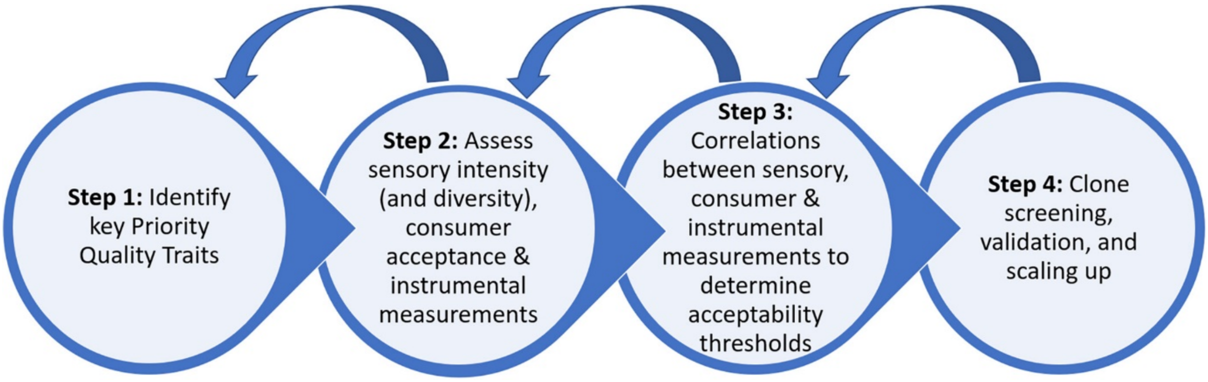

Figure 11 Workflow summarizing the RTB approach for sensory methods.

A combined qualitative and quantitative approach involving different sensory techniques is necessary to capture sensory acceptance of products from new RTB clones. Some sensory traits can be correlated with physicochemical characteristics and could be evaluated using laboratory instruments (e.g., texture). Other traits (e.g., aroma and mealiness) are more difficult to predict, and the use of a sensory panel is still necessary. For these latter traits, more advanced physicochemical methods that could accelerate the breeding selection through high-throughput phenotyping are still to be developed.

The various SOPs and training courses relating to the sensory evaluations of the different RTBs are reported in tables 12 & 13.

See Table 12 Standard Operating Procedures developed for Sensory characterization of RTB food products.

See Table 13 Tutorials developed for Sensory characterization of RTB food products.

3.3 SOPs for trait prediction: SOPs & calibrations (NIRS, HSI, imaging)

The RTBfoods chemometrics team consists of researchers from different institutes (CIAT, CIP, CIRAD, IITA, INRAe, NACRRI, NARL, and NRCRI) in seven countries (Colombia, France, Ghana, Guadeloupe, Nigeria, Peru, and Uganda). The aim of the team is to develop high-throughput phenotyping protocols (mainly near-infrared spectroscopy (NIRS) but also hyperspectral imaging (HSI) that can be applied in national and international breeding programs, postharvest processing, and quality control procedures. The team has been set up to deliver a remarkable contribution to the following outputs: Output 5: “Standardized ontology established for major quality traits and spectral databases developed for food quality traits”, Output 6: “Screening capacity for users’ preferred quality traits developed in key countries” and Output 7: “Operational HTP (or MTP) protocols platform for screening users’ preferred quality traits developed”.

At the beginning of the project 14 NIR spectrometers were available and, except NARL in Uganda, each team owns a least one NIR spectrometer. Over the project period, 3 HTP tools were purchased: 2 hyperspectral cameras (CIRAD, France and IITA, Nigeria) and one benchtop NIRS (CIAT). In addition, the RTBfoods Project has co-funded 2 portable instruments (QualitySpec, ASD), one at CIAT with co-funding from NextGen and one at CIRAD AGAP with co-funding from CIRAD.

From the first year of the project, efforts have been made to train WP3 teams with training in vibrational spectrometry theory, multivariate data analysis, chemometrics, calibration and in the use of software (Winisi and Unscrambler). At the end of the project 14 training sessions were achieved; these sessions were either face-to-face or online (webinars and masterclass). More than 60 partners were thus able to obtain theoretical and practical support for the development of high-throughput phenotyping methods using vibrational spectroscopy.

During the project more than 22,660 spectra were acquired for banana (1,478), cassava (12,873), potato (3,152), sweetpotato (780), and yam (4,378). These acquisitions were made for different presentations of the roots and tubers: from fresh intact to dried flour, passing through fresh ground, or grated. Some of the acquisitions were done on processed products such as fufu, gari, boiled cassava and cooked sweetpotato. In fact, the number of spectra acquired is slightly lower than expected due to the COVID crisis which disrupted access to the fields during harvesting and sampling campaigns. To these spectral data are added images acquired by HSI, CCD digital camera, and the DigiEye system (VeriVide, Leicester, UK).

To carry out these measurements, operational procedures have been established and then standardized (SOP). These procedures have been written and made available online for all types of products and instruments used by RTBfoods researchers.

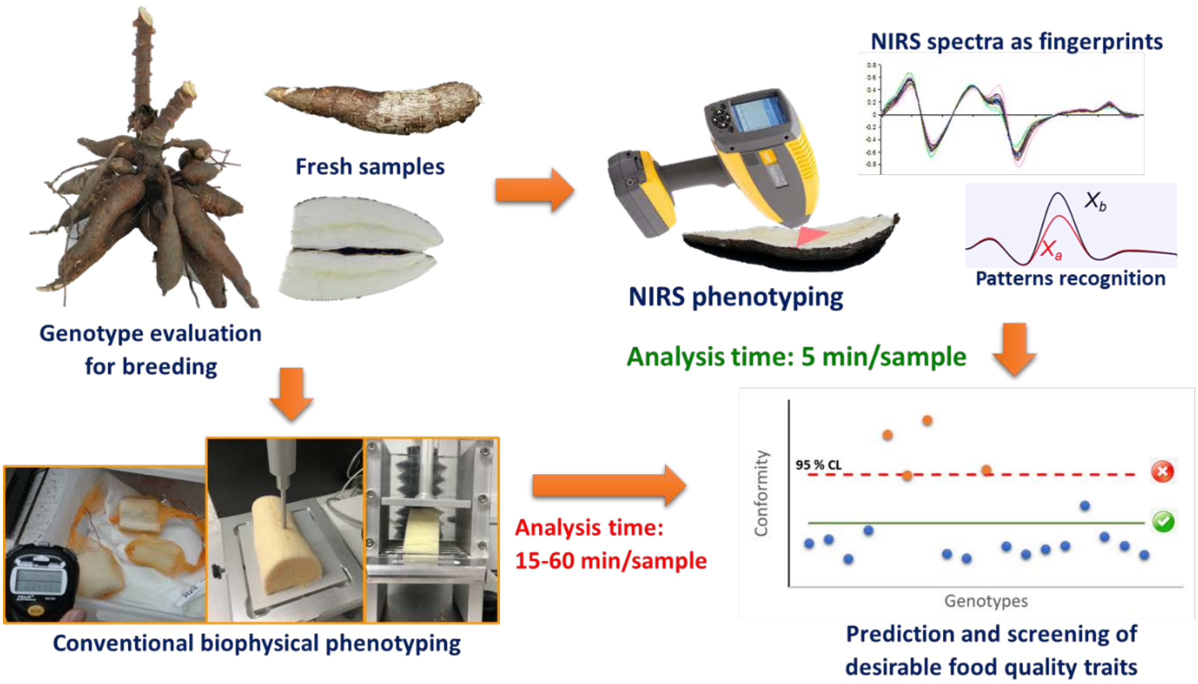

Figure 12 High-throughput phenotyping of roots & tubers using near-infrared spectroscopy (NIRS)

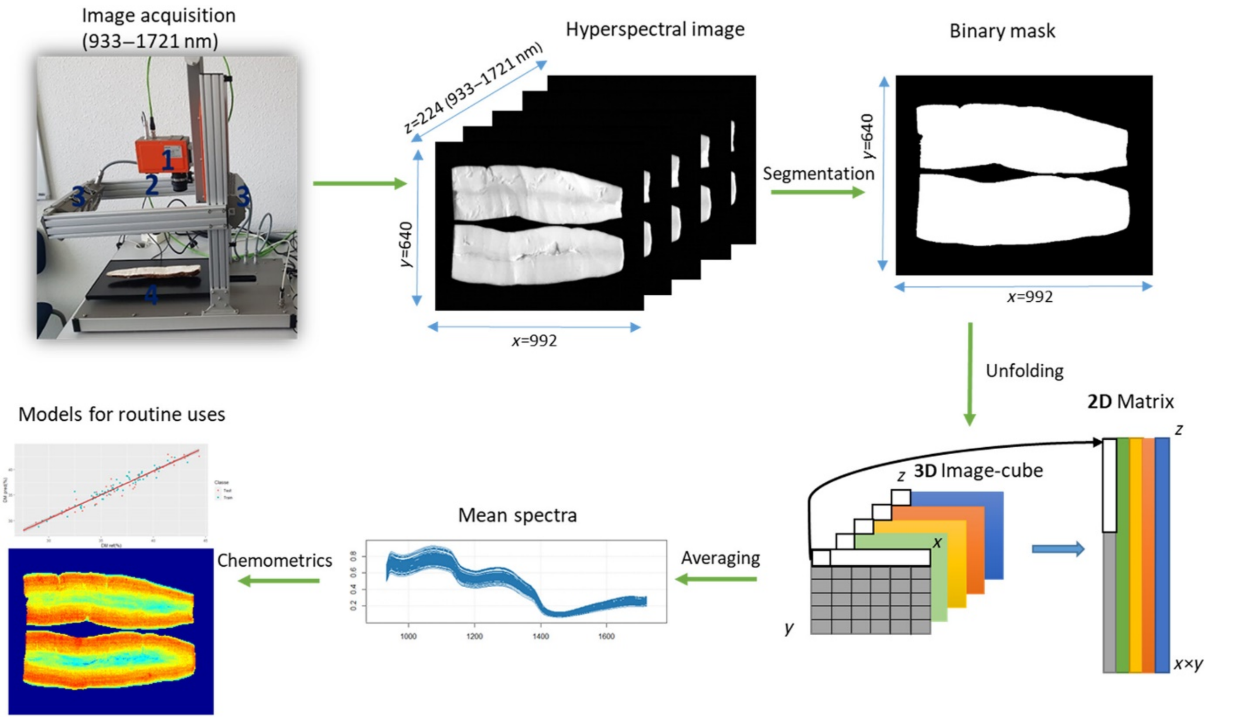

Figure 13 Flowchart of hyperspectral images processing from image acquisition to application of chemometrics methods.

In total 21 SOPs for 7 product profiles (boiled cassava, fufu, gari-eba, boiled potato, boiled sweetpotato, boiled yam and matooke) were developed. These SOPs concern NIRS, MIRS, imaging and HSI measurements using benchtops instruments (FOSS DS2500, FOSS XDS, camera SPECIM FX17 and DigiEye) and portable instruments (ASD QualitySpec and ASD LabSpec). See Table 14 Standard Operating Procedures for Mid and High-throughput measurements on RTB crops & products.

The spectral data, the physico-chemical and/or sensory data, as well as the information relating to the samples, are all recorded by institute/product/presentation in standardized files in ©Excel format. These files also contain the characteristics and performances of the calibrations when these are available. All databases are available on the RTBfoods dataverse repository (https://dataverse.cirad.fr/dataverse/rtbfoods#).

For this project seven institutes (CIAT, CIP, CIRAD, IITA, INRAe, NaCRRI and NRCRI) worked on 5 crops (banana, cassava, potato, sweetpotato, and yam) for 8 product profiles (boiled cassava, fufu, gari-eba, boiled potato, boiled sweetpotato, boiled yam, pounded yam and matooke). For output-7, they developed different calibrations for 51 quality traits using NIRS, MIRS, imaging and HSI. Calibrations were based on measurements done on 16 different presentations (boiled yam, cooked freeze-dried milled, cooked intact, cooked mashed, dried ground, eba, Fresh grated, fresh ground, fresh intact, fufu flour, milled gari, raw freeze-dried milled, raw intact, raw mashed, unmilled gari and wet mashed fufu).

See Table 15 Calibrations developed for medium- and high-throughput prediction of quality traits of RTB crops & products.

The main results confirm that spectral tools are perfectly suited for measuring biochemical parameters (DM, amylose, starch, protein, sugars...) when applied to homogeneous material, such as flour. However, calibrations developed from fresh material, just ground, or grated, present performances that are entirely compatible with an application to high-throughput phenotyping. As an example, the quantification of amylose content (expressed as % of starch) in fresh cassava samples developed by NaCRRI (Uganda) presents high performances with and R^2 of 0,94 and prediction error SEP = 1,02%.

But the studies done for direct characterization of roots and tubers texture using spectral fingerprint measured on fresh material have been inconclusive, whether on the basis of parameters quantified by physical measurements (texturometer) or by sensory evaluation (panel of tasters).

For this, approaches using image analysis (DigiEye, CCD digital camera) have shown that it is possible to link the image of a root or tuber section to texture parameters and color before and after transformation (cooking or pounding). So, CIRAD and INRAe (Guadeloupe) successfully applied, imaging (digital CCD camera) on fresh yam samples for characterizing yam discoloration. For this, they defined a browning index directly calculated from the extracted colors from the images. CIP in and COCIS (Makerere, University) in Uganda characterized sweetpotato color and mealiness using a panel of tasters, with promising results. To do this, the images (DigiEye) of roots (whole and/or cut) were associated with panel scores and effective models were developed for predicting the orange color intensity and level of mealiness-by-hand.

Figure 14 Visualization of the mealy or glassy aspect of some sweetpotato genotypes after cooking (DigiEyes, image processing)

Furthermore, applying hyperspectral imaging, which combines these two approaches: spectral and image, has demonstrated potential for characterizing the processing ability of tubers and roots. Indeed, the possibility of being able to map the spatial distribution of the different constituents in the root makes it possible to imagine calculating a homogeneity index which itself could be linked to an aptitude for transformation.

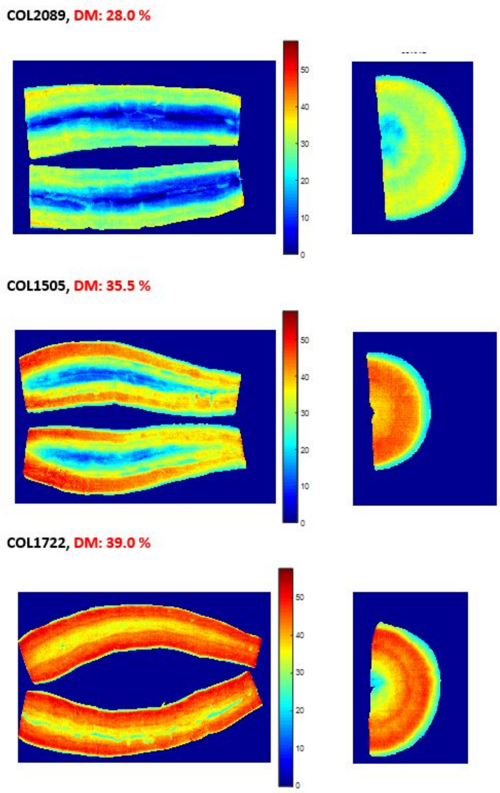

Figure 15 Visualization by hyperspectral imaging of water distribution in three 12 months Colombian cassava landrace genotypes (longitudinal and transversal section) *.

*More information in: **Meghar, K., Tran, T., Delgado, L.F., Ospina, M.A., Moreno, J.L., Luna, J., Londoño, L., Dufour, D. and Davrieux, F.** (2023), Hyperspectral imaging for the determination of relevant cooking quality traits of boiled cassava. *J Sci Food Agric.* Early view. https://doi.org/10.1002/jsfa.12654

Classification approaches based on spectral fingerprints and consumer-defined classes have demonstrated great potential for the selection of genotypes of interest. It was thus demonstrated in a joint CIAT-CIRAD (Colombia, France) study that the spectral fingerprint, taken from ground fresh cassava tubers, made it possible to correctly classify genotypes (classification rate in prediction = 81.4%) according to their ability to absorb water after 30 minutes of cooking. CIAT has demonstrated the strong relationship between cooking time and the ability to absorb water. https://agritrop.cirad.fr/603459/

Similarly, a study conducted by IITA (Nigeria) and CIRAD (France) demonstrated the interest of combining spectral analysis and deep learning tools (convolutional neural network) for the classification of yam genotypes, the classes (poor or good) being defined by the breeders according to the poundability. The validation gave classification rates of 91.7% validation.

The classification approach based on spectral, or image data should be pursued based on acceptability thresholds defined by consumers and formalized by WP2 researchers.

Success Story Box n°5: Convolutional neural network allows amylose content prediction in yam (Dioscorea alata L.) flour using near infrared spectroscopy

Yam (*Dioscorea alata L.*) is a key staple food in the intertropical zone where it is grown. The lack of phenotyping methods for tuber quality hinders the adoption of new genotypes from breeding programs. Recently, near infrared spectroscopy (NIRS) has been used as a reliable tool to characterize the chemical composition of yam tubers. However, it failed to predict amylose content, although this trait greatly influences product quality .

This study used NIRS to predict the amylose content from 186 yam flour samples. Two calibration methods were developed and validated on an independent dataset: Partial Least Square (PLS) and Convolutional Neural Network (CNN). To evaluate final model performances, the coefficient of determination (R2), the root means square error (RMSE), and the Ratio of Performance to Deviation (RPD) were calculated using predictions on an independent validation dataset. Tested models showed contrasting performances (i.e., R2 of 0.72 and 0.89, RMSE of 1.33 and 0.81, RPD of 2.13 and 3.49 respectively, for the PLS and the CNN model). According to the quality standard for NIRS model prediction used in food science, the PLS method has proved unsuccessful (RPD<3 and R2<0.8) for predicting amylose content from yam flour, while the CNN proved reliable and efficient method. With the application of the deep learning method, this study established the proof of concept that amylose content, a key driver of yam textural quality and acceptance, could be predicted accurately using NIRS as a high-throughput phenotyping method. https://doi.org/10.1002/jsfa.12825

This project has enabled teams of researchers in different institutes to develop the skills for autonomous use of vibrational spectroscopy, and the ability to integrate it into their own research and development projects. Moreover, several collaborations between the teams were initiated during the project and have become sustainable. The collaboration between the IITA and the NRCRI in Nigeria, with scientific support, sharing of SOPs, reception of researchers and the provision of spectrometers is a good example. Like, the collaboration between NaCRRI, IITA and CIP in Uganda which has resulted in jointly-developed SOPs, shared resources, and sustainable scientific and technical support. Just as the joint calibration development between CIAT and CIRAD was a success.

4 POPULATION SCREENING & GENETICS

4.1 Genotype extraction & Promotion of released varieties assessed for end-user quality traits

The RTBfoods team achieved significant progress in evaluating new genotypes for suitability to RTB users needs and preferences. These genotypes were evaluated by combining desirable agronomic and food-product quality traits, and having high adoption potential by breeders.

The primary objective was to evaluate clones/genotypes developed by breeders that were identified as having high potential by combining both agronomic and food-product-related quality traits as expected by users in the value chain. Thus, for each of the product profiles studied, the study allowed a complete and multi-level evaluation of these new genotypes in comparison with local reference varieties.

The second objective of this genotype extraction team is more implicit, since it enables the validation of the overall approach proposed by the project. In order to carry out these evaluations, the team had to integrate many results obtained in the different work packages. Food-product quality traits identified for each PP have been prioritized for evaluation. New clones/genotypes were evaluated with value-chain actors under real conditions. The protocols and SOPs developed were simultaneously applied and tested using the very same roots and food samples. This evaluation allowed breeders to verify the suitability of their proposed clones and further select those that would meet the characteristics expected by the users. The team has initiated the deepening of these by applying several existing and newly developed tools. The method is based on Pairwise Ranking of roots and foods, consumer testing, quantitative descriptive analysis (QDA), instrumental measurements at laboratory level, and statistical analysis based on a methodological guidance to evaluate processing ability and food product quality to increase acceptability of new RTB genotypes; https://doi.org/10.18167/agritrop/00584. Acceptability thresholds for each particular quality traits were defined. These promising results, which could also be enriched by additional data, will allow breeders to access rapid feedback (through lab-level analysis) on the intrinsic qualities of the selected clones with respect to consumer expectations regarding food-product quality and processibility. It should also be noted that interesting new important criteria (other than quality) were also identified through processing diagnostics evaluation with processors. Processing productivity and related drudgery levels have been found to be clone/genotype dependent, and the extent to which this is so demands further investigation and monitoring within breeding programs.

Agronomic evaluation of promising cassava, yam, matooke, plantain and sweetpotato genotypes in various locations has enabled identifying clones with good agronomic performance and high or partial resistance to pests and diseases. The implication of champion processors during participatory processing evaluation within their communities significantly contributed to selecting suitable clones for specific food products according to priority key traits defined and preferred by processors. Consumer testing intermediate and final food products using either conventional methods (JAR, CATA, etc.) or the TRICOT approach also enabled identifying clones preferred by consumers.

The new clones/genotypes for each food product have been verified by collaboration of 9 partner institutions including CARBAP, CNRA, CIRAD, IITA, NaCRRI, NARL, UAC-FSA, CIP and NRCRI. Evaluation reports of the suitability of new genotypes to RTB users' needs and preferences are shared in Table 16 Suitability of new genotypes to RTB users' needs & preferences.

For **boiled cassava** (and flour paste), newly-released clone UG120193 performed outstandingly from planting to final food-product qualities, including good agronomic characteristics, ease of peeling, good root taste, mealiness, softness, low root fiber (for boiling), good paste texture, low paste stickiness, and good white paste color (for flour paste). Data evaluation by NRCRI (Nigeria) pinpointed the clones: TMBE419, TMS13F1053P0010, NR15C1aF9P002, and NR15C1aF68P007 as excellent candidates for Fufu by good performance in smoothness, low stickiness and stretchability compared to local varieties. The new cassava clones: TMBE419, TMS13P0010, NR15C1aFP002, NR15C1aF9P002 and TMEB419 exhibited good performance on **gari-eba's** texture and color. Evaluation by IITA (Nigeria) indicated that the cassava clones TMS13F1160P0004 (Game changer), TMS13F1343P0022 (Obasanjo 2), and TMS14F1278P0003, performed equally well or better than commercial checks with regards to gari-eba color and texture of. For **attiéké**, the new varieties, namely Bocou6, Yavo, Bocou5, and Bocou2 were preferred by the users.

New **boiled and pounded yam** clones were evaluated by IITA's team in Nigeria, where the water yam (*Dioscorea alata*) clone TDa1100374 showed low peel loss during processing, and higher tuber dry matter content, and exhibited excellent boiling and pounding qualities. Most farmers preferred the white yam clones (D. *rotundata*) TDr1400158 for excellent pounding qualities and TDr1401220 for good boiled yam qualities, performing well for appearance and texture.

New **boiled plantain** varieties were evaluated at CARBAP (Cameroon), where 969 clones exhibited good agronomic characteristics, interesting quantitative descriptive analysis results (for firmness, sweetness & color) and consumer testing data. Plantain clone CARBAP K74 performed almost as well as the reference cultivar Batard for boiled plantain.

For **sweetpotato**, newly-released varieties were examined at CNRA (Côte d'Ivoire), where twelve cultivars were accepted based on sensory attributes with the different traits of preference. The clones Sanfo Figui 1, Sanfo Figui 2, Chinois Wosso, and Fatoni 2, were most preferred for their texture and yam-like taste for both boiled and fried sweetpotato. The orange-fleshed sweetpotato (OFSP) cultivars Covington TIB-440060, CIP-199062-1 and Irene) and the yellow cultivar (Gotchan) were the most accepted for their attractive appearance and sweet taste. The OFSP cultivars recorded low dry matter, high sugar content and high carotenoid levels. (See https://doi.org/10.9734/JABB/2021/v24i830231).

For **boiled potato**, 16 potato clones were evaluated at CIP. The NARO 2016–19 and NARO 2016–17 were rated as the highest for chalky appearance and mealiness. The CIP 397014-2 had a particularly bitter taste and was rated the lowest for 'Irish' potato aroma and flavor, while the CIP 395-171 was particularly sticky.

These improved RTB new varieties successfully complied with standards for processors and consumers' acceptability. They have become candidates of interest for release and promotion within communities.

The results highlighted the need to upscale participatory varietal selection (PVS) trials in farmers' fields for a more comprehensive assessment and external validation of breeding trials. This resulted in executing Tricot trials in Uganda and Nigeria, where several hundred trials were established. For complex processing such as **gari-eba**, baby trials and their processing cannot accommodate detailed comparison of processability and food-product quality because of the large variation involved, compared with the simpler **boiled cassava** food product in Uganda. A combination of Tricot and processing of a central controlled mother trial as a control is recommended. The Tricot on-farm trials and the processing by each of the Tricot participants into food products can be seen as a higher-level evaluation that checks the external validity of results obtained through the more centralized and processing evaluation with renowned 'champion processors' in local communities.

Success Story Box n°6: Identifying drivers of gari-eba consumer acceptability using a Triadic Comparison of Technologies approach (tricot)

Nigeria and Cameroon are multi-ethnic countries with diverse preferences for food characteristics. This study aimed at informing cassava breeders on consumer-prioritized eba quality traits. Consumer testing was carried out using triadic comparison of technologies (tricot). Diverse consumers in villages, towns and cities evaluated the overall acceptability of eba made from different cassava genotypes. Data from both countries were combined and linked to laboratory analyses of eba and the gari used to make it. There is a strong preference for eba with greater cohesiveness and eba from gari with greater brightness and especially in Cameroon, with lower redness and yellowness. Relatively higher eba hardness and springiness values are preferred in the Nigerian locations, while lower values are preferred in Cameroon. Trends for gari solubility and swelling power differ between the two countries. This study also reveals that the older, improved cassava genotype TMS30572 is a benchmark genotype with superior eba characteristics across different regions in Nigeria, while the recently-released variety Game changer performs very well in Cameroon. In both locations, the recently released genotypes Obansanjo-2 and improved variety TM14F1278P0003 have good stability and overall acceptability for eba characteristics. The wide acceptance of a single genotype across diverse geographical and cultural conditions in Nigeria, and three acceptable new improved varieties in both locations, indicates that consumers' preferences are surprisingly homogeneous for eba. This would enhance breeding efforts for developing varieties with wider acceptability and expand potential target areas for released varieties. https://doi.org/10.1002/jsfa.12867

The Tricot method for consumer testing (where only three food samples are compared with each consumer as part of an incomplete block design that involves more than three varieties) is based on a comparative approach rather than a ranking approach where its advantages still needs to be tested alongside regular consumer testing on the same clones and with consumers in the same region to substantiate its advantage. The method is thought to better integrate human cognition capacity by simply comparing varieties overall and on different traits. If this is validated, the method can also be more cost effective as relatively less consumers testing each variety might be needed. For example, for gari-eba, such work is planned in 2023, based on the uniform yield trials in Ibadan where also NIRS and panel work will be integrated from harvest to final food product.

Although acceptability thresholds have been determined for some product profiles, there is still a lot of work to be done to make sure that parameters measured on food products in the laboratory are workable representatives of the food product quality that value-chain actors seek. This demands more and continued processing evaluation and consumer testing with a wider, more contrasting range of varieties.

Furthermore, breeders have expressed interest and are developing workflows to link quality characteristics to genetic data by using multivariate analysis to allows them to make selections in populations without direct use of thresholds.

When quality traits are very complex and determined by a constellation of many underlying biophysical traits the complementarity of such a multivariate approach to thresholds determination should be considered, especially as it would allow selection also before good thresholds are established. Breeding programs cannot afford to extend selection on quality traits within their breeding projects until clear thresholds are established for all traits.

4.2 Database management & ontologies on quality traits for breeders' use

RTBfoods datasets had been stored into crop-specific breeding databases (Cassavabase, Musabase, Sweetpotatobase, Yambase), all using a single crop agnostic open data model called Breedbase (https://breedbase.org/) that contains an integrated breeding workflow using the Crop Ontology (https://cropontology.org) for storing breeding data.

A common use of agreed lists of traits and variables is particularly important when several sites or breeding programs share data in the database. The Crop Ontology (CO) describes variables for more than 5,000 traits and 33 crops, including the RTB crops.

CO proposes a nomenclature for storing the variables labels and the Trait Dictionary Template with Guidelines (Pietragalla *et al.*, 2022: https://hdl.handle.net/10568/110906). One trait can be linked to several methods of measurement and scales thus enabling side-by-side storage of the variables provided by different research teams.

Starting in 2020, the Bioversity ontology team joined RTBfoods, and developed ontologies adapted to the food science datasets and thus enabled an upload facility in Breedbase. RTB food quality traits were added to the CO with their definitions, methods of measurement and scales, to ensure harmonized description of data resulting from the assessments or measurements of food products' properties.

4.2.1 Trait Dictionaries for new quality traits

Diverse data types were generated on preferred qualities of users (farmers, family and entrepreneurial processors, traders or retailers, and consumers). Country-based target product profiles were produced with a comprehensive market analysis, disaggregating gender's role and gendered preferences, providing prioritized lists of traits to consider when developing new plant varieties.

Participatory Processing trials

121 variables used in measurements during the participatory food processing trials were extracted describing the food product processing techniques (table below). Trait dictionaries (TDs) have not yet been uploaded into the ontology as the teams still need to agree on the display of these concepts in CO given that techniques (e.g., slicing, boiling) are common to all food products. Therefore, to date, participatory processing datasets are not yet uploaded into Breedbase.

Number of measured variables extracted per crop from the participatory processing trial reports – WP1

Food Product	Number of extracted variables
Boiled cassava (Benin, Uganda)	12
Boiled plantain (Cameroon)	9
Boiled potato (Uganda)	8
Boiled sweetpotato (Uganda)	15
Boiled yam (Benin, Nigeria)	19
Fried sweetpotato (Uganda)	6
Fufu (Nigeria)	11
Gari/eba (Nigeria)	13
Matooke (Uganda)	17
Pounded yam (Nigeria)	11
Total	**121**

See Table 17 Survey datasets (Step 2) and Table 18 Survey datasets (Step 3).

Biophysical Traits

A total of 74 biophysical traits were measured for boiled cassava, fufu, eba, pounded yam, and boiled plantain, through laboratory-based protocols (e.g., water absorption, texture analysis, dry matter, etc.). The formatted biophysical files (xls or csv file) were uploaded in the corresponding field trial of Breedbase so they are available side-to-side with the agronomic datasets in the field trial summary page, and can be analyzed with the Breedbase built-in statistical tools. The upload template only accepts the means of the biophysical traits. Nevertheless, raw data can be uploaded as additional files in the corresponding field trial. For example, the post-harvest quality teams at NaCRRI and CIAT uploaded 8 instrumental texture datasets for boiled cassava into Cassavabase, directly linked to the respective field trials. Traits were extracted with the CO Template for integration into the Cassavabase. Texture-related traits were added to the cassava ontology, such as the boiled cassava roots texture characteristic End Force to Max Force Ratio using the texture-extrusion method'.

Names and descriptions of food quality traits were added into the Crop Ontology for labelling data in the databases, along with the various measurement methods used by the project to ensure harmonized data description resulting from the assessments or measurements of food products properties.

See Table 19 Dictionaries developed for traits related to the processing and the quality of RTB food products.

To be uploaded as an additional data file linked to the field trial and the accession, the file must contain information about the plant accession used for the sensory trial, its plots and trial name, in the data file. Attribution to the research team with a usable citation of the dataset was added as a field in the data file. Uploading sensory trained panel data requires first adding the CO identifier (CO ID) of the variable in the headers of the table's columns containing the value of the trait quality. This was done manually in the file using the Trait Dictionary and consulting the ontology in the CO web site.

Sensory traits

A food product ontology was developed enabling the Breedbases to integrate the sensory traits measurements produced by trained sensory panels.

A lexicon was developed by food scientists and was integrated into the SOPs to guide the collection of organoleptic traits measurements. The SOPs were validated. For consistently extracting the elements composing the sensory variable, we used and modified the Crop Ontology Trait Dictionaries Template to adapt it to food products. The resulting validated food-product property dictionaries are uploaded in the RTB platform, the Crop Ontology and in breedbase.

The CO Trait Dictionary (TD) Template format was successfully applied and adapted to fit the variables describing sensory food-product qualities and processing techniques. The extraction of traits and variables used both the food property lexicons of the SOPs developed for trained sensory panels or the participatory processing trials' reports. For all food products, the TD format and content was validated by scientists (Expert groups) and then uploaded both to the CO website (table below) and Breedbase.

Number of sensory traits evaluated per crop during sensory panels and extracted into the Crop Ontology.

Food product	# Sensory traits in CO	Crop Ontology URI
Boiled cassava	33	https://cropontology.org/term/CO_334:ROOT
Boiled potato	20	https://cropontology.org/term/CO_330:ROOT
Boiled yam	14	https://cropontology.org/term/CO_343:ROOT
Eba	11	https://cropontology.org/term/CO_334:ROOT
Fufu	6	https://cropontology.org/term/CO_334:ROOT
Matooke	13	https://cropontology.org/term/CO_325:ROOT
Attiéké	24	https://cropontology.org/term/CO_334:ROOT
Pounded yam	6	https://cropontology.org/term/CO_343:ROOT
Boiled sweet potato	26	https://cropontology.org/term/CO_331:ROOT
TOTAL	**153**	

See Table 20 Laboratory textural datasets.

4.2.2 Development of database templates & data transfer to BreedBase

We developed a centralized and meaningful open access to sensory information on food products and genotypes. Biochemical, instrumental textural, and sensory analysis data were then directly connected to the specific plant record while user survey data, bearing personal information, were analyzed, anonymized, and uploaded in a repository.

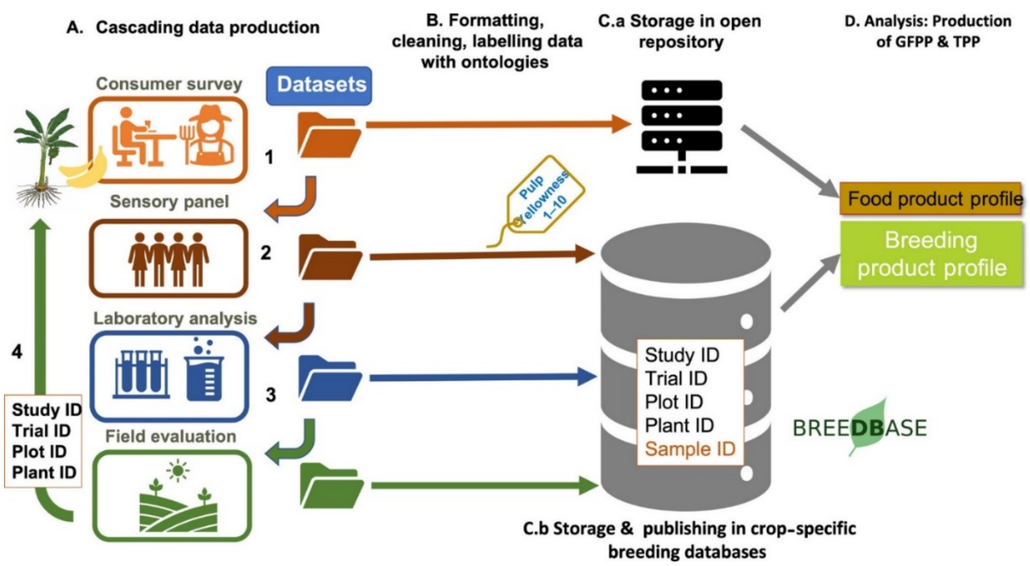

Figure 16 Cascading data flow in RTBfoods project from consumers' preference surveys to trained sensory panels, to biochemical analysis, and selection in the field of the new varieties. GFPP, gendered food product profile; TPP, target product profile.

Adapting Breedbase to Sensory Panel Trials

The Bioversity team and Boyce Thompson Institute (BTI) tested in 2022 two non-exclusive approaches for uploading sensory panel data: (1) Creating a separate record called sensory panel trial for directly uploading the raw data in this trial. The option for a 'Sensory panel' record creation was added in the Breedbase interface. Breedbase can automatically calculate the means and standard deviations from the raw data and provides intensity scale graphs. This mainly interests food scientists who may need to check the quality of the raw data, including the repeatability and accuracy of individual panelists; (2) Directly uploading the means and standard deviations of the sensory panel attached to the field trial record corresponding to the studied material, which makes the data easily accessible and usable by breeders. The test was performed with datasets containing mandatory information on the plot and the accession used in the sensory trial that enables the link with breeders' data.

The development and application of SOPs, data templates, and adapted trait ontologies improved the data quality and its format, enabling the linking of these to the plant material studied when uploaded in the breeding databases or in repositories. Some modifications to the database model were necessary to accommodate the food sensory traits and sensory panel trials.

See Table 21 Laboratory sensory analysis datasets.

NIRS spectral datasets

To date, a total of 21,844 NIRS spectra of fresh grated cassava roots and fresh or boiled yam tubers have been uploaded into CassavaBase and YamBase respectively. NIRS datasets were uploaded in a dedicated NIRS section of Breedbase. Plot names were stored with the NIRS data enabling linking each dataset to its respective field trial record. A reverse link to the available NIRS datasets should automatically be inserted in the field trial summary page, so users are aware of their existence.

See Table 22 Spectral datasets.

4.2.3 Lessons learned from connecting data on food quality and breeding

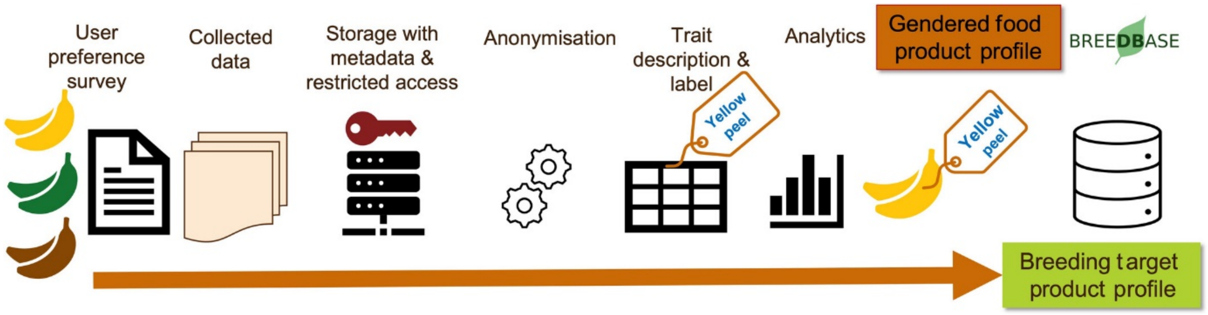

Figure 17 User survey data flow in the RTBfoods project.

The RTBfoods project has increased the number of quality traits assayed by partner breeding programs, and using the data templates and ontologies for food product traits has improved the quality of the datasets generated.

Gender, culture, and socioeconomic factors play important roles that must be considered when collecting food-product profile data. It is important to collect inclusive input that reflects local agriculture and food-system preferences.

Developing SOPs and data templates that integrate the protocols with a defined list of standards and contextual variables to be measured in multi-country and multi-partner projects is a prerequisite to proper data standardization.

Each SOP for sensory panels is specific to a food product and a country. Traits, variables, and scales vary as the consumers' preferences change with the cultural and socioeconomic context. In the CO, one trait can have several methods and scales to reflect the difference.

The CO uses standardized vocabularies for sensory traits included in the SOPs. It facilitates collecting and describing comparable data for consumer preferences, food quality, and breeding. By integrating defined and structured vocabularies of the multidisciplinary teams (e.g., food scientists, socioeconomists, breeders), the ontology supports the interpretation of results across domains.

Recording identifiers of plant accessions, field trial names, and plot numbers in all subsequent data files is crucial for connecting all datasets back to the plant material agronomic data.

More information in:

Arnaud E., Menda N., Tran T., Asiimwe A., Kanaabi M., Méghar K., Forsythe L., Kawuki R., Ellebrock B., Kayondo I.S., Agbona A., Zhang X., Mendes T., Laporte M. A., Nakitto M., Ssali R. S., Asfaw A., Uwimana B., Ogbete C.E., Makunde G., Maraval I., Mueller L. A., Bouniol A., Fauvelle E., Dufour D. (2023). Connecting Data for Consumer Preferences, Food Quality and Breeding in support of Market-oriented Breeding of Root, Tuber, and Banana Crops. *J Sci Food Agric.* Early view, https://doi.org/10.1002/jsfa.12710

4.3 Identification of QTLs for quality traits: texture, color, and end-product yield

Breeders collaborated with social and food scientists and chemometrists during each step of the RTBfoods project. Breeding material was made available to laboratories, panelists, and other stakeholders where relevant. While food and social scientists investigated the traits involved in quality, breeders set up experiments to understand genotype and environment interactions (GEI) using the known quality traits. Throughout the project, they integrated the traits for which protocols had been developed. Finally, key traits for each product profile were identified. Subsequently, breeders focused primarily on these key traits using the developed Standard Operating Protocols (SOPs).

New traits and methods were added to the phenotyping pipeline as they were identified/developed. Texture- and sensory-related traits emerged as the most important for quality. Texture measurement methods were developed, and equipment purchased according to the crop and the targeted product profile. As a result, the traits heritability, the correlation between traits and the GEI are being evaluated for most crops. Molecular markers associated with some traits have been identified.

Success Story Box n°7: Genome-Wide Association Study of Root Mealiness and Other Texture-Associated Traits in Cassava

There is a paucity of genetic information regarding the texture of boiled cassava, particularly with respect to its mealiness, the principal sensory quality attribute of boiled cassava roots. The current study aimed at identifying genomic regions and polymorphisms associated with natural variation for root mealiness and other texture-related attributes of boiled cassava roots, which includes fiber, adhesiveness (ADH), taste, aroma, color, and firmness. We performed a genome-wide association study (GWAS) analysis using phenotypic data from a panel of 142 accessions obtained from the National Root Crops Research Institute (NRCRI), Umudike, Nigeria, and a set of 59,792 high-quality single nucleotide polymorphisms (SNPs) distributed across the cassava genome. Through genome-wide association mapping, we identified 80 SNPs that were significantly associated with root mealiness, fiber, adhesiveness, taste, aroma, color and firmness on chromosomes 1, 4, 5, 6, 10, 13, 17 and 18. We also identified relevant candidate genes that are co-located with peak SNPs linked to these traits in cassava *(M. esculenta)*. A survey of the cassava reference genome v6.1 positioned the SNPs on chromosome 13 in the vicinity of Manes.13G026900, a gene recognized as being responsible for cell adhesion and for the mealiness or crispness of vegetables and fruits, and also known to play an important role in cooked potato texture. This study provides the first insights into understanding the underlying genetic basis of boiled cassava root texture. After validation, the markers and candidate genes identified in this novel work could provide important genomic resources for use in marker-assisted selection (MAS) and genomic selection (GS) to accelerate genetic improvement of root mealiness and other culinary qualities in cassava breeding programs in West Africa, especially in Nigeria, where the consumption of boiled and pounded cassava is low. https://doi.org/10.3389/fpls.2021.770434

For **boiled cassava**, the key traits are softness (or hardness), sweetness, hydrogen cyanide (HCN) content and mealiness. At NaCRRI, the GxE effect was estimated for dry matter content (DMC), water absorption (WAB) and softness. Correlations between traits were calculated to inform selection indices, and whole genome association studies (GWAS) were conducted on C2_clonal evaluation trials (196 clones) in two locations over two seasons. Four quantitative trait loci (QTLs) were found to be significantly associated with the stiffness trait (modulus of elasticity of a sample).

In parallel, at CIAT the GxE effect was estimated for DMC, WAB and texture-extrusion attributes. Work is underway at CIAT to understand the genetic architecture of WAB, HCN and DMC using a multiparental population with five full sib families (237 clones). The heritability of the traits and the correlation between them have been calculated. One significant QTL for cyanide, one for DMC and two significant QTLs for WAB were identified.

For **Gari and Eba**, significant SNP markers (S2_525353 and S10_4463009) were found for cassava root firmness, while an SNP marker (S16_1363504) was observed for peel loss. The GWAS identified 5 candidate genes. Moreover, broad sense heritability of the retting ability traits showed that firmness by penetrometer (65.3%) and turbidity by spectrophotometer (57.2%) had higher heritability estimates than the sensory methods.

Success Story Box n°8: Exploring genetic variability, heritability, and trait correlations in gari and eba quality from diverse cassava varieties in Nigeria

Gari is an affordable, precooked, dry food product, easy to prepare and store. Eba is a stiff dough produced from reconstituting gari in hot water. Gari and eba quality is an important driver of varietal acceptance by farmers, processors, and consumers. The current study characterized the genetic variability, heritability, and correlations among quality-related traits of fresh roots, gari and eba. Thirty-three diverse genotypes, including landraces, and released and advanced breeding genotypes were used in this study. In total, 40 traits categorized into: fresh root quality, color, functional and texture properties trait groups were assessed. We observed broad genetic variability among the genotypes used in this study. Dry matter content (DM) had a positive ($p < 0.05$) correlation with gari%, bulk density and a negative correlation with eba hardness and gumminess. Broad-sense heritability across all environments varied considerably for the different trait groups: 62% to 79% for fresh root quality, 0 to 96% for color, 0 to 79% for functional and 0 to 57% for texture properties, respectively. The stable broad-sense heritability found for gari%, gari and eba color, bulk density, swelling index and instrumental texture profile analysis (ITPA)-hardness coupled with sufficient variability in the population indicates good potential for genetic improvement of these traits through the recurrent selection breeding method. Also, it is possible to genetically improve gari%, bulk density and swelling power by simultaneously improving dry matter content.

Aghogho C. I., Kayondo S.I., Maziya-Dixon B., Eleblu S.J.Y., Asante I., Offei S.K., Parkes E., Smith A.I., Adesokan M., Abioye R., Chijioke U., Kayode O., Kulakow P., Egesi C., Dufour D. & Rabbi I.Y. *(2023), Exploring genetic variability, heritability, and trait correlations in gari and eba quality from diverse cassava varieties in Nigeria. J Sci Food Agric. Accepted manuscript.*

For **yam**, the key characteristics were slightly different for boiled and pounded yam. For boiled yam, the key characteristics are softness/crumbliness/mealiness, sweet taste, color, stickiness, and smell, whereas for pounded yam these are stretchability, moldability, smoothness, oxidative browning (OxB) and color. Breeders have implemented phenotyping activities for quality traits from the beginning of the project, even though high-throughput methods were not available at first.

Thus, at CIRAD, phenotypic data (texture, color, OxB, DMC, etc.) were collected on GWAS panel and biparental populations. In the GWAS panel, 37 significant associations were identified for tuber color, OxB, hardness, DMC, mouldability and cooking time. In the biparental populations, 25 QTLs were identified for DMC, sugars, proteins, and starch. Most of the QTLs were validated in a diversity panel. To complement the GWAS and biparental work, a focus was placed on three metabolic pathways involved in texture, starch content and colour. Using comparative genomics, the annotation of the three pathways was improved by 48% additional genes. A total of 27 genes were found under selective pressure and 18 genes were associated with phenotypic traits.

Success Story Box n°9: **QTLs and candidate genes for physico-chemical and oxidative browning traits related to tuber quality in greater yam (*Dioscorea alata* L).**

At Cirad, the multidisciplinary approach resulted in the phenotyping of 55 *D. alata* genotypes and more than 300 hybrids from two bi-parental populations for tuber flesh color and oxidative browning, tuber dry matter, cooking time and moldability, starch, protein, and sugar contents. Phenotypic data from two locations/growing cycles were used for the estimation of the variance components, correlation, and heritability of these tuber quality traits. Next, the genetic architecture of these quality traits was successfully elucidated based on GWAS and QTL mapping approaches. In total, 64 genomic regions were identified as associated to the tuber quality traits. Several strong and stable QTLs/QTNs (Quantitative Trait Loci/Nucleotides) were highlighted for the first time in *D. alata* genome. Moreover, several candidate genes controlling these quality traits were identified using commentary approaches such as comparative genomics and transcriptomics.

In the same species, IITA conducted a GWAS study focusing on DMC and OxB in water yam, grown in three environments using a diversity panel. Significant SNPs associated with DMC and OxB were identified. Gene annotation identified genes involved in the process of proteolytic modification of carbohydrates in the dry matter accumulation pathway as well as fatty acid β-oxidation in the peroxisome for enzymatic oxidation. They also conducted a GWAS on Guinea yam (184 genotypes). Thirteen SNP markers were found to be associated with quality attributes (appearance, colour, aroma, taste, sensory and instrumental texture and mealiness) of boiled and pounded yam. Gene annotation analysis revealed co-localization of several known putative genes involved in glucose export, hydrolysis, and responsible glycerol metabolism. At the CNRA, phenotyping data for water yam quality (colour, OxB, flesh texture, tuber cooking quality and DMC) were collected on the 188 accessions of the diversity panel. The distribution and variance of the traits and the correlations between them were calculated. The accessions were genotyped using Diversity Arrays Technology (DArT), and GWAS are in progress.

More information available on:

Asfaw, A., Agre, P., Matsumoto, R., Olatunji, A.A., Edemodu, A., Olusola, T., Odom-Kolombia, O.L., Adesokan, M., Alamu, O.E., Adebola, P., Asiedu, R. and Maziya-Dixon, B. (2023), Genome-wide dissection of the genetic factors underlying food quality in boiled and pounded white Guinea yam. *J Sci Food Agric*. https://doi.org/10.1002/jsfa.12816

Gemma, A., Lucienne, D., Emmanuel, E.A., Carine, M.-M., Michel, K.A., Jocelyne, L., Elie, N., Erick, M. and Hana, C. (2023), QTLs and candidate genes for physico-chemical traits related to tuber quality in greater yam (*Dioscorea alata* L). *J Sci Food Agric.* https://doi.org/10.1002/jsfa.12822

Dossa, K., Morel, A., Houngbo, M.E., Mota, A.Z., Malédon, E., Irep, J.-L., Diman, J.-L., Mournet, P., Causse, S., Van, K.N., Cornet, D. and Chair, H. (2023), Genome-wide association studies reveal novel loci controlling tuber flesh color and oxidative browning in *Dioscorea alata*. *J Sci Food Agric.* https://doi.org/10.1002/jsfa.12721

For **boiled sweetpotato**, the key quality characteristics are firmness, mealiness, sweetness, smell, and non-fibrousness. CIP therefore investigated these traits. The SOPS developed were used to evaluate 220 genotypes of the Mwanga Diversity Panel (MDP) together with the 16 parents in three locations in Uganda. Instrumental texture analysis was carried out on 110 genotypes from the MDP and 40 of these were characterized by the sensory panel for 17 traits. Investigation of the distribution of traits, their variance and the correlation between sensory and instrumental traits led to the development of a predictive model to predict sensory firmness in the mouth from positive power 1 (instrumental texture). This is an important step forwards in the understanding of quality attributes and the replacement of sensory evaluation, which is time consuming and costly, by instrumental measures. β-amylase gene expression was found to be negatively correlated with firmness and consequently a KASP marker was developed to screen populations at an early stage.

For **Matooke**, the identified key traits are flavor, colour and texture. While more traits were evaluated in the early years of the project, the identification of the key traits allowed the phenotyping to be narrowed down to these three key traits. IITA, with support from NARL, phenotyped 130 to 149 genotypes, representing about half of the genotypes in the segregating Matooke population. The data indicate low to high traits heritability. Colour L and b are the main traits associated with Matookeness, together with texture distance. Texture gradient appears to be negatively correlated with matookeness. Phenotyping of the segregating population is still ongoing to reach at least 3 bunches per genotype for each of the 261 genotypes in the population. Then the association between the traits and the markers could be started.

In conclusion, all breeding programs are investigating GEI, with the exception of Matooke, which is more complex. Currently, phenotyping is focused on the key traits for each product profile, thanks to the work of social and food scientists (Work package 1). The investigation of the quantitative genetic parameters, to predict the response to selection and guide breeding decisions is ongoing, with progress varying according to the complexity of the crop and the product profile (mashed, cooked or dough). Most populations have been genotyped, thanks to complementary funding from bilateral projects, allowing the association between markers and phenotypic traits to be established. The development of high-throughput phenotyping methods will accelerate the phenotyping process and allow faster progress in unravelling the genetic architecture of quality traits.

5 PROMOTION OF RTBFOODS RESULTS & PROJECT IMPACT

5.1 Talent development

5.1.1 Trainings & workshops

Over the 5 years, several collective trainings & workshops and even more support missions were organized to strengthen capacities of partner teams in carrying out some specific activities of their workplan.

In **WP1**, 3 workshops focused on building common methodologies for the identification of users' preferences. Support missions were also organized by WP coordinators, particularly during the first 3 years, in order to support partners in the logistical planning and the implementation of their field activities (surveys, hedonic tests, participatory processing with champion processors), up to the statistical analysis of their results. See Main Trainings & Workshops by Work Package 1.

In **WP2 2** two major workshops were organized on sensory analysis, from the recruitment of panelists to the processing of data generated by Quantitative Descriptive Analysis. What deserves to be underlined is the large number of specific missions organized by CIRAD's texture focal points to partner laboratory teams, to accompany them in the handling of their texture analyzer and in the analysis of the textural profiles obtained. WP2 partners as a whole were also very much involved - as trainers- in the AfricaYam/RTBfoods workshop to introduce AfricaYam partners to the concept of quality traits in yam and to present them with recent results in the development of new measurement methods and prediction tools. See Main Trainings & Workshops by Work Package 2

In **WP3**, 3 collective trainings were organized during the first years of the project, in order to sensitize the partners to the notion of infrared spectrometry – a new concept for the vast majority of them– and to present them the potentialities of high-throughput tools for breeding purposes. The subsequent years were dedicated to *ad hoc* support for each team to ensure that they applied correct sampling and scanning procedures, and to support them in spectral data management and processing to develop models for predicting the traits measured in the laboratory. See Main Trainings & Workshops by Work Package 3.

Capacity strengthening provided by the **WP4** coordination team was mainly through support missions to each of the breeding program in Colombia, Côte d'Ivoire, Guadeloupe, Nigeria, and Uganda.

Due to the sequencing of the RTBfoods project, the **WP5** methodology started co-construction with the partners in the last 2 years only. It was thus mainly during the Yam Quality Workshop organized in Benin, in November 2021, that a session was devoted to the presentation/discussion of the proposed approach and tools to be implemented in the field for the determination of trait acceptability thresholds. Subsequently, a small number of field support missions were organized in the last year of the project, by WP5 coordinators. Building the capacity of partners on the screening of new genotypes using the protocols for quality evaluation developed in RTBfoods will be at the core of the next phase, beginning in 2023.

The project management team (**WP6**) organized or co-organized 3 major workshops over the 5 years of the project. The first workshop focused on data management for use by RTB breeders, in Montpellier, in June 2019. It was initially initiated by the RTB breeding community of practice and in particular by Bioversity's Crop Ontology team, led by Elizabeth Arnaud. The second major workshop focused on yam quality and was co-organized with the AfricaYam project in November 2021, in Cotonou (Benin). Finally, the RTBfoods PMU organized a writing workshop in Paris in June 2022. More details are available at Main Trainings & Workshops by Work Package 6.

Finally, it should be noted that in the first year of the project, the project manager for monitoring, evaluation, and learning (MEL) also took part in 2 training courses on the approach and tools for monitoring and evaluation, proposed by the CGIAR's MELIA community of practice in Ibadan (Nigeria) and in Rome (Italy).

5.1.2 Student Fellowships

In the past five years, the RTBfoods project co-granted 75 fellowships to post-graduate, graduate and undergraduate students including 3 post-doctoral, 24 doctoral, 41 master/engineer, and 7 diploma/bachelor levels. To date, 16 doctoral and 1 master students are ongoing. Part of the results from the studies were published in the *International Journal of Food Science and Technology (IJFST)*, Special issue: Consumers have their say: assessing preferred quality traits of roots, tubers and cooking bananas, and implications for breeding (https://ifst.onlinelibrary.wiley.com/toc/13652621/2021/56/3). Some studies have been submitted to the *Journal of the Science of Food and Agriculture (JSFA)* and under revision. See Annex 4: List of RTBfoods students.

5.2 Animation of the RTB scientific community

5.2.1 Website & Social networks

Project communication only started in year 2. Priority was given to the creation of various communication tools thanks to the support from CIRAD Information Technology services. The main communication tool: a website (https://rtbfoods.cirad.fr/) was developed during year 2 and dedicated to the presentation of the project, of its scientific ambition and of the partner research team.

The website was designed as a tool to disseminate scientific research progress and to give access to the main documentation produced throughout the 5 years. Internally at CIRAD level, the RTBfoods project was immediately labelled as a CIRAD "Major Project", which led to the creation of a specific template by CIRAD's web design department. This template was then used as a model and branding for other major projects run by CIRAD teams.

The RTBfoods website is an open access reference platform, making the latest project information available to all stakeholders—partners, outsiders, and others. This includes all the documents (reports, presentations, protocols, etc.) produced by the project partners, within the different WPs. On the homepage, the latest news from the life of the project aims to inform on any recent mission, the arrival of a new colleague, the holding of a workshop, or a publication of interest (27 news published during Period 4). The page dedicated to the presentation of the project recalls the project's overall and specific objectives, and also presents the main levels of governance and the key contact persons (coordinators of WPs, focal points of partner institutes, Product Champions).

The page dedicated to deliverables is organized in tabs by year. It contains all documents generated by the project, classified by type (i.e., State of Knowledge Reports, Training Reports & Materials, Methodological Reports & Manuals, Laboratory Reports & Standard Operating Procedures, Field Scientific Reports, Gender Mainstreaming & Lessons Learned, HTP & MTP Prediction Models & Proofs of Concepts). The Annual Project Reports, the 5 WP Scientific Progress Reports and the 15 Institute Activity Reports produced by the partners yearly, are also downloadable.

One of the central pages of the site is that describing the 13 food products based on the 5 RTB crops under study within the framework of the RTBfoods project (i.e., cassava, yam, cooking banana, sweetpotato and potato). These pages currently describe the food products and the processing steps and consumption patterns in the 5 targeted sub-Saharan countries. The final versions of these product profiles are being reviewed by the product champions. In Period 5, one of the main tasks that the product champions will tackle, under the supervision of the project's communication team will be to produce, for each of these 12 RTB food products, a narrative promoting the main project achievements, all WPs included.

Finally, the Resources page links to newsletters, to the RTBfoods YouTube Channel and also to publications of interest, classified by plant.

On this Resources page the programs as well as all presentations broadcast during project workshops and annual meetings are also accessible.

In Period 4, the RTBfoods website has been viewed by 424 different users, mainly from countries covered by the RTBfoods project.

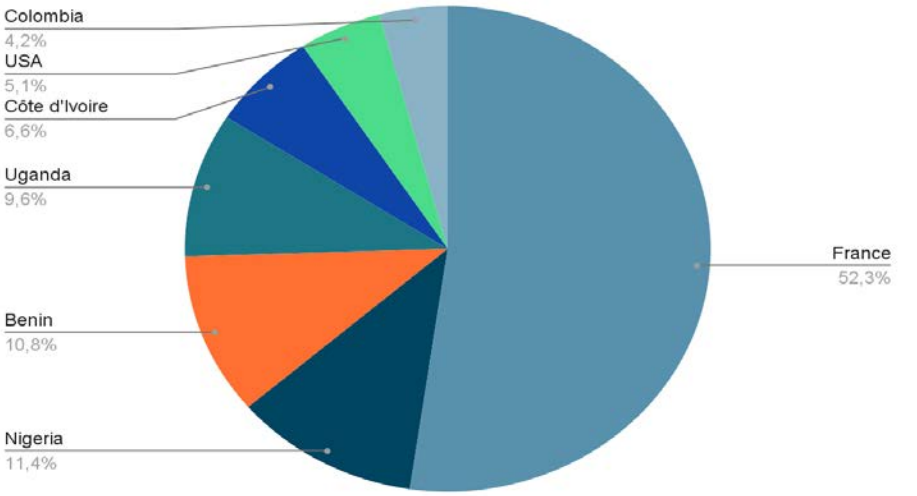

Figure 18 RTBfoods Website viewers' location

Furthermore, on the occasion of the 2021 RTBfoods Virtual Annual Meeting (12-15 April 2021), the communication team organized a photo competition on RTBs, through the RTBfoods website. A rich tableau of more than 150 photos was shared by RTBfoods partners and sympathizers to compete as part of one of the 3 defined categories: "In the field"; "People & Market" (Value Chains); "Ready to eat". The photo gallery was exhibited online during the Annual Meeting week and the photos were put to vote via the RTBfoods community. In each category, the three winners were awarded a poster and a jigsaw puzzle of their photo.

From the second year of the project, the PMU set up an online scientific animation to encourage exchanges between partners and to limit the silo effect between disciplines. Scientific webinars were organized every two weeks with RTBfoods scientists as speakers, striking a balance between countries, plants concerned and disciplines.

To disseminate these exchanges, a YouTube channel has been opened (https://www.youtube.com/channel/UCcwrf1cZavIS7arq_qKtu4Q). This space publishing mp4 formats proved to be very useful as soon as the project produced any preliminary results, and notably boosted the scientific animation by broadcasting clips and numerous webinars animated by the scientists. The RTBfoods YouTube channel is organized into playlists and currently contains over

100 videos; in particular, all webinars (See section 5.2.2) and all presentations prepared by RTBfoods partners for annual meetings or major workshops are viewable there.

A Twitter profile (@RtBfoods) has been opened to extend the diffusion of all these contents. The partners, especially from African countries, are quite active on this network. Throughout Period 4, the Twitter account @RtBfoods has been active with 80 tweets relaying highlights of the project life (workshops, new papers from the RTBfoods community, news published on the website); it has now 268 followers.

The project responded positively to the promotion campaign set up by the Cirad Innov team, most of which was done on the LinkedIn network. (https://www.linkedin.com/posts/cirad%27innov-alimentation-et-technologies-aa_fiche-didentit%C3%A9-produit-attiek%C3%A9-rtbfoods-activity-6881519196988047360-bwvt?utm_source=share&utm_medium=member_desktop).

5.2.2 Scientific webinars

See Table 23 Scientific webinars organized by the PMU between May 2020 and December 2022.

The PMU hosted scientific webinars fortnightly on Friday afternoons, through ZOOM. These 30-minute webinars gave project partners, students, and sympathizers (including members of the advisory committee) the opportunity to share methodological advances and new knowledge produced within the project framework. In 2021, external scientists were also invited to present their work. Suzanne Johanningsmeier, USDA research food technologist and associate professor, gave an overview of her team's investigations on the biochemistry of sweetpotato, over recent decades. Jacqueline Ashby, development sociologist, presented the G+(gender-plus) tool, developed outside the project framework and which has been adapted to answer the needs of RTBfoods WP1 for the development of RTB gendered food product profiles.

Particular attention was paid, in the appointment of webinar speakers by PMU, to provide a balanced representation of the disciplines, crops and countries featuring in RTBfoods.

The first cycle of 2020 webinars was mainly dedicated to presenting project findings on the quality characteristics of the 11 (ultimately 13) food product profiles studied by RTBfoods teams. In 2021 they aimed to share project achievements in developing proofs of concept and new methods to measure and predict quality traits.

In total, 41 webinars have been organized and moderated by Eglantine Fauvelle with an average of 38 participants.

These webinars allowed project partners to progressively share their results (summary of surveys on quality traits, dissemination of a new laboratory protocol, presentation of a tool or a proof of concept in progress, etc.). The webinars have been recorded and made publicly available on the RTBfoods YouTube channel: https://www.youtube.com/@rtbfoods7746.

5.3 Publications

Over five years, the RTBfoods project achieved 142 peer-reviewed articles in the fields of Food Science & Technology and Agriculture. The articles have been submitted and published in scientific journals with high impact factor (IF). The RTBfoods program has promoted excellence in science by organizing the publication of the project results in 2 special issues in open access peer-reviewed international journals. The 1st special issue was published by the *International Journal of Food Science and Technology* (IJFST, IF 2022 = 3.612), Special issue: Consumers have their say: assessing preferred quality traits of roots, tubers and cooking bananas, and implications for breeding, volume 56, number 3, March 2021 (https://ifst.onlinelibrary.wiley.com/toc/13652621/2021/56/3). Thirty articles include 23 original research papers, 5 review papers, 1 methodology paper and 1 editorial paper. The authors are affiliated with national research programs, universities, CGIAR centers (IITA- Nigeria, CIP-Peru and the Alliance of Bioversity International and CIAT-Colombia), NRI, CIRAD, NGOs and others. All the RTBfoods partners contributed to this issue. Recently, the 1st special issue has reached 246 citations (accessed on 7 April 2023). The 2nd special issue is under revision organized by the *Journal of the*

Science of Food and Agriculture (JSFA, IF 2022 = 4.125), focused on interdisciplinary studies at the agriculture/food interface. A total of 42 manuscripts were submitted: 7 articles have been published and 35 manuscripts are in revision. All the RTBfoods partners have affiliations in this issue. The other 70 articles from the project results were published in recognized scientific journals, for example: *Frontiers in Plant Science*, IF (2022) = 6.627; *Frontiers in Sustainable Food Systems*, IF (2022) = 5.005; *Scientific Reports*, IF (2022) = 4.997; *Journal of Food Quality*, IF (2022) = 3.200; and *International Journal of Food Properties*, IF (2022) = 3.388. All the peer-reviewed articles are listed into 8 topics in the RTBfoods website > Papers of interest (https://rtbfoods.cirad.fr/resources/papers-of-interest), including RTB in General (4 articles), Cassava (42 articles), Yam (21 articles), Banana (19 articles), Sweetpotato (15 articles), Potato (4 articles), Tools & Methods (33 articles), and Gender (4 articles). In addition, the RTBfoods members contributed to writing of 7 Book Chapters and Working Reports, and delivered 38 presentations of knowledge and outcomes to a wider community by attending diverse international scientific conferences. See Annex 5: List of RTBfoods publications

5.4 Outcome assessment study

Outcome evaluation of the RTBfoods project, https://doi.org/10.18167/agritrop/00748

The evaluation

This study has been undertaken as part of the final assessment of the project. It helped the project team in **assessing the progress made toward the expected outcomes and in formulating recommendations** for the way forward. It was also part of Cirad's institutional efforts to promote a "culture of impact". The study was funded and supported by Cirad as first pilot of an internal mechanism fostering the use of impact and outcome evaluations as reflexive exercises to generate knowledge and learn lessons on the contributions and contribution pathways of research to societal impacts.

The evaluation was realized between **June and December 2022** by a mixed evaluation team composed by one external evaluator from Quadrant Conseil, one evaluator from Cirad ImpresS team and the RTBfoods project manager for monitoring, evaluation, and learning (MEL). The **outcome harvesting method** has been adapted and used. Participatory workshops, exploratory interviews, an online survey, in-depth bilateral interviews, and documentary analysis were used as main tools for the identification and the substantiation of project outcomes.

Main results

The project was implemented in a relatively conducive context where other initiatives and projects were supporting breeding programs led by international and national research centers in better integrating quality and post-harvesting related traits as part of their breeding objectives.

An uneven level of awareness about the importance of integrating user needs and preferences in breeding programs existed across crops and countries when the project started. Participants in the evaluation acknowledged that **RTBfoods made significant contributions to make mindsets change and interdisciplinary collaboration capacities and practices evolve** across the diversity of situations. These intermediary outcomes were not explicitly defined in the project results framework. Nevertheless, participants agree on the fact that they were instrumental for the achievement of the expected outcomes and will contribute to the sustainability of the results achieved.

The evaluation found that the project **strengthened partners' capacities for the development and use** of:

- **participatory and gender-sensitive methods and tools** to understand user needs and preferences;
- **food product profiles**;
- **standard operating procedures** to assess quality traits;

- a set **of low, medium, and high-throughput phenotyping protocols** to measure and predicts quality traits. Both technical and equipment capacities were strengthened in this field;
- **harmonized tools and databases** to collect, store and analyze data related to quality traits.

These changes in capacities are acknowledged both by partners that were already using these methods, tools, and technical equipment before RTBfoods, and by partners that started using them thanks to the project. Notably, with reference to the set of practices examined and based on the results of the survey, **between 20 and 37% of the respondents stated that they started a new practice thanks to RTBfoods** (more details are presented in the table below).

Practice	Used before RTBfoods	Started with RTBfoods
Data collection on user needs and preferences	41%	21%
Food product profiles development	37%	36%
Use of laboratory SOPs to assess quality traits	39%	37%
Use of MTP or HTTP to predict quality traits	35%	20%
Use of standardized methods and tools for data management	54%	24%
Integration of information on user preferred traits in decision-making processes along breeding pipelines	26%	26%
Assessment of RTB clones/varieties against traits linked to food product profiles	30%	37%

Interviews and documentary analysis confirm these trends in terms of enhancement and introduction of these practices. For instance, **biophysical and biochemical analyses** (i.e., texture, color, water absorption capacity, sensory characteristics) are now used beyond the development and testing phase by a **great majority of food labs in RTBfoods partner organizations**.

The **progress with near-infrared spectroscopy analysis (NIRS) has been slower than expected** due to an underestimation of the amount of data, time and financial resources needed to validate calibration curves and build prediction models. Use of NIRS in cassava and yam breeding programs has been documented for some traits (i.e., dry matter, starch, total carotenoids, cooking time, proteins). **Building on previous results on calibration curves for these traits, RTBfoods** served as platform for knowledge sharing and capacity development.

Progress on the **use of information generated on quality traits in decision-making** processes has been noted. However, the **limited access to validated and affordable HTP and MTP protocols** for assessing quality traits has been one of the main constraints to integrating selection criteria related to quality traits in decision-making processes in the **early stages** of the breeding programs. In the **later stage** of breeding pipelines, when the number of samples to be assessed is less important, **the integration of new traits as part of the selection scheme has been observed** and information obtained through sensory analysis, textural and colorimetric analysis used.

Key recommendations

1. **Consolidate and communicate** results on low, medium, and high throughput phenotyping methods and tools for quality traits
    a. Before project closure, focus on making broadly accessible through scientific and training materials the results on methods and tools validated or close to validation.
    b. Before the project closing, work on the accessibility of all the data that could be further used to calibrate and validate assessment methods and tools

2. **Prioritize and demonstrate**
    a. Before project closure, further document the cases where information on quality traits has integrated in decision-making processes in breeding programs.
    b. For the coming phase, prioritize, through multidisciplinary consultation, a limited number of SOPs for quality traits assessment which results have high probability of being integrated in breeding pipelines.
    c. For the coming phase, identify a limited set of traits for which SOP and thresholds can be determined and validated.
3. **Integrate and institutionalize**
    a. Build on the actual use of quality-related data to develop procedures and standards in relation with stage-gating and adapted to different organizational models.
    b. Generate data on effort / time needed to develop/adapt low, medium, and high-throughput protocols for new traits to better plan the investment needed.

6 CONCLUSION & PROPOSITIONS FOR FURTHER DEVELOPMENT

6.1 Advisory committee feedback and recommendations

Overall comment across work packages

Collaboration across disciplines, institutions, and geographies:

- One of the key messages from this project is the need, as well as the pathway, for plant breeders to work closely with social scientists and food technologists.
- Collaboration within and across work packages has been critical for success. The synergies clearly led to a success greater than the sum of the parts.
- But collaboration does not occur automatically. It is imperative in any continuation of this activity to ensure adequate funding and time to allow for strong interdisciplinary collaboration and to continue to refine the process and tools for translating producer-processor- consumer data into breeding priorities.

Sustainability and scaling

- RTBfoods worked with a daunting 13 food product profiles. What is the potential social and economic impact from future investment in each of these products?
- Sustainability of efforts to improve varieties for end-user acceptance will depend on perceived cost: benefit by agricultural research organizations.
- The RTBfoods project is having its first impact at the level of project partner institutions. However, the eventual impact of scaling out and scaling up these tools and methods has a very broad potential, including across Latin America and Asia.

Deepening RTBfoods project impact

- This work will contribute to the growing fields of both inclusive crop improvement and linking breeding product profiles to market segmentation efforts, especially the gendered food product profiles.
- A next step would be to make the findings more broadly known and relevant by developing clear, standardized summaries of each of the food product profiles.
- Finally, documentation of results has been an outstanding feature of this project, both in peer-reviewed journals, project reports, and as part of publicly available websites.

WP1 overall achievements, challenges, and recommendations for the way forward

WP1 standardized an innovative, mixed methods, interdisciplinary 5-step methodology for developing Food Product Profiles to provide data on the quality characteristics for RTB food products to breeders. This new, coordinated, and sequenced approach involved:

1. Step 1: Writing 12 separate State of Knowledge reports and one synthesis covering 13 food products prepared from 5 crops in 5 countries
2. Steps 2, 3 & 4: Field research to:
    a. Create gendered food maps
    b. Carry out participatory processing diagnoses
    c. Conduct consumer testing
3. Step 5: Data analysis resulting in gendered Product-Food Profiles with preferred trait prioritization

Some of the recent work period covered by the annual report documents the near completion of all of WP1's expected outputs:

- Validation of 15 of 16 reports on consumer testing
- Final 4 reports on gendered food mapping
- Adaptation of the G+ tool for developing engendered Food Product Profiles
- Authoring the gender analysis report ("gender output") that presents the tool, development process, and preliminary results of the gender assessment.
- Successful participation by the team's Gender Working Group
- Good connections made with other projects on RTB crops and food products in Tanzania, Mozambique, and with the Gender and Breeding program, among others

WP1 challenges

- RTBfoods started with an innovative vision of interdisciplinary research, but the new approach needed more time, feedback, and resources than was initially anticipated to collect data and conduct analysis, and refining the methods it developed
- Delays and quality issues sometimes occurred when:
- Covid-19 pandemic limited in-person activities
- NAROs and other partners had different skill levels in the social and physical sciences needed to carry out the gender-integrated food science, gender, economics, and plant breeding research; and
- Resources were used up more quickly than anticipated.
- Linkages between WP1 and other WPs did not develop as well as they might have, due to these delays, sequencing issues, and methodological and conceptual differences

WP1 recommendations for the future

- A next phase of RTBFoods/Breeding work could ensure better attention to gender and social factors into the breeding work by intentionally engaging a larger pool of gender analysts and social scientists
- It would also benefit the program to build on current work and refine the evidence base emerging from WP1 to be of greater use to breeders and food product developers
- Strengthen communication across WPs: encourage greater participation in the Friday talks and other opportunities to share exposure to different methods and scientific approaches.
- Build skills in scientific communication for non-technical or popular audiences

- As already noted, provide adequate funding to cover the time needed to make collaborative work a success.

WP2 overall achievements, challenges, and recommendations for the way forward

As the 5-year RTBfoods project comes to an end in January 2023, the WP2 group has some major achievements to be proud of:

There has been a development of methodologies accompanied with training exercises that have led to a harmonization of sensory and instrumental methods and of many descriptors for product profiles for texture, for most of the RTB products

Screening protocols in the form of standard operating procedures (SOPs) for a wide range of roots, tubers and bananas and products are now available:

- 10 SOPs for sensory evaluation and screening using trained panels
- Establishment of objective instrumental screening tests, through sensory data correlations, for 7 SOPs for firmness for non-destructured (whole) products and for mealiness of boiled cassava. 3 SOPs for textural characterization were finalized in this period for Gari-Eba, Fufu, and pounded Yam. Genotypes from breeding programs have been assessed using these SOPs and scored for textural parameters.
- Kitchen-test SOPs were finalized. Water absorption for the boiled cassava screening test functions well.
- 12 SOPs for biophysical analyses, though not clear what test or combination of tests predict quality of the products

Some good progress on the proof-of-concept biochemical basis of pectin behavior for some product qualities.

It is apparent that the range of RTBs and products inherently have different bases of quality traits, making it impossible to reach all objectives. However, excellent overall progress has been made towards WP2 objectives.

The reporting emphasizes successful process and documentation, with some results (details in current and future publications).

Comprehensive overviews that tell if and how well the priority sensory attributes of the studied crops and related products can be explained by instrumental measurements in a quantitative way would give (better) insight in the progress of the project.

The report is more success-oriented and less oriented towards documenting ‘remaining challenges’.

Interactions between WPs seem to be underdeveloped and may hinder the translation/transfer of lab-scale protocols to high-throughput protocols in WP3, but in a next project phase this could be made possible.

<u>Sensory descriptions & instrumental protocols:</u>

Sensory descriptions of the same crop and/or derived products by different partners result in variation of attributes, some are overlapping while others are different, thus attributes are not yet harmonized across all partners.

The number of samples profiled by sensory panels is quite variable for the different crops and products and on many occasions not optimal/ fully representative for robust associations with instrumental measurements. Some crops and products still need to be profiled, though the team could just choose to focus on those with sufficient numbers.

Sensory profiles of crops and derived products and their association to instrumental measurements are yet not validated in independent experiments (and years) and ultimately by prediction of attributes from instrumental measurements with good accuracy. This could be a focus of the next project?

Partners have not equally focused on required instrumental protocol development for priority attributes/traits in crops and derived products, and spent at times quite some time on traits and attributes of lower priority while the priority traits work was not progressing adequately. Also, for potential future focus – consider narrowing down the instrumental tests.

Various 'significant' associations between instrumental measurements and sensory attributes are 'adopted' for routine applications without validation and further exploration of the breeding program for the trait. There is a need to demonstrate their performance over time, their consistent associations to sensory attributes, and the heritability of the traits in the breeding programs. This is also part of the potential focus for the next project.

Biochemical analyses and mechanisms:

Some SOPs for biochemical analyses may be useful and others not. This should be clarified in the final report.

The pectin work seems promising, even though there are some contradictory results.

The (lack of) applicability of the semi-high throughput pectin protocol in certain crops seems to be based on the simplification of the role of pectins in cell walls. Esterification of pectins, secondary side chains on pectins and cross-linking to cellulose and hemicellulose and monomeric composition of cell walls seem relevant and are not considered in the current approach.

WP2 ideas/recommendations for future work

- Narrow the focus to robust sensory to instrumental/kitchen test methods, which make sense as breeding targets
- Validate and communicate (publish?) as signature outcomes of project that can be used and scaled
- The pectin work seems promising and could continue towards further understanding of detailed molecular characteristics and cell-wall networks that impact quality
- Expand work with HTPP (WP3) and breeders (WP4) to create a transformational change in RTB production and consumption
- Sensory profiling
    - Further harmonize the list of attributes for specific crops and products over different panels through profiling and sharing of identical samples and creation of consensus about the attribute list.
    - Start, continue, and complete sensory profiling of crops and products on a relevant scale that covers the full sensory space of breeding programs to obtain robust sensory Datasets that are required for robust instrumental associations.
    - Validate sensory profiles over trials, years, and sample series in terms of repeatability & heritability/correlation and associations to instrumental measurements
    - Repeat consumer/end user preference studies for robustness and coverage of sensory profiles in breeding programs, using the full representation of the sensory attributes in the variety list to be studied. This study will validate the attributes and their priority in preferences and the required product profiles
- Instrumental measurements
    - Develop protocols for instrumental measurement of priority sensory attributes for those traits that are yet to be successfully measured
    - Switch to alternative instruments or principles for those measurements that do not associate with sensory attributes
    - Validate protocols for performance as function of trials, years, breeding programs and heritability as requirements for routine application

- Give more attention to esterification and monomeric composition of cell walls and their nature as function of raw product, cooking and preparation. This should lead to good associations between cell-wall composition and texture traits in all crops and products

WP3 overall achievements, challenges, and recommendations for the way forward

WP3 challenges

Organizing the report by product profiles leads to much repetition that can make the reading tedious.

Reading the text, many traits seem to be working but, when opening the calibration files, we can observe many R2 of validation less than 0.5. Sometimes NIRS results are disappointing. This is normal and nothing to be ashamed of. These results deserve to be published and help avoid others starting hopelessly-costly new experiments. Traits must be examined one by one, and decisions made to proceed or abort.

Calibration results are presented with 16 or 20 samples. These numbers are actually insufficient, and results should not be presented before reaching 50 samples (not spectra).

WP3 way forward: suggestions for the next phase of research

- SOPs

Several SOPs are concerned with the same product (e.g., cassava) and differ only for the NIR instrument. One SOP/product would be more efficient to harmonize the sample presentation.

In the future, the aspect of model transfer will be important. In a first step, model transfers could occur between the existing instruments (FOSS 6500, DS2500, XDS, ASD, ...). But the development of new portable instruments is important and the current databases will be very valuable. The model transfers are facilitated when the sample preparations are identical. Moreover, the reference methods must be standardized for an efficient enhancement of the transferred datasets.

SOPs from WP2 (wet chemistry) and from WP3 could likely be merged to provide a better handling of the samples. The people doing the reference methods should carry out the NIRS measurements or reverse. The same samples need to be manipulated at the same time for both methods.

- Validation

Many datasets are not fully validated, showing overestimated accuracies. The validation of the models should be reviewed.

Cross validation is a good technique provided that the different blocks are independent of each other. If data concerned several harvests, blocks per year is the best cross-validation method. The principle of the validation is to estimate the accuracies with samples not included in the model.

A random or a Kennard-Stone selection does not provide a good validation set. NIRS developers must use independent test sets or apply double cross validations. (See: K. Varmuza and P. Filzmoser. Repeated double cross validation (rdCV) -- a strategy for optimizing empirical multivariate models, and for comparing their prediction performances. In M. Khanmohammadi, editor, Current Applications of Chemometrics, Nova Science Publishers, New York, USA, 2015, pages 15-31.)

- Databases (deliverables)

Some datasets are split/year as deliverables, but data of the same applications should be stored in one file. An Excel template has been discussed, prepared, and adopted by all the NIR users.

It would be nice to complete the datasets on this basis for the end of the project. Datasets are currently separated by product and location should be merged across the network. For instance, all the data of the dried and ground roots could be merged to predict the composition and other traits, providing the reference methods are compatible.

- Standard Error of Laboratory method (SEL)

Most of the Datasets did not include this parameter. SEL should have been estimated by the reference method developers or users (WP2). SEL is a key point and must be known at the start of a NIR (or imaging) application.

- NIRS operators and "calibrators"

An important project deliverable is the installation of 10 NIR instruments and 2 HS cameras and the training of the people needed to run and calibrate these instruments. What is the plan during this last year to maintain this equipment and to keep the trained people in place? Some labs could be heavily affected by high personnel turnover.

WP4 overall achievements, challenges, and recommendations for the way forward

WP4 builds on the knowledge and tools from previous work packages to:

- Prioritize selection criteria
- Apply high throughput phenotyping for priority traits

High quality RTB varieties and associated processing systems already exist BUT

- maintaining quality has generally had a lower priority compared to improving yield and disease resistance; and
- screening tools have been inadequate

WP4 key accomplishments

- Collaboration among multiple research centers has clearly paid off
- For all crops, new knowledge and tools have been integrated into breeding programs
- Early applications of high throughput phenotyping tools focused on texture, a key quality trait across nearly all RTB food products
- The refinement of selection tools and methods allowed moving to next steps, including study of GxE interaction, heritability, QTLs, and candidate genes
- Data management has been highly systematized through using BreedBase and other databases.

WP4 challenges

- Understand priorities and trade-offs that consumers will apply, in situations where not all traits are expressed at optimum levels
- For maximum efficiency, high throughput phenotyping systems should be developed for application to raw roots or tubers
- Food product profiles must be compatible with, and integrated into, comprehensive variety profiles (e.g., yield, resistance, plant type, climate adaptability)
- More complete analysis and synthesis of information across institutions and locations will be helpful

WP4 way forward

- Investing in high throughput screening requires a high level of confidence that: 1) the rapid screening results are highly correlated with the variation valued by users; and 2) there is a favorable cost: benefit ratio relative to conventional screening
- The potential for GxE interaction to complicate selection calls for great caution about conclusions based on one or two years or locations
- One of the key impact pathways for RTB breeding may be through the One-CGIAR Excellence in Breeding (EiB) platform

WP5 overall achievements, challenges, and recommendations for the way forward

PVS methodologies have been around for many years, but systematic application to consumer quality traits is limited. WP5 provides final testing/confirmation for breeding products, but also feedback to breeders to further refine selection criteria. WP5 did not specifically require new varieties from WP4 to develop and test methodologies, so it could advance this as research agenda item earlier in the project.

WP5 key accomplishments

- An innovative WP5 methodological guidance document, with special attention to the TRICOT system, was developed
- Work has been carried out across 9 food product profiles and among 6 partner institutions.
- Participatory trials are establishing the validity of food product profiles and drive their refinement. This is especially important for understanding regional variations, environmental effects, and GxE interactions.
- Several candidate varieties with confirmed consumer acceptance have been identified through the participatory trials for release consideration

WP5 challenges

- Every country has its own system of evaluating and approving new varieties for release
- Research programs will need to engage with varietal release authorities to make sure that the added value of better-quality traits is adequately recognized.
- Breeding programs have become highly focused on speeding up the breeding process. However, at the point of participatory selection, the best strategy will be to slow down to assure success with end users.

WP5 way forward

- Participatory breeding is time-consuming and costly, but essential to success.
- In a post-project era, participatory breeding will continue to benefit from a strong collaboration among breeding programs to share information, experiences, and germplasm.
- Breeding programs need to avoid being a series of experiments and pilot testing of methodologies to become efficient, effective whole-systems of plant breeding

6.2 Proposed cross-cutting activities in RTB Breeding project

Based on the recommendations of the advisory committee and the multiple challenges encountered by each WP during the first phase of the project, it was decided to structure the activities within the RTB breeding project concerning the aspects of post-harvest quality and consumer preferences into 5 cross-cutting scientific themes

1. Finalizing SOPs & Proofs of Concept to measure key priority quality traits
2. Extracting RTB genotypes with preferred key priority quality traits, from RTB breeding populations (screening)
3. Defining acceptability thresholds for selected key priority quality traits
4. Developing high and medium throughput methods for predicting key priority quality traits
5. Ontologies and Database management

Workplans are currently being validated with each partner institution in the project's various target countries, based on the coordination of activities around these 5 themes

7 APPENDICES

7.1 Annex 1: Summaries on work packages scientific achievements from Period 1 to 5

7.1.1 WP1 key scientific achievements from Period 1 to 5

Understanding the Drivers of Trait Preferences and the Development of Multi-user RTB Product Profiles

(See Table 24 WP Achievement Reports (Period 1 to 5))

There are several achievements of note pertaining to WP1 outputs 1, 2 and 5. Firstly, the leadership of WP1 focal points and coordinators to key scientific and methodological publications. These methodologies led to the production of further scientific publications led by RTBfoods collaborators showcasing innovative, novel methodologies and new knowledge on characteristics preferences. The profile for boiled cassava in Uganda showed a number of characteristics not previously evidenced in literature. For fresh cassava characteristics, this included big roots, smooth skin, white flesh, and not bitter. For processing, this was white, non-fibrous, firm root, cooks fast. For the final product, sticky was not previously mentioned. Following the gender assessment, it is likely that a number of these characteristics will be included in the profile. WP1 also led publications of the WP1 Gendered Food Product Profile (GFPP) methodology, measuring drudgery, and sensory methods for RTB variety acceptability forthcoming in a Special Issue of the *Journal of the Science of Food and Agriculture* (JSFA) in 2023. Nine further partner publications are expected in the same issue. In 2021, WP1 focal points and coordinators contributed to a publication on the WP1 methodology in a Special Issue of the International Journal of Food Science and Technology (IJFST) https://doi.org/10.1111/ijfs.14680), as well as contributing to 11 other partner publications https://rtbfoods.cirad.fr/news/11-publications-acceptability-preferences-rtb-africa-ijfst in the same issue https://rtbfoods.cirad.fr/news/ijfst-special-issue-online. The complete list of RTBfoods publications on gender is available on this link: https://rtbfoods.cirad.fr/resources/papers-of-interest/gender.

Another area we are very proud of is the Gender Output (output 1.1.2). Importantly, the Gender Output was co-developed with partners through the creation of the Gender Working Group (GWG), which consists of 16 members from 9 institutes, working on 8 RTB products in 3 target sub-Saharan countries. This provided a means to develop a cross-product and country data aggregation, analysis and report writing in a participatory way. The model has been so successful that other WP coordinators would like to use the method. The GWG developed and presented our initial findings at the GREAT gender-responsive crop breeding conference; wrote a blog on the presentation for the RTBfoods website, our findings informed PMU's presentation to the ANR (French National Research Agency) conference on Gender in Research (of which a paper will be published in the ANR Handbook on the subject), in addition to the co-development of a publication of the gender output data in a Special Issue on Innovations in Gender Research for Sustainable Food Systems, in Frontiers in Sustainable Food Systems. (To be submitted end of March 2023).

Other important achievements are the development of the WP1 Targeted Gendered Food Product Profile (TGFPP) guidance document and template by a Food Product Profile working group and the adaptation of the G+ tool by the GWG. This was presented and validated by the RTBfoods Advisory Committee in May 2021. The Gender Working Group (GWG) led the development with the GWG the RTBfoods Product Profile gender assessment document and template and adapted G+ tool. This was developed to fit the focus of the RTBfoods project and approach to gender equity. The aim of these tools is to assess the potential gender impact for RTB crop and food product related characteristics (or expressed as traits if established) to inform what is included and prioritized in the final version of the WP1 Food Product Profile. In addition to the tool and template, Jacqueline Ashby, and Forsythe (2021) gave a webinar on the G+ tool, which is available on the RTBfoods YouTube channel. Another webinar was given to the Innovation Lab for Crop Improvement and the Africa Yam training seminar (See Forsythe et al., (2021) WP1 Food Product Profile Methodology webinar (https://youtu.be/0zsBOg4UEYY) and Forsythe et al., (2021) WP1 methodology for gendered product profiles, Africa Yam webinar (https://youtu.be/9Iv4fgURIb4). Based on this guidance and support from WP1 Coordinator, all WP1 partners for all product profiles were submitted. This was a significant achievement we are proud of.

These tools led to gender impact – which will be captured in the forthcoming publication in Frontiers. Some examples are for the food product profile gari/eba from ITTA in Nigeria, prior to the gender assessment (but nonetheless informed by gender analysis of the data), several important characteristics arise. For raw material, high dry matter, yield, and multiple use characteristics were considered vital. Reducing drudgery, preventing discoloration and the yield were all very important qualities for processers. For eba, the first three quality traits established are colour, texture and swelling power. For gari, this is colour, heavy weight and again, swelling power.

Another significant achievement was the tools, learning material and ongoing support and capacity strengthening facilitated and provided by the Coordination Team. This was highly valued by WP1 partners. Group and one-to-one support were provided for partners with relevant templates and data analysis tools, which led to the delivery of 75 open access partner reports. This is a significant contribution to new knowledge regarding the gendered differences in varietal and quality characteristic preferences of vitally important RTB food crops in sub-Saharan Africa. The key manuals and tools that were developed, and the partner reports they contributed to (output 1.1.1), include:

- **Step 1:** State of Knowledge (SoK) https://doi.org/10.18167/agritrop/00568 and **13 partner reports**.
- **Step 2:** Gendered food mapping https://doi.org/10.18167/agritrop/00569 and **20 partner reports**.
- **Step 3:** Participatory Processing Diagnosis and Quality https://doi.org/10.18167/agritrop/00570 and **15 partner reports**.
- **Step 4:** Consumer Testing in Rural and Urban Areas https://doi.org/10.18167/agritrop/00571) and **16 partner reports**.
- **Step 5:** Product Profile Consolidation. Understanding the Drivers of Trait Preferences https://doi.org/10.18167/agritrop/00661 and **14 profiles.**

There were also several new scientific collaborations between partners. In addition to the establishment of the GWG, there was also continuing partnership between NRCRI and Bowen in Nigeria on Boiled & Pounded Yam, and NRCRI & IITA in Nigeria on Gari-Eba, and ENSAI & IITA in Cameroon on Gari. The five-step methodology was used in the NextGen Cassava project in Tanzania (in period 3) and SweetGains project in Mozambique (in period 4). Results from the studies were published in the Special Issues of *International Journal of Food Science & Technology*, 2021; https://ifst.onlinelibrary.wiley.com/toc/13652621/2021/56/3, *Frontiers in Sustainable Food Systems* (https://doi.org/10.3389/fsufs.2021.740926; Crop Science https://doi.org/10.1002/csc2.20680; and book chapter https://doi.org/10.2499/9780896293915_02. The WP1 Leader and other RTBfoods project members presented for the Gender and Breeding Initiative, Africa Yam annual meeting and the Innovation Lab for Crop Improvement. The WP1 Coordinators/focal points were also regularly engaged with WP5 and contributed to the outputs specified in WP5 report.

7.1.2 WP2 key scientific achievements from Period 1 to 5

Biophysical Characterization of Quality Traits

(See Table 24 WP Achievement Reports (Period 1 to 5))

Implementation of the RTBfoods project WP2 brought together food scientist teams from various universities and research organizations in Africa, Europe, and Latin America. A first key achievement was the establishment of standard operating protocols (SOPs) common to RTBfoods partners, enabling the production of post-harvest quality phenotyping data of similar scientific quality, and under similar database format.

The majority of activities of WP2 consisted in collecting datasets of sensory, biophysical, and functional characterizations of the 11 RTB product profiles included in RTBfoods. These datasets demonstrated the range of phenotypic diversity among RTB crops in terms of postharvest quality traits, and the importance of screening for such traits. Moreover, genotypes with particularly desirable quality traits were identified for the 13 product profiles and selected as potential progenitors for breeding. Correlations were identified between instrumental measurements, e.g., texturometer or water absorption, and sensory attributes, e.g., hardness, mealiness, stretchability, etc.; which confirmed that instrumental measurements are relevant to describe sensory perception of RTB products, and can be used for medium-throughput phenotyping of RTB quality traits.

Two WP2 datasets (boiled cassava and gari/eba) were combined with the consumer preference studies provided by WP1, in order to define quantitative thresholds of acceptability for key quality traits. These thresholds can then be integrated to the corresponding product profiles, such as those developed by Excellence in Breeding (EiB), for use by breeding programs to screen for quality traits. WP2 datasets were also shared with WP3 to develop calibrations with NIRS, enabling rapid prediction (high throughput phenotyping) of some traits including dry matter, starch, and in the case of boiled cassava, cooking quality.

To explain the molecular phenomena that underpin the observed sensory and texture attributes, 12 SOPs for biochemical analyses of the composition of RTB were developed. Various relations were found between pectins, starch, amylose, and texture properties. These were highly dependent on each food product. For instance, in the case of boiled cassava, pectins appear to be a key factor controlling cooking quality, whereas dry matter seemed to be the main factor for boiled yam and fried plantain, and amylose for boiled sweetpotato.

The SOPs and WP2 phenotyping datasets were uploaded and are publicly available in the Dataverse open access repository. Preliminary to this, a total of 163 sensory traits for different food product profiles were defined in trait dictionaries and uploaded to the open access Crop Ontology website and also in Breedbase. Furthermore, 88 instrumental textural traits for boiled plantain in Cameroon, pounded yam in Nigeria, boiled yam in Benin, boiled cassava in Colombia, & Uganda, fufu and eba in Nigeria have been annotated into trait dictionaries.

Overall, the RTBfoods project fostered intense interactions and exchanges of experience among partners, which helped solve bottlenecks and facilitate the research work for all 13 product profiles. A strong network of food science researchers is now in place with shared methods and same outlook on the importance of integrating postharvest quality traits among product profiles, to be used as selection criteria for the breeding and adoption of improved RTB crops.

Activities of WP5 were organized along the following five major steps:

(1) **To develop standard operating protocols (SOPs)** for sensory, biophysical (composition) and functional (texture and other properties related to cooking quality) characterizations of 11 RTB products. The 13 partners involved in WP2 developed 11 SOPs (100% of target) for sensory quantitative descriptive analysis (QDA), 12 SOPs for biophysical analyses and 12 SOPs for functional analyses (86% of target: water absorption, texture-extrusion, penetrometry, texture-profile analysis (TPA), etc.). These SOPs are publicly available in the Dataverse open access repository. They provide a standardized toolbox to phenotype and screen RTB populations, both as fresh and after processing into final products.

(2) **To apply the SOPs to phenotype RTB populations**, focusing on the priority quality traits identified and provided by WP1, for each product profile. WP2 partners selected the SOPs most relevant to their product profiles, and generated corresponding datasets including in the majority of cases sensory QDA and texture analysis. Correlations were identified between instrumental hardness measured by texturometer on the one hand, and on the other hand various sensory attributes, depending on the type of product, for instance, with sensory hardness and chewiness in the case of boiled cassava; moldability in the case of gari/eba; crumbliness and ease of breaking (boiled tam); etc. TPA, a specific texture SOP that measures other attributes than hardness: chewiness, gumminess, cohesiveness, put in evidence other correlations with sensory attributes such as moldability and stretchability in the case of pounded yam. Texture-extrusion also put in evidence a correlation between End force: Max_force ratio, an instrumental parameter describing breaking behavior of boiled cassava, and sensory mealiness. These correlations were a major

achievement of WP2, demonstrating that the texture SOPs can describe various sensory attributes (hardness, mealiness, etc.), and are therefore relevant for medium-throughput phenotyping quality traits of RTB populations.

Sensory and instrumental texture measurements were conducted on collections of RTB genotypes selected for their contrasted attributes, from very good to very poor processing quality. This approach allowed WP2 teams to demonstrate the range of phenotypic diversity in terms of postharvest quality traits, and the importance of screening for such traits. Moreover, for all the 13 product profiles, genotypes with particularly desirable quality traits were identified and selected as potential progenitors for breeding, while others were ruled out due to unsuitable sensory and/or texture attributes.

The resulting datasets of sensory, texture and biophysical data were uploaded to Dataverse (34 datasets registered with DOI) and Breedbase (12 datasets). The datasets were shared with WP3 to develop calibrations with NIRS, enabling rapid prediction (high throughput phenotyping, HTPP) of some traits including dry matter, starch, and cooking quality of boiled cassava (evaluated as water absorption). Further collection of biophysical and functional datasets in the next phase of RTBfoods will increase the quality of NIRS calibrations, and allow predicting additional traits.

(3) **To establish thresholds of acceptability to complete RTB product profiles**. Consumer's preference studies provided by WP1 (Just-About-Right method for example) also provided information on the thresholds of acceptability of various quality traits. Using correlation analyses first between preference studies and sensory QDA, then between QDA and instrumental measurements, these thresholds were translated into quantitative acceptability thresholds in terms of laboratory-based characterizations. Quantitative acceptability thresholds can then be integrated to the corresponding product profiles, such as those developed by Excellence in Breeding (EiB), for use by breeding programs to screen for quality traits. Two product profiles (boiled cassava, gari/eba) have reached this stage so far, and more product profiles will be added in the next phase of RTBfoods.

(4) **To establish biochemical proofs of concepts**. Twelve SOPs for biochemical analyses of the composition of fresh RTB were developed, in order to explain the molecular phenomena that underpin the observed sensory and texture attributes. Various relations were found between pectins, starch, amylose, and texture properties. These were highly dependent on each food product. For instance, in the case of boiled cassava, pectins appear to be a key factor controlling water absorption and texture, whereas dry matter and starch had no correlation with indicators of cooking quality. In contrast, in boiled yam and fried plantain, dry matter was related to harder samples, as measured by instrumental texture as well as sensory QDA. Amylose was related to firmness in the case of boiled sweetpotato. Initial evidence is also available of the role of enzymatic activity during cooking of some RTB, for instance, amylases reducing the molecular weight of starch and releasing dextrins and sugars, and pectin-methyl-esterase debranching pectins and thus rigidifying the pectin network.

(5) **To collect laboratory data in a standardized way across partners and upload to open access online repositories**. During the course of the project, a total of 163 sensory traits for different food product profiles were extracted in trait dictionaries and uploaded into an open access Crop Ontology website and also in Breedbase. Furthermore, 88 instrumental textural traits for boiled plantain in Cameroon, pounded yam in Nigeria, boiled yam in Benin, boiled cassava in Colombia, & Uganda, fufu and eba in Nigeria have been annotated into trait dictionaries. Nine textural traits for boiled cassava in Colombia have already been uploaded in Cassavabase. A standard template for WP2 data collection was developed and adopted by partners, with ongoing training to improve inclusion of metadata and documentation. Datasets generated by WP2 are collected and first stored in Dataverse. Regarding the use of Breedbase, sensory panel data on boiled cassava generated by NaCRRI in Uganda was uploaded in Cassavabase; as well as eight biophysical & instrumental texture datasets by the post-harvest quality teams in NaCRRI and CIAT. IITA also uploaded datasets on gari/eba to Breedbase.

Overall, the RTBfoods project fostered intense interactions and exchanges of experience among partners, which helped solve bottlenecks and facilitate the research work for all 13 product profiles. A strong network of food science researchers is now in place with shared methods and same outlook on the importance of integrating postharvest quality traits among product profiles, to be used as selection criteria for the breeding and adoption of improved RTB crops.

7.1.3 WP3 key scientific achievements from Period 1 to 5

High-Throughput Phenotyping Protocols

(See Table 24 WP Achievement Reports (Period 1 to 5))

The WP3 of RTBfoods project consists of eight teams from different institutes (INRAe, CIAT, CIP, IITA, NACRRI, NARL, NRCRI and CIRAD) over seven countries (Uganda, Nigeria, Colombia, Peru, Guadeloupe, Ghana, and France). The aim of WP3 is to develop high throughput phenotyping protocols (mainly NIRS) that can be applied in national and international breeding programs, postharvest processing, and quality control procedures. WP3 has been coordinated by **IITA** (E. Alamu), **CIRAD** (F. Davrieux, K. Meghar and D. Cornet) and **CIP** (T. zum Felde). The work of WP3 aimed to make a strong contribution to the following outputs: Output 5: “Standardized ontology established for major quality traits and spectral databases developed for food quality traits”, Output 6: “Screening capacity for users’ preferred quality traits developed in key countries” and Output 7: “Operational HTP (or MTP) protocols platform for screening users’ preferred quality traits developed”.

From the beginning of the project, the states of knowledge regarding the use of spectral methods and hyper-spectral imaging for the characterization of tubers and roots have been drawn. The conclusions of this first work made it possible to collectively define the work priorities, the actions to be carried out within each institute, the pooling of instruments and the investments to be favored. At the beginning of the project 14 NIR spectrometers were available and, except NARL in Uganda, each team owns a least one NIR spectrometer. Over the project period, 3 HTP tools were purchased: 2 hyperspectral cameras (CIRAD, France and IITA, Nigeria) and one benchtop NIRS (CIAT). In addition, the RTBfoods Project has co-funded 2 portable instruments (QualitySpec, ASD), one at CIAT with co-funding from NextGen and one at CIRAD AGAP institute with co-funding from CIRAD.

From the first year of the project, efforts have been made to train WP3 teams with training in vibrational spectrometry theory, multivariate data analysis, chemometrics, calibration and in the use of software (Winisi and Unscrambler). At the end of the project 14 training sessions were achieved; these sessions were either face-to-face or online (webinars and masterclass). More than 60 partners were thus able to obtain theoretical and practical support for the development of high-throughput phenotyping methods using vibrational spectroscopy.

During the project more than 22,660 spectra were acquired for cassava (12,873), yam (4,378), banana (1,478), sweetpotato (3,152) and potato (780). These acquisitions were made for different presentations of the roots and tubers: from fresh intact to dried flour, passing through fresh ground, or grated. Some of the acquisitions were done on processed products such as fufu, gari, boiled cassava and cooked sweetpotato. in fact, the number of spectra acquired is slightly lower than expected due to the COVID crisis which disrupted access to the fields during harvesting and sampling campaigns. To these spectral data are added images acquired by HSI, CCD digital camera, and DigiEye system (VeriVide, Leicester, UK).

To carry out these measurements, operational procedures have been established and then standardized (SOP). These procedures have been written and made available online for all types of products and instruments used by WP3 researchers. In total 21 SOPs for 7 product profiles (boiled cassava, fufu, Gari-Eba, boiled potato, boiled sweetpotato, boiled Yam and matooke) were developed. These SOPs concern NIRS, MIRS, imaging and HSI measurements using benchtops instruments (FOSS DS2500, FOSS XDS, camera SPECIM FX17 and DigiEye) and portable instruments (ASD QualitySpec and ASD LabSpec). The spectral data, the physico-chemical and/or sensory data as well as the information relating to the samples are all recorded by institute/product/presentation in standardized files in Excel© format. These files also contain the characteristics and performances of the calibrations when these are available. All databases are available on the RTBfoods dataverse repository) and are listed in Table 22 Spectral datasets.

For this project seven institutes (CIRAD, IITA, CIAT, NRCRI, NaCRRI, CIP and INRAe) worked on 5 crops (banana, cassava, yam, sweetpotato and potato) for 8 product profiles (boiled cassava, fufu, Gari-Eba, boiled potato, boiled sweetpotato, boiled Yam, pounded yam and matooke). For output-7, they developed different calibrations for 51 quality traits using NIRS, MIRS, imaging and HSI. Calibrations were based on measurements done on 16 different presentations (boiled yam, cooked freeze-dried milled, cooked intact, cooked mashed, dried ground, eba, fresh grated, fresh ground, fresh intact, fufu flour, milled gari, raw freeze-dried milled, raw intact, raw mashed, unmilled gari and wet mashed fufu).

The main results confirm that spectral tools are perfectly suited for the measurement of biochemical parameters (DM, amylose, starch, protein, sugars...) when applied to homogeneous material, such as flour. However, calibrations developed from fresh material, just ground, or grated, present performances that are entirely compatible with an application to high-throughput phenotyping. As an example, the quantification of amylose content (expressed as % of Starch) in fresh cassava samples developed by NaCRRI (Uganda) presents high performances with and R^2 of 0,94 and prediction error SEP = 1,02%.

But the studies done for direct characterization of roots and tubers texture using spectral fingerprint measured on fresh material have been inconclusive, whether on the basis of parameters quantified by physical measurements (texturometer) or by sensory evaluation (panel of tasters).

For this, approaches using image analysis (DigiEye, CCD digital camera) have shown that it is possible to link the image of a root or tuber section to texture parameters and color before and after transformation (cooking or pounding). So, CIRAD and INRAe (Guadeloupe) applied, with success, imaging (digital CCD camera) on fresh Yam samples for the characterization of Yam discoloration. For this, they defined a browning index directly calculated from the extracted colors from the images. And the CIP in collaboration with the COCIS (Makerere, University) in Uganda carried out with promising results the characterization of the color and mealiness of sweet potatoes, both evaluated by a panel of tasters. To do this, the images (DigiEye) of roots (whole and/or cut) were associated with the scores of the panel and effective models were developed for the prediction of the intensity of the orange color and the characterization of mealiness-by- hand.

Furthermore, the application of hyperspectral imaging, which combines these two approaches: spectral and image, has demonstrated potential for characterizing the processing ability of tubers and roots. Indeed, the possibility of being able to draw up a cartography of the spatial distribution of the different constituents in the root makes it possible to imagine the calculation of a homogeneity index which itself would be linked to the aptitude for transformation.

Classification approaches based on spectral fingerprints and consumer-defined classes have demonstrated strong potential for the selection of genotypes of interest. It was thus demonstrated in a joint CIAT-CIRAD (Colombia, France) study that the spectral fingerprint, taken from grounded fresh cassava tubers, made it possible to correctly classify genotypes (classification rate in prediction = 81,4%) according to their ability to absorb water after 30 minutes of cooking. CIAT has demonstrated the strong relationship between cooking time and the ability to absorb water. Similarly, a study conducted by IITA (Nigeria) and CIRAD (France) demonstrated the interest of combining spectral analysis and deep learning tools (convolutional neural network) for the classification of yam genotypes, the classes (poor or good) being defined by the breeders according to the poundability. The results obtained showed classification rates, in validation, of 91,7%.

The classification approach based on spectral or image data should be pursued based on acceptability thresholds defined by consumers and formalized by WP2 researchers.

This project has enabled teams of researchers in different institutes to develop the skills for autonomous use of vibrational spectroscopy, and the ability to integrate it into their own research and development projects. Moreover, several collaborations between the teams were initiated during the project and have become sustainable. The collaboration between the IITA and the NRCRI in Nigeria, with scientific support, sharing of SOPs, reception of researchers and the provision of spectrometers is a good example. Like, the collaboration between NaCRRI, IITA and CIP in Uganda which has resulted in jointly developed SOPs, shared resources, and sustainable scientific and technical support. Just as the joint calibration development between CIAT and CIRAD was a success.

The remaining scientific & technical challenges to be overcome within the next 2 years are:

- Effort on the rigor of the implementation of the analytical chain: sampling - physico-chemical & sensory measurement - spectral measurements - modeling - external validation.
- Increase robustness of current NIRS models using external validation and continuous model enrichment.
- Capacity enhancement on equipment maintenance Support for the use of free and open-source software, exchange of scripts.
- Use future acceptability thresholds (from WP2) to calibrate dedicated classification models using NIRS.
- strengthen proof of concept for the characterization of quality traits from measurements on fresh products.
- Application of hyperspectral imaging for the characterization of the spatial distributions of constituents (homogeneity) within roots and tubers. Study of the relationships between levels of homogeneity and physical properties and aptitude for transformation.
- Developing specific scripts for data management, calibration development, image analysis…, using a common language.
- Thinking the best solution for images and HSI images storage and sharing.
- Creating web interface for deep learning/PLS models to share and apply the models in routine analysis.

7.1.4 WP4 key scientific achievements from Period 1 to 5

Integrated End-user Focused Breeding

(See Table 24 WP Achievement Reports (Period 1 to 5))

At the beginning of the project, quality was not systematically included in the selection criteria in the breeding process and was often considered as an afterthought. This resulted in some varieties being rejected due to poor quality that did not meet the requirements of the different value chain actors. While breeders were aware of certain quality traits (e.g., low cyanide in cassava or white colour in yam), quality is a complex issue that depends on the crop and the final product profile. Over the course of five years, the RTBfoods project aimed to identify the key quality attributes for each product profile, the traits related to the attributes, develop biophysical measures, and determine acceptance thresholds. Breeders collaborated with social and food scientists and chemometricians at each step. Breeding material was made available to laboratories, panelists, etc. While WP1, 2 and 3 investigated the traits involved in quality, breeders set up experiments to understand genotype and environment interactions (GEI) using the known quality traits. Throughout the project, they integrated the traits for which protocols had been developed (WP2). Finally, key traits for each product profile were identified by WP1 and 2 in the fourth phase of the project (See https://collaboratif.cirad.fr/alfresco/s/d/workspace/SpacesStore/66a07f5e-3d8a-4528-b272-a03f21a1f800?attach=true). Subsequently, breeders focused primarily on these key traits using the developed Standard Operating Protocols (SOPs).

For boiled cassava, the key traits are softness, sweetness, cyanide content and mealiness. At NaCRRI, the GxE effect was estimated for dry matter content DMC, water absorption (WAB) and softness. Correlations between traits were calculated to inform selection indices, and whole genome association studies (GWAS) were conducted on C2_clonal evaluation (196 clones) in two locations over two seasons. Four quantitative trait loci (QTLs) were found to be significantly associated with the stiffness trait (modulus of elasticity of a sample). In parallel, work is underway at CIAT to understand the genetic architecture of WAB, HCN and DMC using a multiparental population with five full sib families (237 clones). The heritability of the traits and the correlation between them have been calculated. A major finding is that clones with low DMC did not have higher water absorption during boiling. One significant QTL for cyanide, one for DMC and two significant QTLs for WAB were identified. For Gari and Eba, product conversion was investigated, mainly the GxE interaction and heritability**.**

For yam, the key characteristics were slightly different for boiled and pounded yam. For boiled yam, the key characteristics are softness/crumbliness/mealiness, sweet taste, colour, stickiness and smell, whereas for pounded yam these are stretchability, mouldability, smoothness, oxidative browning (OxB) and colour. Breeders have implemented activities of phenotyping for quality from the beginning of the project, even though high-throughput methods were not yet available. Thus, at CIRAD, phenotypic data (texture, colour, OxB, DMC, etc.) have been collected on GWAS panel and biparental populations. In the GWAS panel, 37 significant associations were identified for tuber colour, OxB, hardness, DMC, mouldability and cooking time. In the biparental populations, 25 QTLs were identified for DMC, sugars, proteins, and starch. The majority of the QTLs could be validated in a diversity panel. To complement the GWAS and biparental work, a focus was placed on three metabolic pathways involved in texture, starch content and colour. Using comparative genomics, the annotation of the three pathways was improved by 48% additional genes. A total of 27 genes were found under selective pressure and 18 genes were associated with phenotypic traits. In the same species, IITA conducted a GWAS study focusing on DMC and OxB in a water yam diversity panel grown in three environments. Significant SNPs associated with DMC and OxB were identified. Gene annotation identified genes involved in the process of proteolytic modification of carbohydrates in the dry matter accumulation pathway as well as fatty acid β-oxidation in the peroxisome for enzymatic oxidation. They also conducted a GWAS on Guinea yam (184 genotypes). Thirteen SNP markers were found to be associated with quality attributes (appearance, colour, aroma, taste, sensory and instrumental texture and mealiness) of boiled and pounded yam. Gene annotation analysis revealed co-localization of several known putative genes involved in glucose export, hydrolysis, and responsible glycerol metabolism. At the CNRA, phenotyping data for water yam quality (colour, OxB, flesh texture, tuber cooking quality and DMC) were collected on the 188 accessions of the diversity panel. The distribution and variance of the traits and the correlations between them were calculated. The accessions were genotyped using Diversity Arrays Technology (DArT) and GWAS are in progress.

For boiled sweetpotato, the key quality characteristics are firmness, mealiness, sweetness, smell, and non-fibrousness. The CIP therefore investigated these traits. The SOPS developed in WP2 were used to evaluate 220 genotypes of the Mwanga Diversity Panel (MDP) together with the 16 parents in three locations in Uganda. Instrumental texture analysis was carried out on 110 genotypes from the MDP and 40 of these were characterized by the sensory panel for 17 traits (WP2). Investigation of the distribution of traits, their variance and the correlation between sensory and instrumental traits led to the development of a predictive model to predict sensory firmness in the mouth from positive power 1 (instrumental texture). This is an important step forward in the understanding of quality attributes and the replacement of sensory evaluation, which is time consuming and costly, by instrumental measures. β-amylase gene expression was found to be negatively correlated with firmness and consequently a KASP marker was developed to screen populations at an early stage.

For Matooke, the identified key traits are flavor, colour and texture. While more traits were evaluated in the early years of the project, the identification of the key traits allowed the phenotyping to be narrowed down to these three key traits. IITA, with support from NARL, phenotyped 130 to 149 genotypes, representing about half of the genotypes in the segregating population of Matooke. The data indicate low to high heritability of the traits. Colour L and b are the main traits associated with Matookeness, together with texture distance. Texture gradient appears to be negatively correlated with matookeness. Phenotyping of the segregating population is still ongoing to reach at least 3 bunches per genotype for each of the 261 genotypes in the population. Then the association between the traits and the markers could be started.

In conclusion, all breeding programs are investigating GEI, with the exception of Matooke, which is more complex. Currently, phenotyping is focused on the key traits for each product profile, thanks to the work of social and food scientists (Work package 1&2). The investigation of the quantitative genetic parameters, to predict the response to selection and guide breeding decisions is ongoing, with progress varying according to the complexity of the crop and the product profile (mashed, cooked or dough). Most populations have been genotyped, thanks to complementary funding from bilateral projects, allowing the association between markers and phenotypic traits to be established. The development of high-throughput phenotyping methods will accelerate the phenotyping process and allow faster progress in unravelling the genetic architecture of quality traits.

7.1.5 WP5 key scientific achievements from Period 1 to 5

Gender Equitable Positioning, Promotion and Performance

(See Table 24 WP Achievement Reports (Period 1 to 5))

Within the RTBfoods project architecture, WP5 has several objectives. The primary objective of this WP was to evaluate clones/genotypes developed by breeders that were identified as having high potential by combining both agronomic and food product related quality traits as expected by users in the value chain. Thus, for each of the product profiles studied, this WP allowed a complete and multi-level evaluation of these new genotypes in comparison with local reference varieties. The second objective of this WP is more implicit, since it enables the validation of the overall approach proposed by the project. In order to carry out these evaluations, WP5 had to integrate many results obtained in other work packages. Food product quality traits identified by WP1 for each PP have been prioritized for evaluation. For this evaluation and testing of new clones/genotypes with value chain actors in under real conditions. The protocols and SOPs developed in WP2 were simultaneously applied and tested using the very same roots and food samples. This evaluation allowed breeders to verify the suitability of their proposed clones and further select those that would meet the characteristics expected by the users.

In close collaboration with WP2, WP5 has initiated the deepening of these evaluations by the development of an integrated method to evaluate clones with processors and consumers that also allows toto define acceptability thresholds for each of the expected quality traits. This approach integrates the results of several existing and developed tools (pairwise ranking of roots and foods, Consumer Testing, Qualitative Descriptive Analysis, instrumental measurements at laboratory level, statistical analysis). This has allowed us to define threshold values for some quality traits of some food product profiles. These promising results, which could be enriched by additional data, will allow breeders to have rapid feedback (through lab level analysis) on the intrinsic qualities of their clones with respect to consumer expectations regarding food product quality and processibility. It should also be noted that interesting new important criteria (other than quality) were also identified through processing diagnostics evaluation with processors: important Processing productivity and the related drudgery have been found to be clone/genotype dependent and the extent to which this is so demands further investigation and monitoring within breeding programs.

Nine partner institutions, namely: CARBAP, CNRA, CIRAD, IITA, NaCRRI, NARL, UAC-FSA, CIP and NRCRI carried out WP5 activities related to twelve product profiles: boiled cassava, gari, gari-eba, attiéké, fufu, boiled yam, boiled and pounded yam, matooke, boiled plantain, fried plantain, boiled sweetpotato and fried sweet potato. In order to establish mechanisms to link breeding outputs to key users, from producers to processors and consumers as well as to provide feedback to breeders on any adjustments to be made during selection of genotypes with potential for high food product quality, a general methodological guidance was elaborated within the framework of WP5 (https://doi.org/10.18167/agritrop/00584). It was designed to provide a guide to RTBfoods partners to evaluate promising clones/genotypes. The evaluation has a two-fold objective: (1) evaluating new varieties to determine suitability for release and promotion, and (2) providing feedback to breeders and food scientists so that they better understand the specific quality criteria and their thresholds to apply throughout the entire breeding process.

Agronomic evaluation of promising cassava, yam, matooke, plantain and sweetpotato genotypes in various locations has enabled identifying clones with good agronomic performances and high or partial resistance to pest and diseases. The implication of champion processors during participatory processing evaluation within their communities strongly contributed to the selection of suitable clones for specific food products according to priority key traits defined and preferred by processors. Consumer testing of intermediate and final food products using either conventional methods (JAR, CATA, etc.) or the Triadic comparison of samples (Tricot) technique also enabled the identification of clones preferred by consumers. For each product profile, Key Quality Traits (KQT) of the intermediate and final products were assessed through Quantitative Descriptive Analysis with trained panelists. The implementation of these steps contributed to the identification and selection of new genotypes with KQT that met the preferences of value chain actor's (producers, processors, and consumers) of the localities where the studies were carried out. This includes for:

- Boiled cassava (& flour paste): UG120193 was chosen because of its excellent performance from planting to final food product: good agronomic characteristics ease of peeling, good root taste, mealiness, softness, low fibers in the root (boiled cassava) and good paste texture, low paste stickiness, good white paste colour
- Fufu (NRCRI): TMBE 419, TMS13F1053P0010, NR15C1aF9P002, NR15C1aF68P007 portrayed excellent performance for smoothness and low stickiness and stretchability as compared to local varieties.
- Gari-Eba (NRCRI): TMBE419, TMS13P0010, NR15C1aFP002, NR15C1aF9P002 and TMEB419 had good performance on eba texture and colour and most even performed better than the checks
- Gari-eba (IITA): Game changer (TMS13F1160P0004), Obasanjo 2 (TMS13F1343P0022), and TMS14F1278P0003 performed equally well or better than commercial checks with regards to product colour and texture. Interestingly it was found that an older variety released in 2006, TMS30572 was found to be an example reference for excellent food product quality with regards to colour and texture of the food product. All these varieties performed equal or better than the local checks with regards to colour and textural properties.
- Attiéké: Bocou6, Yavo, Bocou5, and Bocou2
- Boiled and pounded yam (IITA): TDr1401220 performed better than the commercial checks on appearance and texture and TD1400158 performed equally well on these aspects.
- Boiled plantain: CARBAP 969 exhibited good agronomic characteristics, interesting quantitative descriptive analysis (firmness, sweetness & colour) and consumer testing data. It performed almost as well as the reference cultivar Batard for boiled plantain.
- Boiled sweet potato: Sanfo Figui 1, Sanfo Figui 2, Chinois Wosso and Fatoni 2
- Fried sweet potato: Sanfo Figui 1, Sanfo Figui 2, Chinois Wosso and Fatoni 2

These Improved cassavas, yam, plantain and sweetpotato clones meeting standards for processors and consumers' acceptability identified through participatory varietal selection, participatory processing, consumer testing and QDA are interesting candidates for release and promotion within communities.

WP5 developed a method to evaluate promising clones with farmer-processors and end users for Gari-Eba based on Nextgen 2-year Mother baby trials in Nigeria which is a component of the earlier mentioned integrated WP5 method. This has shown the need to upscale PVS trials in farmers' fields for a better assessment of the external validity of breeding trials that subsequently resulted in executing Tricot trials in Uganda and Nigeria where several hundred trials were installed. For complex processing such as gari-eba, baby trials and their processing cannot allow doing detailed comparison of the processability and food product quality because of the large variation involved, while this approach however well informed the food product quality of varieties in Uganda in relation to the simpler food product boiled cassava in Uganda. A combination of Tricot and processing of a central controlled mother trial as control is recommended. The tricot on farm trials and the processing by each of the tricot participants into food products can be seen as a higher-level evaluation that checks the external validity of results obtained through the more centralized and processing evaluation with renowned 'champion processors' in local communities.

The Tricot method for consumer testing (where only 3 food samples are compared with each consumer as part of an incomplete block design that involves more than 3 varieties) is based on a comparative approach rather than a ranking approach and its advantages still need to be tested alongside regular consumer testing on the same clones and with consumers in the same region to substantiate its advantage. The method is thought to better integrate human cognition capability by simply comparing varieties overall and on different traits. If this is validated, the method can also be more cost effective as relatively less consumers testing each variety might be needed. E.g., for gari-eba such work is planned this year based on the uniform yield trials in Ibadan where also NIRS and panel work will be integrated from harvest to final food product.

Although thresholds have been determined for some product profiles, there is still a lot of work to be done to make sure that parameters measured on food products in the laboratory are workable representatives of the food product quality that value chain actors are looking for. This demands more and continued processing evaluation and consumer testing with a wider more contrasting range of varieties. Furthermore, breeders have expressed interest and are developing workflows to link quality characteristics to genetic data by using multivariate analysis to allow them to make selections in populations without direct use of thresholds. When quality traits are very complex and determined by a constellation of many underlying biophysical traits the complementarity of such a multivariate approach to thresholds determination should be considered especially as it will allow selection also before good thresholds are established. Breeding programs cannot afford to extend selection on quality traits within their breeding projects until clear thresholds are established for all traits.

7.2 Annex 2: Summaries on partner institutes achievements from Period 1 to 5

7.2.1 Bioversity key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

Bioversity International (now Alliance of Bioversity International and CIAT) was involved in work packages (WP) 1, 2 and 5 for the Matooke profiles. This section summarizes the highlights and achievements of Bioversity and partners during the project in these work packages which were jointly coordinated with the National Agricultural Research Laboratories (NARL). WP1 focused on desired product characteristics, demand segments, trends, and socio-cultural context for cooking banana; designed pilot tools to conduct surveys and focus group discussions to characterize food consumption habits and preferences for men and women. Two Masters students- Moreen Asasira (Makerere University) and Nelson Willy Kisenyi (Kyambogo university), were recruited and trained. Product profile tables were made. All final tools, consent forms, scanned interview sheets and de-identified datasets for WP1 are uploaded on the RTBfoods internal website (Gendered food mapping, Participatory processing diagnosis, Consumer testing in rural and urban areas). For WP2, the main work involved identification and prioritization of the key traits for gendered food mapping. Ontology dictionaries were developed for sensory traits and processing techniques in the first instance, for Matooke but also for all RTB food products: attiéké, boiled cassava, boiled potato, boiled sweet potato, boiled yam, fried plantain, fried sweetpotato, gari-eba, fufu. Textural Traits are added. This enables the Breedbases to integrate the sensory traits measurements produced by trained sensory panels. All Trait Dictionaries for sensory traits are available on Crop Ontology web site (cropontology.org). Amos Asiimwe participated to the creation of the ontology first as junior consultant, being Master Student of Makerere University, Kampala, and then as CIRAD RTBfoods Data Manager. Capacity development has been an integral part of Bioversity's work and contributed to various work packages of the project.

7.2.2 Bowen University key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

Bowen University was involved majorly in WPI and WP2 activities on Pounded yam however in addition we were involved in WP3 and WP4 through collaborating institutes; IITA and NRCRI. In WPI two reports were submitted on state of knowledge studies on Boiled and Pounded Yam in Nigeria (WPI) we reported that textural quality was the most important index of food quality to farmers in South-West Nigeria and farmers did not have quality indicators in yam but based their quality index on yam farming experience. State of knowledge report on fresh yam and Pounded Yam (WP2) was a literature review on composition and Structure of raw yam, processing of pounded yam, product characterization and relationship with sensory evaluation, changes in composition and structure of yam/ pounded yam during processing, instrumental texture assessment and relationship with sensory evaluation -correlations between ITPA (Instrumental Texture Profile Analysis) and STPA (Sensory Texture Profile Analysis)- and relationship between composition and sensory evaluation.

Through gendered mapping the food quality profile of Pounded yam from raw yam (low moisture, regular shape) through processing (no colour change, easy formation of stretchable dough) into final product (pounded yam) (colour and textural quality) was established. Gender analysis showed that there was no main difference between women and men preferences in terms of raw material or end-product traits. Participatory diagnosis identified peeling, cooking, and pounding as processing steps that may easily alter the quality pounded yam if conducted badly. Consumer preferences test showed that high quality characteristics related to the most liked pounded yam samples were colour (cream, white or yellow) smoothness, mouldability, stretchability, moderate softness/ hardness. Triangulation for G+ Food Product Profile showed that characteristics of raw yam which will invariably give good quality pounded yam were tubers with low water content, smooth and regular shape. Easy to peel, no discoloration, short cooking time and easy formation of dough were the essential and winning traits during processing. High quality traits from the gender impact scores (G+ tools) highlighted easy to form dough, and ease of peeling (do no harm score of 0 and a positive benefit of 2).

Bowen team has contributed three SOPs in WP2: SOP for determination of starch and sugar by acid hydrolysis, SOP for sensory characterization of pounded yam, SOP for textural characterization of pounded yam and validation of two other SOPs (Dry matter and extensibility measurement of pounded yam).

Since key priority traits identified from WP1 activity in Pounded yam were Colour and Textural quality. Bowen university team established colorimeter as a MTTP method for colour measurement in pounded yam and Texture profile analysis as MTTP for textural attributes such as Adhesiveness, cohesiveness, and hardness in Pounded yam. In terms of Biochemical analyses, we identified starch and amylose as determinants of stickiness/ adhesiveness in pounded yam and correlation between ash content of the tuber and mouldability of pounded yam.

Bowen University participated in many of the RTBfoods webinars and interacted with other organizations such as IITA, NRCRI, CNRA, CIRAD, UAC-FSA through exchange of information, trainings, workshops, and publications. We also participated as lead authors and co-authors in about six manuscripts in the RTBfoods special edition of JSFA: Tropical roots, tubers, and bananas: New breeding tools and methods to meet consumer preferences.

7.2.3 CARBAP key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

This report aims at highlighting CARBAP's major achievements throughout the first phase of the RTBfoods project (from November 2017 to January 2023), while giving some insights of activities to be carried out during the second phase of the project (February 2023 to December 2024). CARBAP actively contributed to the organization of the inception meeting of the project held in Buea – Cameroon from 22nd to 28th January 2018 and was implicated in three Work Packages namely: WP1, WP2 and WP5. CARBAP completed most of its activities despite the COVID-19 pandemic. For WP1, CARBAP elaborated boiled plantain product profile through a series of steps: State of Knowledge, Gendered food mapping, Participatory processing demonstration, Consumer testing in rural and urban segments, and Triangulation for G+ food product profile consolidation. As for WP2, CARBAP analyzed raw and boiled plantain clones for their physicochemical and nutritional properties. Quantitative Descriptive Analysis and texture analysis were carried out with 9 plantain clones. CARBAP equally developed a SOP for assessing texture of boiled plantains. Finally, for WP5, CARBAP carried out a multi-local evaluation of 10 plantain clones in Njombe and Bansoa as well as a participatory varietal evaluation with the various plantain stakeholders. In all, out of the nine main RTBfoods outputs, CARBAP successfully achieved five main outputs.

RTBfoods revealed that boiled plantain key priority quality traits were pulp color for raw fruits, easiness to peel and cooking time to be considered during processing. For the final product pulp color, plantain aroma and pulp firmness were the most important traits. RTBfoods enabled the training of eight Masters' students, two PhD students (on going) and three laboratory technicians on sensory and texture analysis techniques. The project also enables CARBAP to establish new scientific partnerships, to acquire new equipment (Colorimeter, Texture Analyzer & Spectrophotometer) and to develop activities related to end-user preferences. CARBAP participated in almost all the RTBfoods webinars and interacted with national (University of Douala, University of Ngaoundere – ENSAI, University of Dschang & University of Yaounde I) and international institutions (IITA, CNRA, CIRAD, UAC-FSA & NRI) through exchange of information, trainings, workshops, annual meetings, and publications. The team also participated as lead authors and co-authors in about six manuscripts in the RTBfoods special edition of JSFA:Tropical roots, tubers, and bananas: New breeding tools and methods to meet consumer preferences.

Regarding the second phase, CARBAP will focus on (i) developing SOP & Proofs of Concept, (ii) screening plantain genotypes with preferred quality traits from Musa populations, (iii) assessing thresholds of acceptability of selected quality traits and (iv) ontologies and database management.

7.2.4 CIAT key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

Implementation of the RTBfoods project at CIAT opened several research avenues on breeding and phenotyping for the cooking quality of boiled cassava. The progress over the past five years (2017-2022) can be summarized as follows:

Based on existing knowledge on cooking behavior of cassava landraces kept in the gene bank of CIAT, 30 contrasted genotypes were selected to establish a progenitor population in the field. Crossings resulted in an F1C1 progeny population of ~400 clones, enabling the study of heritability of good cooking quality traits. Self-pollination trials of this progeny population are ongoing to create a second generation with the expression of more recessive traits related to cooking quality.

The progenitor population was also used as a source of root materials to develop a series of new methods (2018-2020) to phenotype cooking quality, including sensory characterizations (quantitative descriptive analysis, QDA) and biophysical characterizations in particular water absorption (WA30), texture-extrusion and Mattson cooker. Correlations between sensory descriptors and instrumental parameters were identified, showing that textural Hardness and textural Distance-at-peak-force can predict sensory hardness and sensory mealiness, respectively. Water absorption was also shown to predict mealiness, which is a key acceptability criterion for boiled cassava. The newly developed methods were described in detail in standard operating protocols (SOPs) format. In parallel, protocols for acquisition of NIRS data on fresh grated roots and on fresh cut roots were developed, with the aim of using NIRS as high-throughput phenotyping (HTPP) tool for some of the quality traits of boiled cassava.

Using data from NaCRRI on consumers preferences of boiled cassava (overall liking and liking for specific traits Mealiness and Hardness), it was also possible to establish thresholds of acceptability first in terms of QDA scores, and then in terms of WA30 and texture Gradient values. These thresholds are now available to include in the product profiles of boiled cassava proposed by CIAT Cassava program to Excellence in Breeding. This approach of linking consumer preferences, QDA and instrumental datasets will be repeated during RTBfoods phase 2 (2023-2024) with additional data collected in Colombia on exactly the same population of genotypes, for better accuracy of the acceptability thresholds.

Once the phenotyping methods were well established, a large dataset of biophysical data was collected by planting the progenitor population for three years in a row (2019, 2020, 2021) and harvesting three times each year (9, 10 and 11 months after planting) for phenotyping. The resulting dataset (272 datapoints) enabled investigating the effect of plant age and environment on cooking quality, and was large enough to develop a robust NIRS calibration to predict dry matter of fresh cassava roots. 15 promising genotypes with good cooking quality were identified among the progenitor population, and can be integrated as parents in breeding pipelines of the CIAT cassava program.

HTPP of cooking quality proved challenging at first, as NIRS spectra provide a fingerprint of the chemical composition of the fresh roots (e.g., dry matter, starch content), but cannot directly predict the chemical reactions and mechanical changes that take place within the food matrix during cooking and contribute to the quality of the end product. As water absorption was increasingly adopted within CIAT Cassava Program as routine analysis to characterize cooking quality of several populations (including non-RTBfoods populations, 2020-2022), it became possible to assemble a larger dataset (2905 datapoints) of NIRS spectra and reference data (WAB). Thanks to the reduced noise-to-signal ratio of such dataset, a calibration between NIRS and WAB resulted in successful classification of cassava genotypes between good-cooking and bad-cooking quality, defined as WAB above and below 12% respectively, with 81.4% accuracy. This represents a major step forward and the culmination of the RTBfoods phase 1 research at CIAT, with the demonstration that NIRS can reliably screen out bad-cooking cassava genotypes, thus cutting analysis time from 30 min/sample with the WAB method to less than 5 min/sample with NIRS.

Additional HTPP methods were investigated in the course of the project, such as hyperspectral imaging (HSI - NIRS). Images of root sections obtained with this method give access to the spatial distribution of components within cassava roots. So far prediction of the distribution of water has been achieved, showing that the inner, more fibrous part of fresh cassava roots contains more water than the starch-rich outer part.

Finally, proof-of-concept analyses of the composition of cassava fresh roots indicated that dry matter and starch have little to no effect on the texture of boiled cassava, and that genotypes with less pectins were associated with higher water absorption and better cooking quality. These results need to be consolidated during RTBfoods phase 2.

7.2.5 CIP key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

CIP contributed to the RTBfoods project on the product profiles of boiled sweetpotato, fried sweetpotato and boiled potato. For boiled sweetpotato, the WP1 team has identified sweetness, mealiness, firmness, aroma, and non-fibrousness as the priority quality traits. WP2 has developed standard operating procedure (SOPs) for sensory characterization to 1) validate the instrumental texture SOP; 2) generate sensory profiles for the Mwanga diversity panel; 3) establish the GxE interaction for sensory attributes for advanced sweetpotato clones; and 4) establish reference values for near infrared spectroscopy (NIRS) and image analysis prediction by WP3. Nine sweetpotato genotypes were evaluated on 75 on-farm trials in Uganda and the consumer testing and descriptive sensory analyses were conducted at harvest. For fried sweetpotato, WP1 has identified crispness, crunchiness, mealiness, non-oiliness as the priority quality traits for the fried sweetpotato product. For potato and boiled/steamed sweetpotato, the gender and livelihoods assessments were conducted with quality traits identified by the evidence report from WP1 in the food product profile by stakeholders using the gender responsive breeding tools (G+ Tools).

Boiled sweetpotato (Uganda): The boiled sweetpotato product profile brief was published in IJFST in September 2020 entitled Development of a food product profile for boiled and steamed sweetpotato in Uganda for effective breeding, doi:10.1111/ijfs.14792. This highlighted the desirable quality characteristics for raw sweetpotato root, processing, and the final product. A gender and livelihood analysis were conducted to prioritize the key traits for the breeding program to address. These traits include sweet taste, firmness, mealiness, sweetpotato aroma and fibrousness of the boiled sweetpotato root. Experiments have been conducted to understand the biochemical and biophysical aspects of these priority quality traits and subsequently to develop standard operating procedures for uniform and consistent sample preparation and quantification. Sweet taste significantly correlates to maltose content of the boiled sweetpotato and near infrared spectroscopy (NIRS) calibrations to predict maltose content will enable us to predict sweet taste in samples at high throughput. Firmness of boiled sweetpotato can be predicted by the force of the first cycle of the texture analyzer using the texture profile analysis (TPA) probe. A ‘kompetitive allele-specific PCR’ (KASP) marker has been developed and validated for marker-assisted selection for firmness. Mealiness of boiled sweetpotato roots can be predicted from DigiEye images at high throughput. These standard operating procedures (SOPs) have been integrated into various stages of the breeding program to advance clones with consumer-preferred traits. Combining consumer testing with quantitative discriminant analysis (QDA) has illuminated the desirable thresholds for four priority traits that can be used to guide breeding decisions.

Fried sweetpotato (Nigeria/Ghana): The desirable attributes for fried sweetpotato product are detailed in an IJFST article entitled Fried sweetpotato user preferences identified in Nigeria and Ghana and implications for trait evaluation, doi:10.1111/ijfs.14764. Root characteristics, processing attributes, in-mouth attributes and appearance of fried product were critical to final product quality. Raw roots should be hard, have smooth skin and no off-odors. Peeled roots should be hard to slice and not sticky. Stickiness and moist surface indicate high moisture content, associated with excessive oil absorption during frying. Hard-to-slice roots indicate high dry matter. Fried product should be crisp, slightly sugary and mealy, have a uniform color with brown tint and not be soggy.

Boiled potato (Uganda/Kenya): The desirable attributes for boiled potato have been published in an IJFST article entitled Prioritizing quality traits for gender-responsive breeding for boiled potato in Uganda, doi:10.1111/ijfs. The root size, skin and flesh color are linked to market preferences. Mealiness and firmness were the key quality traits that the breeding program needs to consider.

Subsequently, experiments are still underway to develop and validate standard operating procedures for sample preparation, optimal cooking, water absorption, quantitative discriminant analysis and texture analysis.

7.2.6 CIRAD key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

CIRAD, as project coordinator, carried out the coordination of the different scientific activities between the target and spillover countries and project partners. A project management unit was set up to monitor activities and deliverables organize annual meetings, training and follow-up missions of field activities and communication, as well as partner and consultant sub-contracts and financial monitoring of project expenses. A website, bi-monthly webinars, and a platform for the exchange and storage of documents and deliverables were developed and kept active. Permanent communication was maintained between the RTBfoods project teams and RTB crop breeding projects such as Nextgen, ABBB, AfricaYam, SweetGains. For CIRAD, the guiding principle for the 5-year project was to establish “Food target product profiles (FTPP)” for the most widely consumed products in sub-Saharan Africa based on Roots Tubers & bananas (RTB): cassava, sweet potato, yam, and cooking banana (plantain and Highland bananas). The scientific activities of the project were organized around 5 work packages (WP) to strengthen and validate in an iterative way new method of evaluation of the essential quality traits and the implementation of biochemical, spectral, or imaging methods at high and medium flow within the varietal breeding programs.

In association with the local partners, new methodologies specifically developed to collect the information needed to build the TFPP have been developed, tested, and validated with value chain actors (farmers, processors, traders, end-users, and consumers). https://doi.org/10.1111/ijfs.14680. At the end of the varietal selection cycle, the validation of new genotypes, including the quality traits essential for better varietal adoption, are evaluated in participatory mode.

To achieve this phase, CIRAD participated in the collection of information through gender-disaggregated surveys and in the diagnosis of processing operation, through numerous field missions in support of local partners. These missions were associated with consumer testing with more than 80 consumers in order to highlight the genotype quality traits essential to processing drudgery alleviation contributing to the preference of consumers according to the quality of the ready to eat end products.

These traits were dissected with the partner’s teams by product profile, to develop methods to evaluate them. Numerous Standard Operating Procedures (SOP's) have been developed in collaboration with the partners. The SOP's have been tested, validated, and implemented in the laboratories to allow the extraction of genotypes presenting these traits within the RTB breeding pipelines. In parallel, high throughput methods by spectral or image analysis have been implemented in the different varietal breeding programs. Prediction curves for some of the quality traits have been established and each harvest is now used to strengthen the databases to improve predictions. In order to be able to introduce the results from the measurement of traits from the developed SOPs into the existing databases e.g., breedbase, ontologies have been developed and trait dictionaries (sensory, textural, physicochemical analyses) have been produced. Breedbase is developing extensions to collect this new information generated by the laboratories for each genotype studied.

Genetic architecture of users' preferred quality traits is under development. Many geneticists have already been able to find QTLs for some preferred quality traits and have developed powerful tools for genomic research. CIRAD coordination is conducted in close collaboration with the crop program of Nextgen, AfricaYam, ABBB, SweetGAINS. CIRAD mainly looked for QTL related to the quality of D. alata yams after steaming or boiling in Guadeloupe.

CIRAD has proposed a new method for establishing thresholds of acceptability for essential traits. https://doi.org/10.18167/agritrop/00584.Trait acceptability thresholds are validated by target consumers through consumer testing and sensory panels (Quantitative Descriptive Analysis) for each product profile. New genotypes containing the quality traits essential to consumers are grown and tested against locally adopted varieties (landrace). Each genotype is processed for a specific product profile. Validation is carried out in participatory mode by evaluating the yields of the end product, the drudgery related to the difficulty of processing, mainly carried out by women, and the organoleptic properties. The most promising clones are selected to be presented to the varietal release committees of each partner.

7.2.7 CNRA key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

In the RTBfoods project, CNRA was involved in all work packages. The activities of WP1, WP2 and WP5 focused on attiéké. Work packages 4 and 5 dealt with the products: pounded yam, fried plantain, and fried sweet potato. In addition, WP3 and WP4 activities on yam quality traits were conducted in collaboration with CIRAD.

Attiéké: In **WP1**, through gendered mapping, the food quality profile of attiéké from raw cassava (white hard flesh, with less water and insoluble fiber) through processing (sweet taste, not sour and with round, hard, and not sticky granules) into final product (attiéké) (colour and textural quality) was established. Gender analysis showed that females dominate the processing. Triangulation for G+ Food Product Profile showed that adults and elders want attiéké that is not sour with visible granules in rural areas. Women pay more attention to the white color and the visibility of the grains as well. Young people, whether in rural or urban areas, are less demanding about the quality of attiéké. The most important characteristics defining a good variety of cassava for a good quality of attiéké are: mature tuber with less physical damage and very few insoluble fibers, a beautiful color of the flesh, a skin easy to remove, and a hard flesh (not too dry, not too wet either). Concerning the end product, the descriptors of a good quality attiéké are slightly fermented and sour taste, bright color, well-shaped and round grains. In **WP2**, a SOP for sensory evaluation of attiéké was developed by using contrasting genotypes https://doi.org/10.18167/agritrop/00607. The texture attributes (mouth filled sensation, moldability, cohesiveness, stickiness), taste and sensation (sourness, red oil taste), and appearance attributes (brightness, fibers, and color) as priority traits. In **WP5**, Bocou 2, Bocou 6 and I090006 were identified as hybrids cassava suitable for good quality attiéké. One article was published on agronomic and sensory evaluation of some cassava varieties in three agro-ecological zones of Côte d'Ivoire (http://dx.doi.org/10.5281/zenodo.6593224). In addition, two other articles have been submitted on attiéké and a thesis is being completed.

Pounded Yam: The results of **WP1** show that yam production activity is mainly done by men. The desirable attributes for the quality of yam tuber hat gave a good pounded yam are: healthy and mature tuber, with a yellow second skin, medium shape, tuber which do not exude water when cut or pinched with fingers. For pounded yam, stretchability, smoothness, masticability, stickiness, firmness (moderately hard/soft) were the key quality traits that the breeding program needs to consider. In the **WP3**, in collaboration with the CIRAD, prediction equations have been developed from NIRS for *D. alata* pounded yam texture parameters such as firmness, elasticity, stickiness, malleability and physicochemical as dry matter, starch, proteins and sugars. Among these attributes, dry matter, sugar content and starch content could be well predicted by the NIRS. On the basis of these prediction equations, the determination of physicochemical and textural parameters of a sample of 56 hybrids developed by CNRA was performed. For the **WP4**, 22 506 markers SNP were developed on 188 samples of the germplasm of D. alata by genotyping by sequencing (GBS). Phenotyping data for water yam quality (colour, OxB, flesh texture, tuber cooking quality and DMC) were collected on the 188 accessions of the diversity panel. The distribution and variance of the traits and the correlations between them were calculated. The accessions were genotyped using Diversity Arrays Technology (DArT) and GWAS are in progress. For the **WP5**, Participatory evaluation tests permitted to identify 14 clones (8 *D rotundata* and 6 *D. alata*) well appreciated for pounded yam. Two articles have been published (DOI: 10.1177/09670335211007575; https://doi.org/10.3390/plants10122562). Two PhD thesis were conducted and defended on yam with the support of the RTBfoods project.

Fried plantain: For fried plantain (Alloco), ten (10) plantain varieties (Horne 1, Orishele, PITA 3; FHIA 21; French dark, BITA 3; Zakoi, SH 3640, Corne 18 Rouge and French 2) are being evaluated (**WP5**). Texture attributes (firmness, chewiness, Stickiness), Color Homogeneity, Appearance attribute (fatty aspect), taste and Mouth impression attributes (fat feeling, Astringency, acidity) and frying odor has been identified on **WP1** as the priority quality traits. **WP2** has developed standard operating procedure (SOPs) for sensory characterization of alloco produced from different genotypes of plantain (https://doi.org/10.18167/agritrop/00709). Physicochemical analyses showed a decrease in dry matter content during ripening, while sugar and lipid content increased. In terms of physicochemical and textural analyses, the results indicated a positive correlation between meaning firmness, stickiness, chewiness attributes of fried plantain and the dry matter and starch content; but no correlation was found with pectin content. As a lab texture analyzer was acquired this 2022, a SOP for instrumental textural evaluation of sensory attributes is on progress. One article was published (https://american-jiras.com/Catherine-Ref11ajira210921.pdf).

One Master was conducted on plantain and defended.

Fried sweetpotato: In WP5, participatory agronomic and sensory evaluation were conducted with 22 sweetpotato varieties in two regions (Gbêkê and Poro). At Bouaké, the local varieties Aleda ouffouet, Sanfo figui 1, Sanfo figui 2 and the improved varieties TIB-440060, CIP-199062-1 and Irene were the most appreciated. In Korhogo, the improved varieties TIB-440060, Irene, CIP-199062-1 and Covington were appreciated. The texture (crisp, dry, and crumbly) and the taste (low sweet) have been identified as the priority quality traits (**WP1**). Biochemical analysis of the preferred varieties has showed considerable presence of Na, Mg, P, Ca, Mn, Fe, Cu and Zn in fresh roots. In addition, farmers indicated a preference for varieties with white, yellow, or orange flesh, spreading stems, round, oblong or elliptical shape, red or orange skin.

One article was published on these results (10.9734/jabb/2021/v24i830231) and two communications have been presented (https://africanpotatoassociation.org/wp-content/uploads/2022/07/APA-2022-Book-of-Abstracts_Final.pdf).

In addition, two other articles have been submitted on sweetpotato and a thesis is being completed.

Capacity building

The RTBfoods project contributed to the strengthening of the CNRA's capacities through the purchase of a 4X4 field vehicle and a texturometer for biophysical analysis.

An operational image acquisition laboratory has been installed: for all measurements that can be extracted from images (determination of color, tuber oxidation, size, and shape of tubers, etc.).

One (1) researcher and one (1) PhD student benefited from a training stay at CIRAD in Montpellier and Guadeloupe on modern method of yam phenotyping and genotyping.

One (1) researcher and one (1) technician received training on yam quality in Benin.

Nine (9) students were trained on the project including 5 PhD and 4 Masters.

One breeder, one technician and one driver have been recruited to reinforce the research team.

Objectives for phase 2 of RTBfoods

The main objective for phase 2 is to continue to develop medium- and high-throughput phenotyping of yam quality. Then to determine the textural characteristics of different genotypes for pounded yam and to screen the breeding genotypes for good and bad pounding yam.

To achieve these objectives, the newly acquired texturometer and the image acquisition laboratory will be strongly involved.

7.2.8 IITA key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

The document is a comprehensive report of IITA activities and achievements in the past 5 years of the RTBfoods project. The report includes the milestones on Gari/Eba, Matooke, boiled yam, and Plantain/Banana product profiles. WP1 produced three states of knowledge documents that informed the gendered survey work on trait preferences for fried plantain and Gari/Eba including gender mapping and gender inclusiveness. The results of which have formed the basis for the interdisciplinary efforts to identify the priority quality traits for the target product profiles. During the five years' cycle of the project, the key priority quality traits were identified for the product profiles. Assessment of the gender responsiveness of the target product profiles through the G+ tools showed that proper gender inclusion was mainly due to having a multidisciplinary (social and natural science) team involved in all the WP1 activities. For plantain, the key traits that determine the plantain food product quality are ripening stages and varietal differences. Color, texture, and taste were discovered to be the main traits for Matooke quality, while texture and color are identified as priority quality traits for Gari/Eba, boiled yam, and matooke. Other traits identified per product profile are water absorption and cooking time for boiled yam and taste for matooke. To accurately evaluate these attributes, 2 SOPs were validated using 30 cassava genotypes for the instrumental and sensory textural profile of Gari/Eba, an SOP was validated for the instrumental and QDA of boiled yam. Colour and texture measurements were conducted using a chromameter (Konica Minolta CR-400/410) and Stable Micro Systems (TA.XTplus) texture analyzer. WP2 suspected that the biochemical components responsible for the textural quality of the product profiles are dry matter, starch, and amylose, while polyphenols are suspected to be responsible for color. To rapidly evaluate these quality traits, high throughput techniques were developed, such as, 2 SOPs for NIRS on fresh blended cassava roots for Dry matter and starch, 1 SOP for NIRS on intact cassava roots for Dry matter, and 1 SOP for NIRS on evaluation of functional properties and color of cassava flakes (milled and unmilled gari). NIRS prediction models were also developed for the textural characterization of boiled yam. WP5 then developed a method to evaluate promising clones with farmer-processors and end users for Gari-Eba based on Nextgen 2-year Mother baby trials in Nigeria that also informed the release of a variety. Furthermore, WP5 new clones with farmer-processors and consumers in Nigeria and littoral zone in Cameroon. Results show the need to upscale PVS trials in farmers' fields for a better assessment of the external validity of breeding trials, while it was found that gari colour and instrumental texture profile analysis (ITPA), were related to the overall liking by consumers. For those consuming ethnic groups who practice more fermentation the colour and more ITPA components on the eba are related to the overall liking and they prefer eba made with gari with a lower solubility. Varietal consumer preferences across Nigeria and Cameroon however show similar trends which indicates that breeders can address a wide variety of agro-ecologies and cultural traditions by addressing crosscutting quality characteristics. The existing variability indicates that apart from thresholds determination, directly linking genetic and food science parameters to consumer testing using multivariate analysis might be a complementary way of selection, apart from thresholds. WP4 has established genetic diversity in cassava germplasm which is essential for improving root quality conversion rates and Eba such as texture and colour.

The cassava program focused on evaluation of breeding populations for gari and fufu quantity (conversion rate) and quality traits (biophysical traits and sensory). Genetic parameters associated with the variability of these traits, including variance components, heritabilities, and GxE patterns were determined. Moreover, root conversion rate for both products had a significant positive correlation to Dry Matter content and a negative but insignificant correlation with fresh root yield. There was a strong genotype-by-environment interaction for both product conversion rates, with the environment having a greater effect on the phenotype. We characterized genetic variability, heritability, and correlations among quality-related traits of gari and eba. Thirty-three diverse genotypes were used, and 41 traits were categorized into fresh root quality, color, functional, and texture properties. The study found broad genetic variability among the genotypes, and dry matter content had a positive correlation with gari% and bulk density but a negative correlation with eba hardness and gumminess. The study also found considerable variation in heritability for the different trait groups, with some traits showing good potential for genetic improvement through recurrent selection breeding. However, the environment and residual variance explained a larger percentage of the variation among genotypes, emphasizing the need to explore high-throughput phenotyping methods for direct selection of these traits in the breeding pipeline.

Intrinsic food quality related to the genetics of the crop is an important factor influencing the acceptability of the yam crop for consumption. The yam program dissected the genetic factors underlying sensory and textural quality attributes of the two dominant food products from white Guinea yam - 'boiled yam' and 'pounded yam' - using a genome-wide association study (GWAS) on a panel of 184 genotypes derived from five multi-parent cross populations. The panel was phenotyped for the qualities of boiled yam and pounded yam using sensory and instrument based textural profile assays. The evaluated genotypes displayed significant variations for boiled and pounded food quality attributes. The GWAS results from a multi-random mixed linear model with kinship and PCA used as covariate identified 13 single nucleotide polymorphic (SNP) markers associated with the boiled and pounded yam food qualities. The associated SNP markers explained 7.51 to 13.04% of the total phenotypic variance. Regions on chromosomes 7 and 15 were found to be associated with boiled and pounded yam quality attributes from sensory and instrument assays. Gene annotation analysis for the regions of associated SNPs revealed co-localization of several known putative genes involved in glucose export, hydrolyze and responsible glycerol metabolism.

In the 5th year of the project, WP2 narrowed down on 3 main traits for Matooke quality: colour, texture and taste. Colour is measured using a chromameter (Konica Minolta CR-400/410) and texture is measured using a texturometer (TA.XT, Stable Micro Systems). So far there is no means of measuring taste. In March 2022 we started phenotyping the segregation population for colour and texture on raw matooke bunches, using the WP2 SOPs for the two traits. The genotypes come from one field in Sendusu in Uganda. Because bunches are evaluated as they mature, we have the phenotypic data for 130 to 149 genotypes which represent about half of the genotypes in the segregating population mainly made of triploid hybrids from crosses between 4x (matooke-derived) and 2x parents.

The data we have so far indicate low to high heritability of the traits (0.27 to 0.81). The PCA biplot confirmed that colour L and colour b are the main traits associated with matookeness, together with texture distance, which is a measure of force used to penetrate the first 1 mm of the sample. Texture gradient seems negatively correlated with matookeness. However, one needs to keep in mind that matookeness is not about softness vs. hardness, yellowness or orangeness, but rather the right ranges of the traits. These ranges are yet to be validated by WP2. We are still phenotyping the segregating population to reach at least 3 bunches per genotype for each of the 261 genotypes in the population. The genotypic data are already available.

7.2.9 INRAe key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

INRAE was involved in boiled yam and boiled plantain product profile. INRAE developed strategies and methods with the aim of unravelling the impact of cell wall polysaccharides and polyphenols on cooking ability and the mechanisms involved. For boiled and pounded yam only, NIRS calibration models for biochemical traits determination and hardness, and prediction models, were developed. Yam plants sanitation was also carried out.

Yam production, yam cooking and texture evaluation took place in Guadeloupe whereas cell wall analyses were carried out in Avignon. Ten varieties of Dioscorea (D.) alata, D. trifida and D. esculenta have been studied for their processing ability and texture. INRAE Guadeloupe results confirm the variability within species and varieties for all the criteria studied and pointed out noticeable differences according to growing area. Cell wall analyses on these samples showed differences between genotypes and harvest locations that could be related to textural properties and putative mechanisms of modifications during cooking. The absence of pectin methyl esterase (PME) activity indicates a prevalence of chemical degradation during cooking.

Ten varieties of plantain from Ivory Coast (CNRA) were analyzed for their textural properties and cell wall composition. Pectin seems to be highly degraded during plantain cooking probably mainly by both PME and polygalacturonase endogenous enzymes. Moreover, firmness seems to be related to a lower pectin methylation after boiling. Starch content also positively correlates with firmness which suggests that it is also a key parameter for cooked plantain texture.

7.2.10 JHI key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

The cell walls of sweetpotato (SWP) roots have an important role in the development of texture during cooking and may influence the textural quality and consumer acceptability of major processed SWP products. Specifically, cell walls may resist swelling pressures caused by gelatinization of starch during cooking, so the considerable differences in textural properties noted between SWP genotypes may arise through differences in starch, or cell wall structure/ composition.

Objective- to investigate the role of cell wall biochemical parameters on textural differences in sweetpotato roots

JHI focused on biochemical attributes that may influence cell wall strength and thereby affect cooking time or firmness. To achieve this, we have developed methods to assess the textural strength of cooked SWP roots (See SOPs) and adapted methods to measure pectin methyl esterase [PME] (which can affect pectin methylation and cell wall strength) as well as assessing α-amylase activity (which influences starch gelatinization). We also developed a method to extract cell walls from SWP roots (See SOPS) so we could assess if the composition of cell wall polymers could influence texture. We also developed FT-IR spectroscopy methods to non-destructively assess cell wall structure. Over various studies on SWP genotypes with differing boiling texture properties (supplied by CIP Uganda & Kenya), we found no correlation with PME or α-amylase activities, nor with cell wall monosaccharide composition and textural properties. FT-IR spectroscopy also did not provide any spectral features related to pectin methylation that could be correlated with textural differences. However, integrating work done at CIRAD Montpelier suggested a partial correlation between SWP firmness and starch amylose content and sugar contents (See paper in preparation). Similarly, there seems to be little influence of cell wall composition/ structure and the textural properties of SWP genotypes that have different textural properties upon frying.

7.2.11 NaCRRI key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

During the past five years NaCRRI has implemented research activities across five work packages all hinged on boiled cassava roots, the target food product. Resources for this work have leveraged both RTBfoods and NextGen projects.

WP1 activities enabled prioritization of end-user attributes for raw, processed, and final-end products, a finding that wasn't known before. Relatedly, concepts related to development product profiles were learned and boiled root food product profile developed.

WP2 activities enabled translation of desired quality attributes into measurable units. This entailed the development of standard operating procedures (SOPs). Notable of these included sensory evaluations, instrument-based texture assessment for boiled roots and other methods (i.e., water absorption). A total of 21,038 observations have been generated.

Under WP3, SOPs for spectra acquisitions were developed; Near-infrared spectroscopy (NIRS) models deployed for routine assessments (i.e., root dry matter content and starch content). We generated 5,969 spectra for model development to measure amylose, hydrogen cyanide, and softness.

Under WP4, white-fleshed and/or provitamin A (pVAC) clones have been evaluated for preferred quality traits. Generated datasets enabled selection decisions (i.e., advancement of clones for farmer's evaluations) and for genotype-by-environment analyses.

WP5 activities enabled deployment of triadic comparison of technologies (TRICOT) on 480 farmer's fields across 10 districts. Host farmers included youth, men, and women. Generated datasets will enable decisions for varietal release.

Three students Ms. Fatimah Babirye, Mr. Enock Wembabazi and Mr. Micheal Kanaabi, have written thesis using datasets generated from this project.

7.2.12 NARL key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

This report presents achievements of NARL in RTBfoods project from November 2017 to November 2022. Activities were initiated with reviews of state of knowledge https://doi.org/10.5281/zenodo.7057374 and gendered food mapping surveys of user preferred characteristics https://doi.org/10.1111/ijfs.14813. Priority characteristics were big compact bunches, long, straight/slightly curved finger, compactness, yellow and soft fruit pulp. Basing on these results, matooke product profile, https://doi.org/10.18167/DVN1/HQX13V was developed.

A trained panel was used to generate a sensory lexicon, a matooke sensory analysis protocol and sensory profiles for quality characteristics of matooke. Suspects biochemicals underpinning the key characteristics were identified and prioritized as dry matter, total starch, pectins and amylose content (for texture) and; carotenoids and polyphenols (for colour). Instrumental indicators of textural characteristics-hardness, cohesion and adhesion were assessed by penetration/double compression while yellow colour was assessed using chroma L*a*b* colour coordinates. SOPs for sensory https://doi.org/10.18167/agritrop/00593 and instrumental (texture analysis of cooked matooke were completed https://doi.org/10.18167/agritrop/00602) while those for raw matooke texture and colour are under review. Correlations between biophysical, instrumental, and sensory profiles were performed, revealing that total polyphenols influence taste and colour while amylose influenced textural properties. Sensory textural properties - firmness by mouth and hardness by touch were strongly correlated with instrumental hardness.

A correlation of the laboratory, instrumental and consumer assessment of four advanced genotypes revealed strong associations suggesting a possibility to predict consumer characteristics using quantitative laboratory assessments. RTBfoods also supported three students and strengthened laboratory capacities. Future activities will focus on acceptability thresholds analysis, rapid kitchen tests to screen germplasm, completing pending SOPs, screening matooke germplasm and data management.

7.2.13 NRCRI key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

This report captures the contribution and achievements of NRCRI, Umudike within RTBfoods project over the past five year. The contributions of the institute spans across wp1, 2, 3, 4 and 5 leading to identification end-user preferred quality traits, development of SOPS, proof of concepts studies and release varieties that meet needs cassava and yam end-users within and outside Nigeria. These deliverables contributed to the success of the RTBfoods phase 1. Key achievements recorded by the institute include; identified important end-user traits for cassava, yam, and their product; fufu, eba, boiled and pounded yam. The prioritized traits include ease of peeling, retting ability stability of color after peeling, texture, taste, and colour. NRCRI also participated in development of SOPs for profiling sensory and instrumental textural properties of fufu and eba, boiled and pounded yam. Rapid kitchen tests such as hand-held penetrometer, foaming ability, water clarity and turbidity were developed for characterizing the retting ability of cassava genotypes. SOP for evaluation ease of peel of yam and cassava varieties has been developed and is being validated by CIRAD. Proof of concept studies have also been carried out at NRCRI to ascertain the biophysical properties of cassava genotypes responsible for variation in retting ability and ease peel of cassava genotypes. We have also developed a rapid kitchen test for screening the cooking time of different yam accessions. Different models have also been developed for predicting biophysical properties of raw and intermediate from yam and cassava using ASD quality Spec NIRs. Priority trait such as fufu yield and retting ability are now mainstreamed into selection index of cassava breeding program at NRCRI. Within the past 5 years NRCRI has registered and released cassava and yam variety with quality attributes that meet needs of end-users in Nigeria

7.2.14 NRI key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

This paper presents the achievements report for the Natural Resources Institute (UK) (Lora Forsythe and Aurelie Bechoff) for Periods 1-5 for the RTBfoods project. NRI has contributed to several important achievements pertaining particularly to Work Package 1 (WP1) outputs 1 and 2. Firstly, NRI has led a number of important publications, including for the recent Special issue of the Journal of the Science of Food and Agriculture including the Gendered Food Product Profile (GFPP) methodology (Forsythe) and Sensory Methods for RTB variety acceptability (Bechoff), along with 8 other papers in the same issues. NRI also led on the publication of the WP1 methodology in a Special Issue of the International Journal of Food Science and Technology https://doi.org/10.1111/ijfs.14680, and contributed to 4 other partner publications in the same issue. WP1 Step 2 data, of which Forsythe is a focal point, contributed to 11 publications in this issue.

NRI is also particularly proud of its Gender Output. The Output was co-developed with partners through the creation of the Gender Working Group (GWG), which consists of 16 members from 9 institutes, working on 8 RTB products in 3 target sub-Saharan countries. This provided a means to develop a cross-product and country data aggregation, analysis and report writing in a participatory way. The model has been so successful that other WP coordinators would like to use the method. We developed and presented our initial findings at the GREAT gender-responsive crop breeding conference; wrote a blog on the presentation for the RTBfoods website, our findings informed PMU's presentation to the ANR (French National Research Agency) conference on Gender in Research (of which a paper will be published in the ANR Handbook on the subject), in addition to the co-development of a publication of the gender output data in a Special Issue on Innovations in Gender Research for Sustainable Food Systems, in Frontiers in Sustainable Food Systems (Forsythe first author).

Other important achievements are the development of the WP1 Gendered Food Product Profile (GFPP) guidance document and template by a Food Product Profile working group and the adaptation of the G+ tool by the GWG, led and facilitated by Step 5 Focal point (Forsythe). This was presented and validated by the RTBfoods Advisory Committee in May 2021. Two webinars were developed and available on the RTBfoods YouTube platform, one for the RTBfoods guidance and another for the Africa Yam training seminar (See Forsythe et al., (2021) WP1 Food Product Profile Methodology webinar and Forsythe et al., (2021) WP1 methodology for gendered product profiles, Africa Yam webinar. Based on this guidance and support from WP1 Coordinator, all WP1 partners for all product profiles were submitted. The GWG coordinator (Forsythe) led the development with the GWG the RTBfoods Product Profile gender assessment document and template and adapted G+ tool. This was developed to fit the focus of the RTBfoods project and approach to gender equity. The aim of these tools is to assess the potential gender impact for RTB crop and food product related characteristics (or expressed as traits if established) to inform what is included and prioritized in the final version of the WP1 Food Product Profile. In addition to the tool and template, Jacqui Ashby, and Forsythe (2021) gave a webinar on the G+ tool, which is available on the RTBfoods YouTube channel.

Another significant achievement was the tools, learning material and ongoing support and capacity strengthening facilitated and provided by Forsythe and Bechoff to partner teams. Specifically, Forsythe as focal points for Step 1, 2 and 5 and Bechoff as Step 4 focal point and WP1 coordinator in partnership with Laurent Adinsi (FSA-UAC). This was highly valued by WP1 partners. Group and one-to-one support were provided for partners with relevant templates and data analysis tools, which led to the delivery of over 12 partner reports for Steps 1, 2, 4 and 5. This is a significant contribution to new knowledge regarding the gendered differences in varietal and quality characteristic preferences of vitally important RTB food crops in sub-Saharan Africa.

7.2.15 UAC-FSA key achievements from Period 1 to 5

(See Table 25 Institute Achievement Reports (Period 1 to 5))

UAC-FSA (Benin) team worked mainly on two products profiles, boiled yam and boiled cassava which were addressed through WP1, WP2 and WP5. Important food quality characteristics of both products were identified by triangulation and consolidated through the G+ analysis of the product profile. For both crops, the SOPs related to sample preparation, sensory profiling and instrumental texture were developed. These SOPs were used to characterize 132 yam samples from 19 varieties and 27 cassava samples from 9 varieties. Other biophysical parameters such as colour, sugars and dry matter were determined on all these samples while cyanide and polyphenols were determined on cassava and yam samples respectively. We assessed the acceptance thresholds of selected key priority quality traits of boiled yam, and established the predictive models for screening yam varieties that meet the required consumers' preferences. Some of the results have been published or submitted for publication. In the next phase of the project, we will focus on yam, mainly the boiled and pounded products. We will focus more on standardizing and validating already existing SOPs to confirm the threshold of key priority traits. We will collaborate with IITA Ibadan to use the yam reference clones. For boiled yam, we will develop the proof of concept to measure mealiness, water absorption, non- starch carbohydrate. Regarding pounded yam, in collaboration with other partners of project, we will harmonize the SOP to measure the stretchability and validate with QDA data

7.3 Annex 3: Summaries on main trainings and workshops by WP

7.3.1 Main Trainings & Workshops by Work Package 1

Capacity Strengthening and Building Common Methodologies Workshop in Cotonou, Benin (16-25 April 2018)

The WP 1 coordination team organized the workshop on Capacity Strengthening and Building Common Methodologies Work was held on 16-25 April 2018 at the Chant d'Oiseau in Cotonou, Benin. The workshop was facilitated by Lora Forsythe (NRI), Genevieve Fliedel (CIRAD), Ulrich Kleih (NRI) and Alexandre Bouniol (CIRAD). The objectives of this workshop were to provide an opportunity for the coordination team to present a 'core' methodology for identifying user preferences and to receive feedback and contributions from participants on the methodology. The workshop targeted on introduction to the project and WP1, sampling framework, and then the sequencing of the three main fieldwork activities including presentation of the tools, data analysis and reporting. The final day focused on the product profile and workplans. Additional guidance was provided on considerations in planning and conducting fieldwork, such as using interpreters, research team composition and note taking. There were 31 participants (48% women, 52% Men) from six countries. Participants represented the following institutions: Bowen, CARBAP, CIP, CIRAD, CNRA, ENSAI, FSA-UAC, IITA, NaCCRI, NARL, NRCRI and NRI. The workshop provided "A Capacity Strengthening and Sharing Kit" including all presentations and learning materials (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/surveys-on-trait-preferences). The workshop report was summarized and shared at https://mel.cgiar.org/reporting/download/report_file_id/13326.

Capacity Strengthening on Identifying User Preferences for RTB breeding under RTBfoods in Kampala, Uganda (10-14 September 2018)

The WP 1 coordination team organized the workshop on capacity strengthening on identifying user preferences for RTB breeding under RTBfoods in Kampala, Uganda on 10-14 September 2018. The workshop was facilitated by Lora Forsythe (NRI), Genevieve Fliedel (CIRAD), Ulrich Kleih (NRI) and Alexandre Bouniol (CIRAD). The workshop was organized in 5 days with 29 participants from Bowen University (3), CARBAP (2), CIP (1), CIRAD (2), CNRA (2), IITA (8), NaCRRI (1), NARL (2), NRCRI (2), NRI (3), UAC-FSA (3). The workshop provided A Capacity Strengthening and Sharing Kit including all presentations and learning materials. The documents can be found on the RTBfoods website > Surveys on trait preferences (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/surveys-on-trait-preferences).

Capacity Strengthening Training in Abuja, Nigeria (18–20 March 2019)

The WP1 Capacity Strengthening Training was held on 18–20 March 2019 in Abuja, Nigeria. The presentation was prepared by Lora Forsythe with input from Geneviève Fliedel (CIRAD), Hale Tufan (Cornell University), and Ulrich Kleih (NRI). The presentation was given by G. Fliedel and U Kleih. The workshop was organized in the 5 sessions included iteration of the product profile, ethics issues, multiple-user preferences and product profiling in RTB value chains – market interviews (https://mel.cgiar.org/reporting/download/report_file_id/17788), qualitative data analysis (https://mel.cgiar.org/reporting/download/report_file_id/17789), and Activity 3 synthesis and reporting (https://mel.cgiar.org/reporting/download/report_file_id/17790). The training was organized over 3 days focusing on PowerPoint presentations with practical sessions and discussions. A guidance document was provided to each participant and a restitution of the training was presented in plenary session at the annual meeting. The training focused on coherent data collection, analysis, and presentation as part of the RTBfoods project. The presentations were shared with the RTBfoods teams participating in the exercise. Overall, the capacity strengthening was well received, and has helped to produce more consistent outputs from WP1. Better distinction between men's and women's preferences regarding the characteristics was achieved. The current versions of the guidance and training materials are available on the project platform for all RTBfoods partners to use and shared with a wider scientific community including Step 1: State of Knowledge (SoK) Guidance (https://doi.org/10.18167/agritrop/00568) and 13 partner reports (see Table 2 Reports from preliminary studies on RTB consumption habits & preferences, Step 1), Step 2: Gendered Food Mapping (https://doi.org/10.18167/agritrop/00569) and 20 partner reports (see Table 3 Reports from preliminary studies on RTB consumption habits & preferences, Step 2), Step 3: Participatory Processing Diagnosis and Quality (https://doi.org/10.18167/agritrop/00570) and 15 partner reports (see Table 4 Reports on participatory processing diagnosis with RTB processors, Step 3), Step 4: Consumer Testing in Rural and Urban Areas (https://doi.org/10.18167/agritrop/00571), Step 4: Supplement for Consumer Testing Data Analysis & Reporting (https://doi.org/10.18167/agritrop/00660) and 16 partner reports (see Table 5 Reports on consumer testing with RTB consumers, Step 4), and Step 5: Guidance for Product Profile Consolidation from Step 1 to 4. (https://doi.org/10.18167/agritrop/00661), and 14 Gendered Food Produce Profiles (see Table 7 Gendered Food Product Profiles, Step 5), and WP1 G+ RTBfoods Product Profile Assessment (https://doi.org/10.5281/zenodo.7565647). Related documents have been published on the RTBfoods website (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/surveys-on-trait-preferences)

Support Training to Bioversity International and CIP teams for implementing Activity 4 and Activity 5 on Matooke and Boiled Sweetpotato in Luwero & Lira regions, Uganda (09-19 September 2019)

The WP1 support training was organized in Luwero and Lira regions, Uganda between 09-19 September 2019. The training was organized by Kephas Nowakunda (NARL), Pricilla Marimo (Bioversity International) and Sarah Mayanja (CIP). The training was facilitated by Geneviève Fliedel and Alexandre Bouniol from CIRAD to support Bioversity International and CIP teams to obtain good quality data by adapting WP1 methodology to their own Product Profile, better target their objectives, and avoid some biases. The practical training included fieldworks with the 2 teams on Matooke and Boiled Sweetpotatoes. The participants included Samuel Edgar Tinyiro, Sarah Kisakye and David Bamwirire (NARL, Uganda), Pricilla Marimo (Bioversity International) and Sarah Mayanja (CIP). All the documents used (manuals for implementing Activity 3, 4 & 5, and for data analysis) were previously distributed during the training workshops in Cotonou, Benin (April 2018) and in Abuja, Nigeria (March 2019). The training was summarized in a report “Support to Bioversity International and CIP teams for implementing Activity 4 -Processing diagnosis and Activity 5 -Consumer testing on Matooke in Luwero region and Boiled Sweetpotato in Lira region” (https://mel.cgiar.org/reporting/download/report_file_id/20571).

7.3.2 Main Trainings & Workshops by Work Package 2

Sensory Panel Training–Sensory Profiles Workshop in Kampala, Uganda (17-21 September 2018)

The WP2 Sensory Panel Training was held on 17-21 September 2018 at the Kabira Hotel Country Club and NARL Food Science and Post-Harvest Laboratories, Kampala, Uganda. The aim of training was 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. The workshop was divided into 3 sections: Sensory methodologies were facilitated by Nelly Forestier-Chiron (CIRAD, France) covered basic principles of sensory analysis, different tests available, panel management, identification of basic taste odor and texture using Matooke; Practical application was demonstrated on Boiled Sweetpotato; and. Data processing of sensory panel results using XL-stat software demonstrated by Christophe Bugaud (CIRAD, France). The workshop provided an inventory of partner laboratories which are already equipped to set up sensory panels included NARL in Kawanda, Uganda, IITA and at Bowen University in Nigeria, CIRAD in Benin and Cameroon, and CIP in Kenya. Researchers at NCRRI have capacity for sensory panels. The training was attended by 41 participants involved in WP2 the RTBfoods project and facilitated by trainers from CIRAD (France) and RTBfoods experts. The CIRAD Sensory team provided a methodological manual and 3 tutorials (See Table 13 Tutorials developed for Sensory characterization of RTB food products) on how training a panel in sensory analysis and implementing descriptive tests (https://doi.org/10.18167/agritrop/00573), a tutorial on how to process data in sensory analysis (https://doi.org/10.18167/agritrop/00573), a tutorial on monitoring panel performance and cleaning data from descriptive sensory panels for statistical analysis (https://doi.org/10.18167/agritrop/00582; in French https://doi.org/10.18167/agritrop/00583), and a tutorial on statistical analyses (PCA and multiple regression) to visualize the sensory analysis data and relate it to the instrumental data (https://doi.org/10.18167/agritrop/00710; in French https://doi.org/10.18167/agritrop/00738). The training activities were summarized in the report "RTBfoods Sensory Panel Training–Sensory Profiles Workshop" (https://mel.cgiar.org/reporting/download/report_file_id/13352). Training materials can be accessed on the RTBfoods website> Sensory (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/sensory).

Satellite Workshop on Sensory Analysis in Abuja, Nigeria (19-20 March 2019)

The WP2 satellite workshop was held in Abuja, Nigeria on 19-20 March 2019. The workshop consisted of biophysical analyses and sensory analyses. For biophysical analyses, four common priority analyses were identified: Dry matter, Starch content, Sugars content, Amylose content. The partners agreed to develop standard operation procedures (SOPs) to harmonize these four priority biophysical analyses between RTBfoods laboratories. The SOP for Dry matter, Starch content by acid hydrolysis and enzymatic hydrolysis, Sugar content by phenol colorimetry and HPLC, Amylose by iodine colorimetry and DSC were developed (see Table 8 Standard Operating Procedures developed for Biophysical & Biochemical characterization of RTB crops). The partners also developed cooking time (for boiled product profiles) and Texture for Boiled Cassava, Boiled Sweetpotato and Matooke and (see Table 11 Standard Operating Procedures developed for Textural characterization of RTB food products). For sensory analyses, partners were grouped by regional areas (Uganda, West Africa), and trainings were planned in each region, by CIRAD (Uganda) and Bowen University (West Africa). Partners developed SOPs for sensory analyses of priority product profiles for Matooke and Boiled Sweetpotato (see Table 12 Standard Operating Procedures developed for Sensory characterization of RTB food products). Training materials can be accessed on the RTBfoods website> Sensory (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/sensory). All the institutes involved in RTBfoods WP2 were represented, with a total of 26 participants. The minutes and documents produced during the WP2 satellite meeting are available on the RTBfoods website > Annual Meeting 2019 > WP Satellite Workshops (https://rtbfoods.cirad.fr/resources/annual-meetings/2019-annual-meeting2/wp-satellite-workshops).

RTB Breeding CoP-RTBfoods Data Management Workshop in Montpellier, France (19-20 June 2019)

The Data Management workshop was held on 19-20 June 2019 in Montpellier, France facilitated by Elizabeth Arnaud (Bioversity, Montpellier, France). A total of 47 attendees represented the RTB Breeding Community of Practice, RTBfoods project and RTB Crop breeding projects, all of which use the RTB Breedbases maintained at the Boyce Thompson Institute. The objective was to identify the existing data sets, data flows, needs in ontology and desirable connections of various project databases and repositories for data sets, with a view to create the foundation of a global information system that will include the NextGen Breeding and RTBfoods databases and repositories, that will enable the tracking of material used across RTBfoods work packages (WPs) and provide documented traits for breeding product profiles. Unstructured and structured data generated by the RTBfoods work packages were considered. The report is accessible at https://mel.cgiar.org/reporting/download/report_file_id/17859.

Support Missions in Texture Analysis in Benin & Uganda (February–September 2019)

Support missions were provided in collaboration with the texture focal point (Layal Dahdouh) to provide specific support to partners. The trainings were facilitated by Julien Ricci (CIRAD). The mission at UAC-FSA, Benin was held on 26 February - 08 March 2019 for installation/setting-up of a new rheometer, and providing theoretical and practical training in rheological and textural analyses applied to on Boiled Cassava. Attendances were PhD students and researchers. At NARL, Uganda on 17–25 July 2019, the mission was to install and the handling of the new texture analyzer TMS Pilot on Boiled Cassava. The audience included Moses Matovu (texture Laboratory manager) and other researchers. Another training at NARL, Uganda was held on 9-20 September 2019 to develop texture test to evaluate the texture of Matooke using their new texture analyzer TMS Pilot and Investigation of correlation between instrumental texture/rheology parameters of Matooke and sensory texture attributes in collaboration with NARL and CIRAD sensory teams. The audiences were mainly NARL texture team (leading by Moses Matovu) and CIP texture team (Mariam Nakitto, Linly Banda on Boiled Sweetpotato. Texture focal point participated in these discussions by videoconferencing. These support missions strengthened the RTBfoods team and standardized the texture and sensory analyses. The SOPs for texture analyses and sample preparation were written by partners, revised by texture focal point and by sensory focal point (see Table 11 Standard Operating Procedures developed for Textural characterization of RTB food products). Support mission reports can be found in RTBfoods website > Texture (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/texture).

RTB Ontology Working Meeting in Ithaca, USA (3-8 November 2019)

The Ontology Working Meeting was organized at Boyce Thompson Institute, Ithaca, USA on 3-8 November 2019. The training was facilitated by Elizabeth Arnaud (Bioversity, Montpellier, France) with 8 participants attending on-site and 5 participants attended online. The meeting aimed to finalize with a common approach the RTB ontologies quality content for Agronomic and Quality traits as planned in the POWB2019 and enrichment with gender-sensitive PVS traits and variables. Based on the conclusions of the RTBfoods-Breeding CoP workshop in June 2019, decide on the workflow and format to integrate RTBfoods traits and terms into the Ontologies, Breedbases and ClimMob and thus support the breeding product profile description. The report is accessible at https://mel.cgiar.org/reporting/download/report_file_id/17860.

Trainings for Sensory Evaluation and Recruitment Panelists in Nigeria (November 2019)

Sensory evaluation trainings to recruit and train panelists were held twice. The 1st training was organized at IITA, Nigeria during 15-19 November 2019 facilitated by Bolanle Otegbayo from Bowen University, Nigeria. The training was conducted at the sensory evaluation room with 21 attendances composed of staffs and university students from various states of Nigeria. The 2nd training was at NRCRI, Umudike, Nigeria during 25-28 November 2019. This training was facilitated by Otegbayo Bolanle and Ugo Chijioke with 19 attendances. The training was started by defining sensory evaluation to evoke, measure, analyze and interpret reactions to the response from the six senses of human in which the relation of characteristics of a product with perception. Different food products (e.g., Agidi–Solid pap, Amala, Lafun, Eba from different varieties etc.) were used to generate sensory attributes to the products. The trainings were organized following the Sensory Panel Training methodological manual and tutorials (See Table 13 Tutorials developed for Sensory characterization of RTB food products).

Texture/Rheology Workshop in Kampala, Uganda (3-7 February 2020)

The Texture/Rheology Workshop took place during the RTBfoods Annual Meeting 2020 in Kampala, Uganda during 3-7 February 2020, facilitated by Layal Dahdouh, the texture focal point. The workshop aimed to familiarize all texture-teams with the strategy to use when setting-up a texture test (step 1 to 5), the impact of sample preparation on the robustness of a texture test; and the importance of statistical analyses for validating a robust texture test with a good discriminating ability; to encourage texture-teams to collaborate with sensory-teams in order to achieve successfully step 4 and 5; and to identify of the specific needs of the texture-teams to the new trainees. The workshop instructed the practical use of a texture analyzer for texture/rheology measurements with the variable textures of RTB products within the same RTB crop category using appropriate preparation protocol for different final products. Moreover, statistical skills to ensure the robustness and the discriminating ability of any texture test, and correlations between instrumental texture parameters and texture sensory attributes were practiced developing a reliable texture test. Specific strategies were provided as support for texture-teams to develop new SOPs for texture analyses. Texture analysis presentation by Layal Dahdouh of can be accessed in RTBfoods website > Resources > Annual Meetings > 2020 Annual Meeting > Scientific Talks (https://rtbfoods.cirad.fr/resources/annual-meetings/2020-annual-meeting/scientific-talks).

Workshop on Data management & Ontology in Kampala, Uganda (7 February 2020)

The Workshop on Data management & Ontology was organized on 7 February 2020 during the RTBfoods Annual Meeting 2020 in Kampala, Uganda. Workshop presentations can be found in the RTBfoods website> Resources > Annual Meetings2020 > Annual Meeting > Scientific Talks (https://rtbfoods.cirad.fr/resources/annual-meetings/2020-annual-meeting/scientific-talks). Overall, 26 Dictionaries have been delivered: 9 for Processing Techniques, 11 for Sensory Descriptors, and 6 for Textural Parameters (see Table 19 Dictionaries developed for traits related to the processing and the quality of RTB food products).

Training on Yam Quality Evaluation in Cotonou, Benin (22 - 26 November 2021)

The WP2 team contributed training part during AfricaYam/RTBfoods Training on Yam Quality Evaluation at Abomey-Calavi, Cotonou, Benin on 22-26 November 2021. Theoretical session provided principles of Boiled Yam quality analysis (Laurent Adinsi, UAC-FSA), Pounded Yam lab analysis (Bolanle Otegbayo, Bowen University), developing of the SOP for yam quality evaluation (Michael Adesokan, IITA), evaluation work on Fresh, Boiled and Pounded Yam for several post-harvest traits (Ugo Chijioke, NRCRI), the impact of non-starch polysaccharides (NSPs) on the textural behavior of processed yam (Aliénor Dutheil De La Rochere, INRAe). The practical sessions on characterization of Yam quality including sampling, preparation, sensory & textural analyses were provided to 30 participants. Sensory training focused on main descriptors for Boiled Yam, the scale, and how to be part of a training / tasting panel. Textural training focused on rheology and Boiled Yam, and the SOP for evaluation. Training report, presentations, teaching materials and SOPs on yam can be found on RTBfoods website (https://rtbfoods.cirad.fr/resources/training-on-yam-quality-evaluation-africayam-rtbfoods).

Technical & Support Missions for Validation of Instrumental Textural Characterization (December 2021)

Three missions were carried out in the laboratories of IITA, NRCRI, Bowen University in Nigeria in December 2021. The facilitator was Oluwatoyin Ayetigbo (CIRAD, France) by assistance with the local teams. The main objectives were validation of SOP on instrumental textural characterization of Pounded Yam, and knowledge share and transfer of SOP among partners. The mission at BOWEN University, Iwo, Nigeria, was on validation and development of instrumental texture SOPs to characterize RTBs and repeatability between replicate measurements and discrimination between various yam genotypes was evaluated based on textural characteristics of Pounded Yam (https://doi.org/10.18167/agritrop/00757). The mission at IITA, Nigeria was on validation of SOP on instrumental textural characterization of Eba by testing protocol for accuracy, repeatability and discriminance (https://doi.org/10.18167/agritrop/00755). The last mission was held at NRCRI, Nigeria on confirmation of experimental outcomes of prior instrumental measurement of texture attributes of Fufu, by testing the current generated data for agreement with prior measurements (https://doi.org/10.18167/agritrop/00756). SOPs used for texture analyses were used as methodological references (see Table 11 Standard Operating Procedures developed for Textural characterization of RTB food products). Support mission reports can be found in RTBfoods website > Texture (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/texture).

Training on Instrumental Textural Characterization of Extensibility and Lubricated compression flow (LSF) (October-September 2022)

In Period 5, the WP2 coordination team offered training to strengthen partners' capacity in texture analyses. The trainings were to equip the partners in preparation for determining extensibility of Pounded yam product profile for the upcoming harvests of yams in 2022 & 2023. Specific objectives of each training were adjusted to the food products at each location. An online training was conducted in Period 5 on set-up and use of texture analyzer for texture measurement with partners at CNRA and CARBAP to assist in understanding how to manage the texture analyzer and texture measurement with focus on Boiled and Fried Plantain. Other on-site trainings carried out as support missions. The training was facilitated by Oluwatoyin Ayetigbo (CIRAD, France). Training mission to train NRCRI team at Umudike, Nigeria was held on 19-23 September 2022 for instrumental textural characterization of extensibility of fufu (https://doi.org/10.18167/agritrop/00753). Training NARL Uganda team on installation and handling of their new texture analyzer and the associated software in period 2, and training on standard methodology of sample preparation for Boiled Cassava. Training mission to train IITA and UAC-FSA Benin teams on instrumental textural characterization of extensibility of Eba and Pounded Yam in Period 5 was held during 26-30 September 2022 (https://doi.org/10.18167/agritrop/00752). Training BOWEN University team in period 5 on how to conduct the new SOP on instrumental textural characterization of extensibility of Pounded Yam was held on 4-7 October 2022 (https://doi.org/10.18167/agritrop/00754). Training mission in Côte d'Ivoire was organized on 27 March-7 April 2023 for 12 staff of the CNRA team. Standard Operating Protocol for Determination of Bi-extensional viscosity of Pounded Yam by Lubricated Squeezing Flow (LSF) Method (https://doi.org/10.18167/agritrop/00686) and the validated SOP for the Instrumental Determination of Extensibility of Pounded Yam (https://doi.org/10.18167/agritrop/00684) were used as methodological references.

7.3.3 Main Trainings & Workshops by Work Package 3

Training workshops on NIRS routine analysis (May-June 2018)

In Period 1, the WP3 coordination team organized 5 training sessions including 2 in Uganda, 2 in Nigeria and 1 in Peru. The objectives of each training were adjusted to the priority needs of participants at each location. Training at NaCRRI, Uganda (23-28 May 2018) was facilitated by Fabrice Davrieux (CIRAD) to provide principle and theory of NIRS, initiation to multivariate analysis, calibration development, and spectral acquisition and measurement protocols. Nineteen trainees from CIP (5), NaCRRI (12), and NARL (2) participated in the training. Activities was summarized and shared at https://mel.cgiar.org/reporting/download/report_file_id/13376. Training at NRCRI, Nigeria (4 -8 Jun 2018) was facilitated by Fabrice Davrieux (CIRAD) to overview the principle and theory of NIRS, configuration and data collection using a portable NIRS and management. Training at CIP, Peru (11-13 June 2018) was organized by Thomas zum Felde and Eduardo Porras (CIP) to refresh on field sampling and sample preparation of Potato, Sweetpotato for HTPP. The trainers provided NIRS basics, calibration development, validation procedures and applications. Participants included 4 staff from CIP. The workshop report can be found at https://mel.cgiar.org/reporting/download/report_file_id/13375. Training at IITA, Nigeria (12-14 Jun 2018) was facilitated by Fabrice Davrieux (CIRAD) to provide principle and theory of NIRS, configuration and data collection using a portable NIRS, and management and processing of NIRS data. A total of 8 participants from IITA attended the training. Workshop report was published at https://mel.cgiar.org/reporting/download/report_file_id/13373. Training at CIP/NARO, Uganda (11-12 October 2018) was facilitated by Ugochukwu Ikeogun (NRCRI) and Thomas zum Felde (CIP). The objectives were to overview principles of NIRS, the needed lab conditions, data management, and application of NIRS analysis to evaluate macro- and micronutrient concentration, routine analysis of freeze dried Sweetpotato samples. The trainee was Edwin Serunkuma. The training toolkits were published in RTBfoods website > High-throughput phenotyping (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/high-throughput-phenotyping).

Development of calibration to predict texture and optimum cooking time parameters in Boiled Cassava in Cali, Colombia (03–15 March 2019)

The WP3 team organized the mission in RTBfoods framework at CIAT (Cali, Colombia) from 03–15 March 2019 in order to knowledge share and transfer on spectral analysis and chemometrics between CIRAD and CIAT. The objective of this work was to investigate the potential of NIRS as an alternative method for predicting the CT and texture parameters from fresh raw Cassava. The facilitator was Karima Meghar (CIRAD). Three CIAT staff: John Belalcazar, Thierry Tran, and Andres Escobar, attended the training. The mission report can be found here https://mel.cgiar.org/reporting/download/report_file_id/17837.

Satellite Workshop in NIRS in Abuja, Nigeria (22 March 2019)

The WP3 workshop was scheduled before the first annual RTBfoods meeting on 22 March 2019 in Abuja, Nigeria. Eighteen participants covering different institutions, CIRAD (3), IITA (4), NaCRRI (2), CIAT (1), NARL (1), NRCRI (4) and CIP (3) plus guest speakers Pierre Dardenne (consultant, Belgium), Hans van Doorn (HZPC, Netherlands) and partially Jim Lorenzen (BMGF) were participating in this workshop. Most of the participants presented their ongoing work related to the framework of the RTBfoods project. The objectives of the workshop were that all WP3 partners expose their scientific advances, ideas, issues encountered during period 1, their needs in training and support and their perspectives for period 2. The workshop program included presentations by Thierry Tran (CIAT) on the standardization of protocol texture of raw and cooked (Boiled) Cassava, Denis Cornet (CIRAD) on advances on machine learning and Pierre Dardenne on calibration transfers between NIRS equipment from different providers and related networking. Fabrice Davrieux (CIRAD) presented scientific & methodological advances on HTP methods in Guadeloupe. Karima Meghar from CIRAD presented hyperspectral imaging applied to RTB crops and products (literature review). Ephraim Nuwamanya from NaCRRI presented spectral acquisition for Cassava, Sweetpotato and Banana at NaCRRI in cooperation with NARL and IITA. Thomas zum Felde (CIP-Peru) presented CIP's global NIRS activities on Sweetpotato and Potato. Emmanuel Alamu from IITA presented reports on the WP3 activities achieved for period 1 which includes the development of sampling and sample preparation protocols, spectral data acquisitions and calibrations development for selected traits like dry matter, starch, protein in fresh Cassava and Yam samples. Hans van Doorn (HZPC) reported on limitations of NIRS technology applied for potato. Workshop training materials were published and shared on RTBfoods website > WP3 Satellite Workshop (https://rtbfoods.cirad.fr/resources/annual-meetings/2019-annual-meeting2/wp-satellite-workshops)

Capacity Building Training in Ibadan, Nigeria (24 June-05 July 2019)

The WP3 Capacity Building training was scheduled from 24 June - 05 July 2019 at IITA in Ibadan, Nigeria facilitated by Karima Meghar (CIRAD), Thomas zum Felde (CIP-Peru), Emmanuel Alamu (IITA-Zambia) and Fabrice Davrieux (CIRAD). The training consisted of lessons on NIR theory, instrumentation, NIRS limitation/NIRS alternatives, signal, and spectra chemometrics, software applications 'from spectra to calibration and validation', sample preparation and NIRS measurement, data handling and management, homogeneity and repeatability of NIRS scans, spectral acquisition of samples for standardization and standardization theory. The practical part of the training included the measurement of different RTB crops and products for application in RTBfoods, including instrument standardization with Winisi, data import and export, calibration tests, validation, standardization with Unscrambler and Excel with own data. A diverse group of 17 participants (scientists, operators, technicians) was trained in NIRS theory and practices covering different institutions and research units, NaCRRI-Uganda (2), CIP-Ghana (1), IITA-Food and Nutrition Sciences Lab (3), NRCRI (3), IITA-Cassava Breeding Unit (3), Nextgen project (2), Bowen University (2), CIP-Uganda (1) plus guest speaker Pierre Dardenne (consultant, Belgium). The trainers provided all presentations given during the training and data management templates with the participants on a USB stick. Training report can be found at https://mel.cgiar.org/reporting/download/report_file_id/33117 The training materials were published in RTBfoods website > High-throughput phenotyping (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/high-throughput-phenotyping).

Capacity Building Training of WP3 team in Namulonge, Uganda (19-23 August 2019)

This WP3 training was scheduled from 19–23 August 2019 at NaCRRI facilities in Namulonge, Uganda to give an overview of the theory and the applications of near infrared spectroscopy (NIRS) to the scientific and technical staffs from NaCRRI, NARL, NARO, IITA and CIP involved or potentially involved in the RTBfoods project. Specific objectives were to perform an audit of the human resources and of the technical capacities, to learn about the basics of the interaction light and matter and vibrational spectroscopy, to familiarize with the mathematics associated to NIRS, to familiarize with the principle of calibration, to understand the different steps from sample preparation to calibration development, and to set up instruments and adapt protocols to the different raw products (Cassava, Banana, Potato and Sweetpotato). The training facilitated by Karima Meghar (CIRAD), Thomas zum Felde (CIP-Peru), Emmanuel Alamu (IITA-Zambia) and Fabrice Davrieux (CIRAD). A diverse group of 13 participants (scientists, operators, technicians) was trained in NIRS theory and practice, covering different institutions and RTB crops, NARL (3), NaCRRI (3), Makerere University (2), CIP Uganda (3), IITA Uganda (1) and CIP Kenya (1). The outputs from this training included a team building for NIRS application across RTBfoods community in East Africa established and a transmission of knowledge of different software application. The training materials were published in RTBfoods website > High-throughput phenotyping (https://rtbfoods.cirad.fr/deliverables/scientific-cross-cutting-activities/methodological-manuals-training-material/high-throughput-phenotyping).

Strengthening the skills of partner researchers: Tools and methods for phenotyping root and tuber plants in Côte d'Ivoire (17 September-15 November 2021)

The mission was organized at CNRA, Côte d'Ivoire from 17 September to 15 November 2021. Denis Cornet transferred the phenotyping methods developed in image analysis within CavalBio and AfricaYam projects: Phenology (dynamics of germination, emergence, and senescence), Dynamics of recovery (percentage and speed of recovery), Physiology (size and stomatal density), and Quality (color and oxidation, characterization of starch grains, peeling yield). Full report and protocol are accessible at https://mel.cgiar.org/reporting/download/report_file_id/36652.

Training and Support Mission on High-Throughput Phenotyping Protocols (HTPP) (November 2021–December 2022)

Two missions on using of hyperspectral imaging, a new high throughput technique combination of near infrared spectroscopy and imaging, were implemented in the AfricaYam/RTBfoods Training (Cotonou, Benin) and at IITA (Ibadan, Nigeria). The mission at AfricaYam/RTBfoods Training (Cotonou, Benin) was organized on 25 November 2021 by Denis Cornet, Karima. Meghar and Emmanuel Alamu. The training focused on context and use of NIRS spectra for calibration and quality traits analysis using hyperspectral imaging for 30 attendances. The summary of mission can be seen in Training Report on AfricaYam/RTBfoods Training on Yam Quality Evaluation (see pages 25, 29-30 https://rtbfoods.cirad.fr/fr/publications/activites-scientifiques-transversales/rapports-supports-de-formation/others). The mission at IITA, Ibadan, Nigeria during 27 November 2021–11 December 2022, facilitated by Karima Meghar (CIRAD) with an online support by Fabrice Davrieux (CIRAD). Two staffs of IITA, Michael Adesokan and Segun Fawole, were trained on installation and setting parameters of acquisition by hyperspectral imaging, images acquisition using Specim FX17 camera hyperspectral camera, and hyperspectral image processing and development of models of prediction using Matlab and R Software (https://mel.cgiar.org/reporting/download/report_file_id/33117). Training materials included Hyperspectral imaging applied to Roots, Tubers and Cooking Bananas (https://doi.org/10.18167/agritrop/00740), Operating mode & configuration of hyperspectral camera Specim FX17 (https://doi.org/10.18167/agritrop/00667), and SOP hyperspectral imaging of fresh RTB crops (https://doi.org/10.18167/agritrop/00666).

7.3.4 Main Trainings & Workshops by Work Package 6

Training "Enhancing Results-Based Management in RTB ME&L systems" in Nigeria (28-31 Jun 2018)

The WP6 training was in Nigeria on 28-31 June 2018 to improve management in the RTB ME&L systems. Eglantine Fauvelle (CIRAD), who is a main responsible for the ME&L system attended this training.

Annual Meeting of the MELIA (Monitoring & Evaluation, & Impact Assessment) for community of practice in Italy (5-8 November 2018)

The workshop was organized at CGIAR and held in Italy on 5-8 November 2018. Eglantine Fauvelle (CIRAD) from WP6 PMU team participated in the workshop.

Training on Yam Quality Evaluation in Cotonou, Benin (22-26 November 2021)

On 22-26 November 2021, in Cotonou, the AfricaYam and RTBfoods projects joined forces to offer a training program dedicated to evaluating yam quality for use by breeders took place, Benin. The University of Abomey Calavi (UAC-FSA) piloted by Prof. Noël Akissoé and his team, hosted and helped organize this training. The training aimed to strengthen the skills of the AfricaYam breeding program teams to integrate new quality traits into their improvement schemes.

The program included two theoretical days and two practical days. The two theoretical days included the approach and methods those developed, adapted, and implemented within the RTBfoods project to study the quality of yam tubers. The following two-day practical workshop was organized in the UAC-FSA laboratories to demonstrate the standardized laboratory protocols for the preparation and cooking of samples, and for their sensory and textural characterization, in particular. This hands-on workshop also presented the potential of infrared spectrometry and image analysis to predict quality traits of Boiled Yam. The RTBfoods PMU established an online open-access pre-meeting toolbox on the project website, including 27 pre-recorded presentations on project progress in each work-package and thematic areas (see Training on Yam Quality Evaluation (AfricaYam/RTBfoods) https://rtbfoods.cirad.fr/resources/training-on-yam-quality-evaluation-africayam-rtbfoods). The website also provided access to all resources produced on yam products by RTBfoods partners (survey reports, protocols, etc.). The workshop presentations, Q&A sessions and panel discussions stimulated dynamic and useful exchanges across disciplines and on a wide range of themes (surveys; specific quality traits; sampling and sample preparation; data collection; laboratory analyses; data analysis and interpretation; selection and breeding).

A total of 30 trainees (50% Women, 50% Men) from 23 partner institutes, attended the workshop. A workshop report, capturing essential exchanges between trainees and trainers, and between food scientists and yam breeders, who come together for the first time in such a workshop, has been consolidated and shared with all participants (see AfricaYam/RTBfoods Training on Yam Quality Evaluation, https://dx.doi.org/20.500.11766/67130). The report was delivered as a joint deliverable for both RTBfoods and AfricaYam projects. Progress and activities of the program were reported online (https://rtbfoods.cirad.fr/news/africayam-and-rtbfoods-collaborate-on-yam-quality-assessment & https://rtbfoods.cirad.fr/news/africayam-rtbfoods-yam-quality-training-a-resounding-success).

List of AfricaYam/RTBfoods Workshop Presentations Available on the Dedicated YouTube Channel:

1. **Agbona Afolabi**. Database storage of yam laboratory quality data: progress & next steps. https://youtu.be/k-llk1TyaiY
2. **Alexandre Dansi, Jeannette Fakorede, Igor Yelome & Eric Dadonougbo**. Yam quality screening and users' acceptability at BIORAVE in Benin. https://youtu.be/R3ohEh0wNfE

3. **Alienor Dutheil De La Rochere, Dominique Rinaldo, Agnès Rolland-Sabaté**. Impact of non-starch polysaccharides on the textural behavior of processed. https://youtu.be/KK2KJZhD-yc
4. **Amos Asiimwe**. Ontologies for Yam Food Quality https://youtu.be/-RBOITV8nQo
5. **Asrat Asfaw**. Yam quality screening and users' acceptability at IITA & NARES Partners in Nigeria. https://youtu.be/JIVOVzXB2S8
6. **Bolanle Otegbayo, Oluyinka Oroniran, Abiola Tanimola & Oluwatomiloia Bolaji**. Lab applications and major results on quality evaluation of yam at Bowen University. https://youtu.be/UivpzAr-5vo
7. **Christian Mestres, Lea Ollier, Romain Domingo, Mathieu Lechaudel, Julien Ricci**. Physico-chemical Proof of Concepts on yam food quality. https://youtu.be/ucpWQABEdAw
8. **Christophe Bugaud & Nelly Forestier-Chiron**. Correlations between consumer testing & sensory evaluation for the definition of acceptability thresholds for sensory traits. https://youtu.be/glcOALpBqDY
9. **Christophe Bugaud, Isabelle Maraval & Nelly Forestier-Chiron**. Sensory profiling: principles & uses in breeding programs. https://youtu.be/57Om8tDmywY
10. **Denis Cornet, R. Fernandez, M. Dejean, Lucienne Desfontaines & D. Lange**. Overview of image analyses as a phenotyping tool: technical opportunities & scientific achievements in agronomy. https://youtu.be/7DzEdth_mHs
11. **Dominique Dufour**. Consumers have their say: assessing preferred yam quality traits and implications for breeding. https://youtu.be/kpwpVLV1LVQ
12. **Emmanuel Chamba**. Yam quality screening & user acceptability at SARI. https://youtu.be/Cx0cxuGKON0
13. **Emmanuel Otoo**. Yam quality screening & user acceptability at CSIR-CRI, Ghana. https://youtu.be/VqjwPhkbsjo
14. **Fabrice Davrieux & Emmanuel Alamu**. NIRS for quality traits prediction: opportunities & challenges in practice. https://youtu.be/w3ihM1ocz2w
15. **Gemma Arnaud**. Yam quality screening & user acceptability at CIRAD, France. https://youtu.be/Cseau5FX69E
16. **Gerard Ngoh Newilah, Alexandre Bouniol & Bela Teekan**. A guidance for food product evaluation from advances RTB clones with crop users: possible applications in yam breeding pipelines. https://youtu.be/b_ap6DuO7eU
17. **Karima Meghar, Fabrice Davrieux, Lea Ollier, Julien Ricci, Christian Mestres & Joel Grabulos**. Applications of hyperspectral imaging to predict yam quality traits. https://youtu.be/7Mt4GsEgNZ0
18. **Laurent Adinsi, Laurenda Honfozo, N. Moussa & Noel Akissoe**. Definition and understanding of sensory attributes of Boiled Yam. https://youtu.be/ccpf8yaDnRg
19. **Layal Dahdouh & Julien Ricci**. Texture profiling: principles & points of attention. https://youtu.be/WG7Pb2MF2SM
20. **Lora Forsythe**. RTBfoods methodology for gendered food product profiles. https://youtu.be/9Iv4fgURIb4
21. **Lucienne Desfontaines, Pascale Bade, Marie Umber, David Lange, Jean-Luc Irep, Denis Cornet & Christian Mestres**. Methodologies to estimate and quantify amylose in yam tubers by iodine staining. https://youtu.be/DP1dMW3quc8
22. **Michael Adesokan, Mariya Dixon Busie, Amele Asrat, Emmanuel Alamu, Wasiu Awoyale, Hakeem Oyedele & Segun Fawole**. Evaluation of cooking qualities of fresh yam (*Discorea rotundata*). https://youtu.be/CSY06WiNcE0
23. **Noel Akissoe**. Overview of Projects on Yam at UAC-FSA. https://youtu.be/jqoiMECg_vw

24. **Oroniran Oluyinka, Otebayo Bolanle, Tanimola Abiola, Fawehinmi Olabisi & Bolaji Tomilola**. Synthesis on pounded yam gendered food product profile. https://youtu.be/_q1T6K02vEU

25. **Patrick Adebola**. Enhancing Yam Breeding in West Africa for increased productivity and improved quality (AfricaYam II).

26. **Tessy Madu, Noel Akissoé, Laurent Adinsi, Okoye Benjamin, Blessing Ukeje, Mariam Ofoeze, Sounkoura Adetonah & Catherine Landry**. Synthesis on boiled yam gendered food product profile. https://youtu.be/b0H-ZnlJTaM

27. **Ugo Chijioke**. Yam quality evaluation at NRCRI, Umudike, Nigeria. https://youtu.be/qNS3mrW4D8k

Workshop on Manuscript Writing in Paris (June 2022)

The workshop was held in June 2022 in Paris. The objective was to prepare the writing of manuscripts for a new special issue dedicated to Roots, Tubers, and Cooking Bananas (RTBs) in the Journal of the Science of Food & Agriculture (JSFA). 43 members from all 15 partner institutes of the RTBfoods project attended the workshop. During the 3-day training, the participants gained knowledge, practices and also spent half a day on a small workshop on RTBfoods outcome mapping. This session was led by a consultant, Agathe Devaux-Spatarakis (QUADRANT conseil), and the ImpresS-CIRAD team working on impact of research at CIRAD (Claudio Proietti, Aurelle de Romémont. From the support of Clair Hershey and Hernan Ceballos, whose extensive experience RTB crops as a key to guide the authors in the writing of the manuscripts until submission to the journal, planned at the end of December 2022. Overall, forty-four manuscripts have been proposed to the editorial committee. The selection will consider key criteria such as the participation of several institutes, multidisciplinary and respect for the editorial line of the JSFA journal. To date, 7 manuscripts are published, and 35 manuscripts are in revision (see Peer-reviewed publications).

7.4 Annex 4: List of RTBfoods students

7.4.1 Postdoctoral Level

1. **Aliénor Dutheil De La Rochere** (2021). *Cell wall and polyphenols composition and its evolution during boiling*, France. RTBfoods Supervision: **Agnes Rolland-Sabate**, INRAe (2020- 2022). Postdoctoral report, INRAe, France. 12 p. *Confidential until 15 March 2025.
2. **Ana Zotta Mota** (tba). *Identification of candidate genes related to quality in three key metabolic pathways*, Guadeloupe, France. RTBfoods Supervision: **Hana Chair**, CIRAD (Sep 2020 - Jan 2022). Postdoctoral Report, CIRAD, France. *Manuscript submission.
3. **Franklin Ngoualem Kegah** (2020). *Understanding the drivers of quality characteristics and the development of multi-user RTB product profiles - Gari Cameroon*, Cameroon. RTBfoods Supervision: **Geneviève Fliedel**, CIRAD/ENSAI (2018-2019). Postdoctoral report, University of Ngaoundéré - ENSAI, Cameroon. 82 p. Related online references: https://doi.org/10.1111/ijfs.14790, https://doi.org/10.1111/ijfs.14867.

7.4.2 Doctoral Level

1. **Adjo Christiane Koffi** (tba). *Déterminants endogènes, agro- morphologiques et physico-chimiques pour une sélection précoce des variétés stables de manioc (Manihot esculenta)*, Côte d'Ivoire. RTBfoods Supervision : **N'Zué Boni**, CNRA (2019-2022). Doctoral dissertation, University Felix Houphouet Boigny, Côte d'Ivoire. *Study ongoing. Related reference: https://doi.org/10.5281/zenodo.6593223.
2. **Adou Emmanuel Ehounou** (2021). *Création et évaluation des clones tolérants à l'anthracnose, Détermination de QTL liés à la morphologie des tubercules et prédiction de la qualité de l'igname pilée de l'espèce (Dioscorea alata L.)*, Côte d'Ivoire. RTBfoods Supervision: **Kouakou Amani Michel**, CNRA (2018-2019). Doctoral dissertation, University Felix Houphouet Boigny, Côte d'Ivoire. 242 p. Related references: https://doi.org/10.1177/09670335211007575, https://doi.org/10.1038/s41598-022-12135-2.
3. **Anne-Marie Tatiana Beugre** (tba). *Physicochemical and biochemical indicators of quality traits of fresh and fried plantain relationship with the sensory properties of the ready-to-eat product*, Côte d'Ivoire. RTBfoods Supervision: **Didier Mbeguie-A-Mbeguie**, CIRAD (Jan 2020 - Sep 2022). Doctoral dissertation, Universié Nangui Abrogoua, Côte d'Ivoire. *Study ongoing.
4. **Annie Takam Ngouno** (tba). *Production technics and preservation conditions of plantain-derived flour: nutritional, organoleptic, and technological properties*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Nov 2020 - Jul 2023). Doctoral dissertation, University of Dschang, Cameroon. *Study ongoing. Related references: http://www.doi.org/10.33425/2641-4295.1036, https://doi.org/10.1111/ijfs.14812.
5. **Antonin Hermann Kouassi** (2021). *Cuisson à l'eau du plantain de Côte d'Ivoire : contribution à la connaissance de la diversité, des usages et des déterminants sensoriels et texturaux*, Côte d'Ivoire. RTBfoods Supervision: **Christophe Bugaud**, CIRAD (Oct 2017 - Sep 2021). Doctoral dissertation, Université Nagui Abrogoua, Côte d'Ivoire. 228 p. Related reference: manuscript JSFA-23-0335 under review.
6. **Cédric Kendine Vepowo** (tba). *Boiled plantain quality traits and consumers' preferences in Cameroon*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Nov 2020 - Jul 2023). Doctoral dissertation, University of Douala, Cameroon. *Study ongoing. Related references: http://www.doi.org/10.33425/2641-4295.1036, https://doi.org/10.1111/ijfs.14812, manuscript JSFA-22-4116 under review.
7. **Chinedozi Amaefula** (tba). *Genetic improvement and physicochemical characterization of Gari quality of cassava*, Nigeria. RTBfoods Supervision: **Hale Tufan**, NRCRI (Jan 2019 - Dec 2023). Doctoral dissertation, Cornell University, USA. *Study ongoing.

8. **Dorcas Akinsany** (tba). *Application of near infrared spectroscopy (NIRS) for quality assessment of fresh and processed plantain and banana cultivars*, Nigeria. RTBfoods Supervision: **Oladeji Alamu**, IITA (Aug 2020 - Aug 2023). Doctoral dissertation, University of Ibadan, Nigeria. *Study ongoing.

9. **Elizabeth Khakasa** (tba). *Developing predictive models for quality traits in cooking banana hybrids*, Uganda. RTBfoods Supervision: **Kephas Nowakunda**, NARL (Oct 2021 - Oct 2023). Doctoral dissertation, Makerere University, Uganda. *Study ongoing. Related references: https://doi.org/10.1016/j.foodqual.2022.104628, https://doi.org/10.1111/ijfs.14813, https://doi.org/10.1111/ijfs.14878, https://doi.org/10.1002/jsfa.12606.

10. **Enoch Wembabazi** (tba). *Genetic Basis of Texture and Associated Traits in Cassava*, Ghana. RTBfoods Supervision: **Robert Kawuki**, NaCRRI (2019-2023). Doctoral dissertation, University of Ghana, Ghana. *Study ongoing. Related references: https://doi.org/10.4314/acsj.v27i2.3, https://doi.org/10.1111/ijfs.14940.

11. **Gemaine-Alice Wakem** (2023). *Physiological basis of retting process: identification of reliable biophysical indicators*, Cameroon. RTBfoods Supervision: **Didier Mbeguie-A-Mbeguie**, CIRAD (Jan 2020 - Sep 2022). Doctoral dissertation, University of Yaounde 1, Cameroon. 147 p. Related reference: manuscript JSFA-22-3781 under review.

12. **Hubert Noel Takam Tchuente** (tba). *Determinants institutionels et organisationnnels de l'adaption des variétés améliorées de manioc au Cameroun : une approche systémique par la chaine de valeur*, Cameroon. RTBfoods Supervision: **Béla Teeken**, IITA (Jan 2018 - Dec 2022). Doctoral dissertation, The University of Dschang, Cameroon. *Thesis finalization. Related references: https://doi.org/10.1111/ijfs.14790, https://doi.org/10.1111/ijfs.14867, manuscript JSFA-22-4176 under review.

13. **Jean Hugues Martial Kouassi** (tba). *Agronomic evaluation of sweetpotato (Ipomoea batatas) varieties and determination of end-user preferences in Côte d'Ivoire*, Côte d'Ivoire. RTBfoods Supervision: **Konan E.B. Dibi**, CNRA (Mar 2019 - Mar 2022). Doctoral dissertation, Université Jean Lorougnon Guédé, Côte d'Ivoire. *Study ongoing. Related reference: https://doi.org/10.9734/JABB/2021/v24i830231, manuscript JSFA-23-0193 under review.

14. **John Belalcazar** (tba). *Rapid evaluation of processing ability of cassava roots by near-infrared spectrophotometry (NIRS)*, Colombia. RTBfoods Supervision: **Fabrice Davrieux**, CIAT (Aug 2018- Aug 2022). Doctoral dissertation, Universidad Nacional de Colombia, Colombia. *Study ongoing. Related references: https://doi.org/10.1039/D2FO00048B, https://doi.org/10.1111/ijfs.14769, https://doi.org/10.1111/ijfs.14773, https://doi.org/10.1111/ijfs.14888.

15. **Kelechi Uchendu** (tba). *Genome-wide association mapping and stability analysis of root mealiness in cassava (Manihot esculenta Crantz)*, Ghana. RTBfoods Supervision: **tbc**, NRCRI (Jan 2017 - tbc). Doctoral dissertation, WACCI, Ghana. *Study ongoing. Related references: https://doi.org/10.3389/fpls.2021.770434, https://doi.org/10.1038/s41598-022-25172-8.

16. **Lassana Bakayoko** (2022). *Diversite genetique de l'igname Dioscorea alata L. cultivee en Côte d'Ivoire et identification par cartographie d'association de QTL de la resistance a l'anthracnose et du rendement*, Côte d'Ivoire. RTBfoods Supervision: **Kouakou Amani Michel**, CNRA (2017-2021). Doctoral dissertation, University Felix Houphouet Boigny, Côte d'Ivoire. 275 p. Related reference: https://doi.org/10.3390/plants10122562.

17. **Laurenda Honfozo** (tba). *Understanding sensory attributes of boiled yam and boiled cassava through robust and objective instrumental parameters*, Benin. RTBfoods Supervision: **Noël Akissoé**, UAC-FSA/CIRAD (Sep 2018 - Jan 2023). Doctoral dissertation, UAC-FSA, Benin. *Thesis finalization. Related reference: https://doi.org/10.1111/ijfs.14707.

18. **Linly Banda** (2021). *Biochemical and genetic determinants of texture in sweetpotato (Ipomoea batatas)*, Kenya. RTBfoods Supervision: **Tawanda Muzhingi**, CIP/JHI (Nov 2018 - Feb 2021). Doctoral dissertation, Pan African University Institute of Basic Science, Technology, and Innovation (PAUISTI), Nairobi, Kenya, Kenya. 193 p. Related references:

https://doi.org/10.5897/AJFS2020.2054, https://doi.org/10.1111/ijfs.14792, http://dx.doi.org/10.1016/j.jafr.2021.100121.

19. **Luis Fernando Londono Hernandez** (tba). *Evaluacion de factors inhibidores de hierro y el efecto del ultrasonido sobre la calidad nutricional del frijol crudo y cocido*, Colombia. RTBfoods Supervision: **Fabrice Davrieux**, CIAT (2018 - tbc). Doctoral dissertation, Universidad Nacional de Colombia (UNAL), Colombia. *Study ongoing.
20. **Mahugnon Ezékiel Houngbo** (tba). *Study of quality determinants and their interdependence with growth and development in yam (Dioscorea alata L.)*, Guadeloupe, France. RTBfoods Supervision: **Denis Cornet**, CIRAD (Oct 2020 - Oct 2023). Doctoral dissertation, Université Montpellier & Montpellier Supagro, France. *Study ongoing. Related reference: manuscript JSFA-22-3281 under review.
21. **Mariam Nakitto** (tba). *Rapid methodologies for improvement of sensory quality traits of orange fleshed sweetpotato*, Uganda. RTBfoods Supervision: **Mukani Moyo**, CIP (Mar 2021 - tbc). Doctoral dissertation, University of Pretoria, South Africa. *Study ongoing. Related references: https://doi.org/10.1111/ijfs.14840, https://doi.org/10.3389/fsufs.2021.620363, https://doi.org/10.5897/AJFS2020.2054, manuscripts JSFA-23-0335 & JSFA-22-3986 under review.
22. **Michael Kanaabi** (tba). *High throughput phenotyping andgenomics assisted breeding for low hydrogen cyanide in cassava*, Uganda. RTBfoods Supervision: **Emphraim Nuwamanya**, NaCRRI (2021-2024). Doctoral dissertation, Makerere University, Uganda. *Study ongoing. Related references: https://doi.org/10.1111/ijfs.14878, https://doi.org/10.1093/g3journal/jkac078, manuscripts JSFA-22-3986 & JSFA-22-3995 under review.
23. **Osvaldo Guambe** (tba). *Evaluation of consumer acceptability of sweetpotato genotypes in mozambique based on biophysical, biochemical and sensory properties*, Mozambique. RTBfoods Supervision: **Mukani Moyo**, CIP (2023 - tbc). Doctoral dissertation, Universidade Eduardo Mondlane, Mozambique. *Study ongoing.
24. **Queen Udodirim Okwu** (tba). *Breeding for improved quality of cassava starch*, Ghana. RTBfoods Supervision: **tbc**, NRCRI (2018 - tbc). Doctoral dissertation, WACCI, Ghana. *Study ongoing.

7.4.3 Engineer & Master Level

1. **Amos Asiimwe** (2021). *Development of trait dictionaries for sensory traits and processing techniques*, Uganda. RTBfoods Supervision: **Elizabeth Arnaud**, Bioversity (Sep 2020 - Jul 2022). Master thesis, Makerere University, Uganda. 28 p. Related online reference: manuscript JSFA-22-3986 under review.
2. **Angelique Morel** (2022). *Étude des bases génétiques des traits de qualité chez l'igname (Dioscorea alata L.)*, Guadeloupe, France. RTBfoods Supervision: **Komivi Dossa**, CIRAD (Jan 2022 - Jun 2022). Master thesis, Université de Montpellier, France. 73 p.
3. **Aurore Mobu Fotso** (2022). *Effet de la cuisson sur les proprietes physicochimiques et la teneur en amidon des pulpes de plantains produits au Cameroun*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Nov 2020 - Jul 2021). Master thesis, University of Dschang, Cameroon. 59 p.
4. **Ayomide Dorcas Alamu** (2022). *Screening tools for preferred pounded yam and yam tuber selection for breeding*, Nigeria. RTBfoods Supervision: **Bolanle Otebayo**, Bowen University (Jul 2019 - Aug 202). Master thesis, Bowen University, Nigeria. 162 p.
5. **Cédric Kuate Kengne** (2021). *Choice and quality criteria of plantain fruits in the cities of Bafoussam and Douala in Cameroon*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Jan 2021 - Jul 2021). Master thesis, University of Dschang, Cameroon. 102 p.

6. **Cendy Raymonde Nya Nzimi** (2021). *Determination of consumer acceptability of boiled plantain pulps in urban areas*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Nov 2020 - Jul 2021). Master thesis, University of Dschang, Cameroon. 97 p.
7. **Christie Marilyne Djidjidohm** (2020). *Evaluation des caractéristiques physico-chimiques, biochimiques et sensorielles des attiékés issus de variétés de manioc améliorées*, Côte d'Ivoire. RTBfoods Supervision: **Djedji Catherine Ebah**, CNRA (Mar 2020 - Oct 2020). Master thesis, Institut National Polytechnique Félix Houphouët-Boigny (INPHB), Côte d'Ivoire. 71 p.
8. **Dallonnes Ruth Fangueng Kamgo** (2022). *Effect of cooking on the physicochemical and nutritional characteristics of plantains*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Aug 2021 - Feb 2022). Master thesis, University of Yaounde 1, Cameroon. 106 p.
9. **Danielle Claude Mbwentchou Yao** (2021). *Varietal complementarity as a factor of appropriation of cassava varieties (Manihot esculenta): case of the regions of central and eastern Cameroon*, Cameroon. RTBfoods Supervision: **Takam Tchuente Hubert Noel**, IITA (Dec 2020 - Dec 2021). Master thesis, The University of Dschang, Cameroon. 152 p.
10. **Djibril Dassebe** (2022). *Use of artificial intelligence to improve robustness of near infrared spectroscopy model calibration*, France. RTBfoods Supervision: **Denis Cornet**, CIRAD (Nov 2021 - Apr 2022). Master thesis, African Institute for Mathematical Sciences, Sounth Africa. 22 p.
11. **Eddy Durand Nankep Njouohou** (tba). *Starch contents of banana fruits during post-harvest maturation*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Nov 2020 - Jul 2021). Master thesis, University of Dschang, Cameroon. *Study ongoing.
12. **Fatumah Babirye Namakula** (2021). *Diversity of root softness and starch content in cassava germplasm*, Uganda. RTBfoods Supervision: **Emphraim Nuwamanya**, NaCRRI (Apr 2019 - Apr 2021). Master report, Makerere University, Uganda. 3 p.
13. **Francis Hotegni** (2019). *Biophysical and texture characteristics of boiled yam*, Benin. RTBfoods Supervision: **Noël Akissoé**, UAC-FSA (Sep 2018 - Feb 2019). Master thesis, UAC-FSA, Benin. 53 p. Related reference: https://doi.org/10.1111/ijfs.14902.
14. **Franck Bertrand** (2019). *Report of cell wall polysaccharides extraction and characterization from raw yam*, Guadeloupe, France. RTBfoods Supervision: **Agnes Rolland-Sabate**, INRAe (Jan 2019 - Jul 2019). Master thesis, Lorraine University, France. 24 p. *Confidential until 15 March 2025.
15. **Gisèle Limanou** (2022). *Post-harvest composition of banana fruits' peel in Cameroon*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Aug 2021 - Feb 2022). Master thesis, University of Douala, Cameroon. 79 p.
16. **Guehayibi Gouleble Linda Syntiche Gougnan** (2018). *Etude du développement du bananier plantain en pepiniere et au champ a Anguédédou (Sud de la Côte d'Ivoire),* Côte d'Ivoire. RTBfoods Supervision: **Siaka Traore**, CNRA (Jul 2018 - Dec 2018). Master thesis, Institut Polytechnique Rural de Formation et de Recherche Appliquée (IPR/IFRA), Mali. 48 p.
17. **Jolaine Ajax** (2021). *Etude de l'aptitude à la cuisson de diverses variétés d'ignames par mesures texturales et biochimiques*, Guadeloupe, France. RTBfoods Supervision: **Mathieu Lechaudel**, CIRAD (Jan 2021 - Aug 2021). Master thesis, Université de Antilles, Guadeloupe, France. 41 p.
18. **Julien Boyer** (2022). *Prediction of yam cooking behavior using hyperspectral imaging*, France. RTBfoods Supervision: **Karima Meghar**, CIRAD (Apr 2022 - Sep 2022). Master thesis, Université de Bretagne Occidentale, France. 24 p.
19. **Juliette Sirejol** (2022). *Analysis of ground cover and senescence dynamics in yam: varietal diversity and relationship with yield and quality*, Guadeloupe, France. RTBfoods Supervision: **Denis Cornet**, CIRAD (Sep 2021 - Jan 2022). Master thesis, INP-ENSAT Toulouse, France. *Thesis finalization.

20. **Juvenald Dongmo Noubouwo** (2022). *Effect of two blanching techniques on the quality of flours from plantain-like hybrid CARBAP K74*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Aug 2021 - Feb 2022). Master thesis, University of Yaounde 1, Cameroon. 93 p.
21. **Kadjo Ayomaibié Jaures Manouan** (2019). *Etude du caractère hédonique de trois variétés d'attiéké biofortifiés et une variété locale : Cas de la variété yace*, Côte d'Ivoire. RTBfoods Supervision: **Djedji Catherine Ebah**, CNRA (Mar 2020 - Oct 2020). Master thesis, Institut National Polytechnique Félix Houphouët-Boigny (INPHB), Côte d'Ivoire. 76 p.
22. **Koffi Yekple-Djilan** (2021). *Development of a generic NIRS calibration pipeline using machin learning and model ensembling: application to some reference datasets*, Vietnam. RTBfoods Supervision: **Denis Cornet**, CIRAD (Sep 2020 - Nov 2020). Master thesis, Université de Toulon et de l'Institut Francophone International (Université Nationale du Vietnam à Hanoi), Vietnam. 86 p.
23. **Kouakou Serge Kouassi** (2020). *Aptitude à la production de frites (alloco) de quelques hybrides de bananes plantains (Musa x paradisiaca)*, Côte d'Ivoire. RTBfoods Supervision: **Djedji Catherine Ebah**, CNRA (Mar 2020 - Oct 2020). Master thesis, Institut National Polytechnique Félix Houphouët-Boigny (INPHB), Côte d'Ivoire. 71 p.
24. **L'Ecrivain Aoudou Mefire Ghangne** (2022). *Influence of packaging modes on the quality of flours from plantain-like hybrid CARBAP K74*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Aug 2021 - Feb 2022). Master thesis, University of Yaounde 1, Cameroon. 102 p.
25. **Laura Pazze** (2020). *Aptitude à la transformation en fonction de la variété chez l'igname (Dioscorea alata)*, Guadeloupe, France. RTBfoods Supervision: **Dominique Rinaldo**, INRAe (Jan 2020 -Jun 2020). Master thesis, French West Indies University, France. 40 p. *Confidential until 15 March 2025.
26. **Louise Schneyder** (2022). *Analysis of ground cover and senescence dynamics in yam*, Guadeloupe, France. RTBfoods Supervision: **Denis Cornet**, CIRAD (Sep 2021 - Feb 2022). Master thesis, University Montpellier SupAgro, France. *Thesis finalization.
27. **Maël Clergue** (2020). *Characterization and control of postharvest physiological deterioration of cassava roots*, Colombia. RTBfoods Supervision: **Jorge Luna**, CIAT (Mar 2020 - Aug 2020). Master thesis, UniLaSalle, France. 137 p.
28. **Matthieu Vergnol** (2020). *Extraction and characterization of cell wall material of cassava roots*, Colombia. RTBfoods Supervision: **Jhon Larry Moreno**, CIAT (Mar 2020 - Aug 2020). Master thesis, Ecole Nationale Supérieure de Chimie Montpellier (ENSCM), France. 38 p.
29. **Mickael Theophile** (2021). *Processing ability of yam as related to the variety and species*, Guadeloupe, France. RTBfoods Supervision: **Dominique Rinaldo**, INRAe (Jan 2021 -Jun 2021). Master thesis, French West Indies University, France. 40 p. *Confidential until 15 March 2025.
30. **Moreen Asasira** (2020). *Consumer preferences for cooking banana attributes. A case for urban consumers*, Uganda. RTBfoods Supervision: **Pricilla Marimo**, Bioversity/NARL (Nov 2018- Dec 2020). Master thesis, Makerere University, Uganda. 69 p. Related reference: https://doi.org/10.1111/ijfs.14813.
31. **Nouha Bouaziz** (2022*). Influence of cell wall and tannins on the cooking behavior of yam and plantain*, France. RTBfoods Supervision: **Agnes Rolland-Sabate**, INRAe (Jan 2022 -Jul 2022). Master thesis, Paris Sorbonne University, France. 38 p. *Confidential until 15 March 2025.
32. **Nourdène Dhaouadi** (2018). *Extraction and analysis by NIRS of cell walls from cassava roots*, Colombia. RTBfoods Supervision: **Jhon Larry Moreno**, CIAT (Apr 2018 - Sep 2018). Master thesis, Supagro Montpellier, France. 92 p.

33. **Pénélope Pede** (2021). *Quantitative descriptive analysis of boiled yam and relationship with biophysical characteristics*, Benin. RTBfoods Supervision: **Noël Akissoé**, UAC-FSA (Jul 2020 - Dec 2020). Master thesis, UAC-FSA, Benin. 78 p.
34. **Smith Kouferidji** (2021). *Quantitative descriptive analysis of boiled cassava and relationship with biophysical characteristics*, Benin. RTBfoods Supervision: **Noël Akissoé**, UAC-FSA (Jul 2020 - Dec 2020). Engineer thesis, UAC-FSA, Benin. 80 p.
35. **Socrate Goummeli** (2022). *Assessment of postharvest characteristics of two plantain-like hybrids produced in two contrasted localities in Cameroon*, Cameroon. RTBfoods Supervision: **Gérard Ngoh Newilah**, CARBAP (Nov 2021 - Jul 2022). Master thesis, University of Dschang, Cameroon. 104 p.
36. **Sylia Bourenine** (2019). *Development and application of a high-throughput phenotyping method for shape characteristics in yam: application to starch grains and tubers*, Guadeloupe, France. RTBfoods Supervision: **Denis Cornet**, CIRAD (Feb 2019 - Aug 2019). Master thesis, Université de Rouen, France. 73 p.
37. **Théo Demartinecourt** (2022). *Characterization of cell walls and pectins from yam and plantain by chromatographies and light scattering*, France. RTBfoods Supervision: **Agnes Rolland-Sabate**, INRAe (May 2022 -Jul 2022). Master thesis, Nantes University, France. 42 p. *Confidential until 15 March 2025.
38. **Thi Ha Giang Pham** (2022). *Link between the transformations during the processes and the final texture of starchy products: case of cooking yam*, France. RTBfoods Supervision: **Santiago Arufe Vilas**, CIRAD (Apr 2022 - Sep 2022). Master thesis, INP-ENSIACET, Toulouse, France. 41 p.
39. **Tiéba Simonis** (2021). *Relation entre l'évolution de la texture de l'igname et les comportements de l'amidon et des pectines au cours de la cuisson*, France. RTBfoods Supervision: **Christian Mestres**, CIRAD (May 2021 -Oct 2021). Master Thesis, Institut Agro Montpellier, France. 55 p.
40. **Vital Winnoc Zohoungbogbo** (2021). *Evaluation de l'impact d'un cuiseur moderne sur la teneur en b-carotène et la qualité de l'Attiéké issu de variétés biofortifiées de manioc (Manihot esculenta Crantz),* Côte d'Ivoire. RTBfoods Supervision: **Djedji Catherine Ebah**, CNRA (Jun 2019 - Jun 2020). Master thesis, Institut National Polytechnique Félix Houphouët-Boigny (INPHB), Côte d'Ivoire. 68 p.
41. **Willy Nelson Kisenyi** (2021). *Physico-chemical and sensory properties of selected local and hybrid bananas in Uganda*, Uganda. RTBfoods Supervision: **Pricilla Marimo**, Bioversity/NARL (Jan 2019- Nov 2020). Master thesis, Kyambogo University, Uganda. 108 p.

7.4.4 Diploma & Bachelor Levels

1. **Daniela Tamayo** (2019). *Extraction of CWM; Starch content protocol by enzymatic hydrolysis,* Colombia. RTBfoods Supervision: **Jhon Larry Moreno**, CIAT (Aug 2019 - Feb 2020). Bachelor report, ICESI, France. 11 p.
2. **Klériane Marseille** (2020). *Amylose content in yam tubers, Guadeloupe*, France. RTBfoods Supervision: **Lucienne Desfontaines**, INRAe (Nov 2019 -Jan 2020). BTS report, Lycée polyvalent Technologique Bellevue, Martinique Academy, France. 36 p.
3. **Melvin Vidau** (2021). *Extraction of cell wall polysaccharides from freeze-dried cooking banana samples*, France. RTBfoods Supervision: **Agnes Rolland-Sabate**, INRAe (May 2021 -Sep 2021). BTS report, Lycée Pétrarque, Avignon, France. 20 p. *Confidential until 15 March 2025.
4. **Clarisse Miossec** (2021). *Développement et validation d'une méthode analytique par analyseur de flux automatisé. Cas spécifique du dosage des pectines*, France. RTBfoods Supervision: **Julien Ricci**, CIRAD (Apr 2021 - Jun 2021). DUT report, Université Montpellier, France. 27 p.

5. **Damien Hoh** (2019). *Elaboration d’un protocole de dosage colorimétrique des pectines dans des extraits de plantes racines*, France. RTBfoods Supervision: **Christian Mestres**, CIRAD (Apr 2019 - Jun 2019). DUT report, Université Montpellier, France. 58 p.
6. **Elisa Zigele** (2019). *Mise au point d’une méthode rapide de mesure d’activité des enzymes liées aux pectines d’amylacées et effets de ces enzymes sur la texture des produits*, France. RTBfoods Supervision: **Christian Mestres**, CIRAD (Apr 2019 - Jun 2019). DUT report, Université Montpellier, France. 40 p.
7. **Lamia El Bojaddaini** (2020). *Creation of a standard database for the study of interoperability between near infrared spectrophotometers*, France. RTBfoods Supervision: **Denis Cornet**, CIRAD (Apr 2020 - May 2020). DUT report, Université Montpellier, France. 53 p.

7.5 Annex 5: List of RTBfoods publications

7.5.1 Peer-reviewed articles

Roots, Tubers and Bananas in General

1. **Dominique Dufour, Clair Hershey, Bruce R. Hamaker & Jim Lorenzen** (2021). Integrating end-user preferences into breeding programmes for roots, tubers and bananas. *International Journal of Food Science and Technology*, **56**(3), 1071-1075. https://doi.org/10.1111/ijfs.14911
2. **Graham Thiele, Dominique Dufour, Philippe Vernier, Robert O. M. Mwanga, Monica L. Parker, Elmar Schulte Geldermann, Béla Teeken, Tesfamicheal Wossen, Elisabetta Gotor, Enoch Kikulwe, Hale Tufan, Sophie Sinelle, Amani Michel Kouakou, Michael Friedmann, Vivian Polar & Clair Hershey** (2021). A review of varietal change in roots, tubers and bananas: consumer preferences and other drivers of adoption and implications for breeding. *International Journal of Food Science and Technology*, **56**(3), 1076-1092. https://doi.org/10.1111/ijfs.14684
3. **Gregory J. Scott** (2021). A review of root, tuber and banana crops in developing countries: past, present and future. *International Journal of Food Science and Technology*, **56**(3), 1093-1114. https://doi.org/10.1111/ijfs.14778
4. **Lora Forsythe, Hale Tufan, Alexandre Bouniol, Ulrich Kleih & Geneviève Fliedel** (2021). An interdisciplinary and participatory methodology to improve user acceptability of root, tuber and banana varieties. *International Journal of Food Science and Technology*, **56**(3), 1115-1123. https://doi.org/10.1111/ijfs.14680

Cassava

1. **Emmanuel Oladeji Alamu, Béla Teeken, Oluwatoyin Ayetigbo, Michael Adesokan, Ismail Kayondo, Ugo Chijioke, Tessy Madu, Benjamin Okoye, Bello Abolore, Damian Njoku, Ismail Rabbi, Chiedozie Egesi, Robert Ndjouenkeu, Alexandre Bouniol, Kauê De Sousa, Dominique Dufour & Busie Maziya-Dixon** (2023). Establishing the linkage between Eba's instrumental and sensory descriptive profiles and their correlation with consumer preferences: implications for cassava breeding. *Journal of the Science of Food and Agriculture*. https://doi.org/10.1002/jsfa.12518; http://agritrop.cirad.fr/604212/
2. **Franklin Ngoualem Kégah & Robert Ndjouenkeu** (2023) Gari, a cassava (*Manihot esculenta* Crantz) derived product: review on its quality and determinants. *Journal of Food Quality*, **2023**, e7238309. https://doi.org/10.1155/2023/7238309
3. **Bello Abolore, Agbona Afolabi, Olaosebikan Olamide, Edughaen Gospel, Dominique Dufour, Alexandre Bouniol, Peter Iluebbey, Robert Ndjouenkeu, Rabbi Ismail & Béla Teeken** (2023). Genetic and environmental effects on processing productivity, gari yields and eba acceptability: drudgery of women's work, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0360, under review.
4. **Cynthia Idhigu Aghogho, Siraj Ismail Kayondo, Bussie Maziya-Dixon, Saviour J.Y. Eleblu, Isaac Asante, Offei Kwame, Elizabeth Parkes, Chijioke Ugo, Andrew Ikpan Smith, Adesokan Micheal, Racheal Abioye, Ogunpaimo Kayode, Peter Kulakow, Chiedozie Egesi, Dominique Dufour & Ismail Y. Rabbi** (2023). Genetic characterization of Gari and Eba from diverse cassava varieties in Nigeria, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-3596, under review.
5. **Germaine-Alice Wakem, Libert Brice Tonfack, Emmanuel Youmbi, Apollin Fotso-Kuate, Cargele Masso, Komi K.M. Fiaboe, Rose Ndango, Isaac Tize, Joel Grabulos, Geneviève Fliedel, Dominique Dufour, Robert Ndjouenkeu & Didier Mbéguié-A-Mbéguié** (2023). Histological and biophysical changes of cassava roots during retting, a key step of fufu processing, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-3781, under review.

6. **Hubert Noël Takam Tchuente, Guillaume Hensel Fongang Fouepe, Danielle Claude Bwentchou Yao, Syndhia Mathe, Genevieve Fliedel & Béla Teeken** (2023). Varietal diversity as a lever for cassava variety development exploring varietal complementarities in Cameroon, *Journal of the Science of Food and Agriculture*, accepted manuscript JSFA-23-4176, under review.
7. **Maria Alejandra Ospina, Jhon Moreno, Thierry Tran, Angelica Jaramillo, Sonia Gallego, Bernardo Ospina & Dominique Dufour** (2023). Kinetics of thermal degradation of carotenoids related to potential of mixture of wheat, cassava and sweetpotato flours in baking products, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12831.
8. **Maria Alejandra Ospina, Thierry Tran, Monica Pizarro, Sandra Salazara Luis Londoño, Luis Augusto Becerra López-Lavalle & Dominique Dufour** (2023). Content and distribution of cyanogenic compounds in cassava roots and leaves in association with physiological age, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0213, under review.
9. **N'Nan Affoué Sylvie Diby**, **Prudence Deffan, Laurent Adinsi, Aurelie Bechoff, Landry Kanon, Alexandre Bouniol, Yapi Eric, Zoe Deuscher, Christophe Bugaud, Boni N'Zue & Bomoh Catherine Ebah Djedji** (2023). Use of sensory properties and physico-chemical parameters to understand consumer perception of Attiéké, a fermented cassava product, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0359, under review.
10. **Paula Iragaba, Laurent Adinsi, Luis Fernando Delgado, Ann Ritah Nanyonjo, Ephraim Nuwamanya, Enoch Wembabazi, Michael Kanaabi, Laurenda Honfozo, Imayath Djibril Moussa, Luis Londoño, Christophe Bugaud, Dominique Dufour, Robert Sezi Kawuki, Noël Akissoé & Thierry Tran** (2023). Definition of sensory and instrumental thresholds of acceptability for selection of cassava genotypes with improved boiling properties, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0358, under review.
11. **Ugo Chijioke, Simon Peter Abah, Oluchi Achonwa, Benjamin Okoye, Ayetigbo Oluwatoyin, Mercy Ejechi, Ugochi Jane Iro, Damian Njoku, Nwamaka Ogunka, Sonia Osodeke, Chukwudi Ogbete, Kayondo Siraj Ismail, Tessy Madu, Hernán Ceballos, Dominique Dufour & Chiedozie Egesi** (2023). Cassava retting ability and textural attributes of fufu for demand-driven cassava breeding, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0343, under review.
12. **Cynthia Idhigu Aghogho, Saviour J. Y. Eleblu, Moshood A. Bakare, Ismail Siraj Kayondo, Isaac Asante, Elizabeth Y. Parkes, Peter Kulakow, Samuel Kwame Offei & Ismail Rabbi** (2022). Genetic variability and genotype by environment interaction of two major cassava processed products in multi-environments. *Frontiers in Plant Science*, **13**, e974795. https://doi.org/10.3389/fpls.2022.974795
13. **Emmanuel Oladeji Alamu, Busie Maziya-Dixon & Alfred Gilbert Dixon** (2022). Evaluation of the pasting characteristics of cassava roots grown in different locations in Nigeria from the Genetic Gain Assessment trial. *Frontiers in Sustainable Food Systems*, **6**, e1012410. https://doi.org/10.3389/fsufs.2022.1012410
14. **Kelechi Uchendu, Damian N. Njoku, Ugochukwu N. Ikeogu, Daniel Dzidzienyo, Pangirayi Tongoona, Samuel Offei & Chiedozie Egesi** (2022). Genotype-by-environment interaction and stability of root mealiness and other organoleptic properties of boiled cassava roots. *Scientific Reports*, 12, 20909. https://doi.org/10.1038/s41598-022-25172-8
15. **Wasiu Awoyale, Hakeem Oyedele, Ayodele A. Adenitan, Michael Adesokan, Emmanuel O. Alamu & Busie Maziya-Dixon** (2022) Correlation of the quality attributes of fufu flour and the sensory and instrumental texture profiles of the cooked dough produced from different cassava varieties. *International Journal of Food Properties*, **25**(1), 326-343. https://doi.org/10.1080/10942912.2022.2026955
16. **Wasiu Awoyale, Hakeem Oyedele, Michael Adesokan, Emmanuel O. Alamu & Busie Maziya-Dixon** (2022). Can improved cassava genotypes from the breeding program substitute

the adopted variety for gari production? Biophysical and textural attributes approach. *Frontiers in Sustainable Food Systems*, **6**, e984687. https://doi.org/10.3389/fsufs.2022.984687

17. **Alexandre Bouniol, Laurent Adinsi, Sègla Wilfrid Padonou, Francis Hotegni, Désiré Gnanvossou, Thierry Tran, Dominique Dufour, Djidjoho Joseph Hounhouigan & Noël Akissoé** (2021). Rheological and textural properties of lafun, a stiff dough, from improved cassava varieties. *International Journal of Food Science and Technology*, **56**(3), 1278-1288. https://doi.org/10.1111/ijfs.14902
18. **Andrés Escobar, Eric Rondet, Layal Dahdouh, Julien Ricci, Noël Akissoé, Dominique Dufour, Thierry Tran, Bernard Cuq & Michèle Delalonde** (2021). Identification of critical versus robust processing unit operations determining the physical and biochemical properties of cassava-based semolina (gari). *International Journal of Food Science and Technology*, **56**(3), 1311-1321. https://doi.org/10.1111/ijfs.14857
19. **Ann Ritah Nanyonjo, Robert Sezi Kawuki, Florence Kyazze, Williams Esuma, Enoch Wembabazi, Dominique Dufour, Ephraim Nuwamanya & Hale Tufan** (2021). Assessment of end user traits and physicochemical qualities of cassava flour: a case of Zombo district, Uganda. *International Journal of Food Science and Technology*, **56**(3), 1289-1297. https://doi.org/10.1111/ijfs.14940
20. **Béla Teeken, Afolabi Agbona, Abolore Bello, Olamide Olaosebikan, Emmanuel Alamu, Michael Adesokan, Wasiu Awoyale, Tessy Madu, Benjamin Okoye, Ugo Chijioke, Durodola Owoade, Maria Okoro, Alexandre Bouniol, Dominique Dufour, Clair Hershey, Ismail Rabbi, Busie Maziya-Dixon, Chiedozie Egesi, Hale Tufan & Peter Kulakow** (2021). Understanding cassava varietal preferences through pairwise ranking of gari-eba and fufu prepared by local farmer–processors. *International Journal of Food Science and Technology*, **56**(3), 1258-1277. https://doi.org/10.1111/ijfs.14862
21. **Christiane Koffi Adjo, Boni N'Zué, Bomoh Catherine Ebah Djedji, Sidoine Essis Brice, N'Nan Affoué Sylvie Diby, Konan Dibi, Amani Michel Kouakou & Assanvo Simon Pierre N'guetta** (2021). Agronomic evaluation of some cassava varieties (*Manihot Esculenta* Crantz) and sensory evaluation of Attieke from these varieties in three agro-ecological zones of Cote D'ivoire. *International Journal of Agriculture and Biological Sciences*, **31**, 51-67. https://doi.org/10.5281/zenodo.6593223
22. **Emmanuel Oladeji Alamu, Chileshe Prisca, Bukola Olaniyan, Mary Omolola Omosebi, Mojisola Olanike Adegunwa, David Chikoye & Busie Maziya-Dixon** (2021). Evaluation of nutritional properties and consumer preferences of legume-fortified cassava leaves for low-income households in Zambia. *Cogent Food & Agriculture*, **7**(1), 1885796. https://doi.org/10.1080/23311932.2021.1885796
23. **Jorge Luna, Dominique Dufour, Thierry Tran, Mónica Pizarro, Fernando Calle, Moralba García Domínguez, Iván M. Hurtado, Teresa Sánchez & Hernán Ceballos** (2021). Post-harvest physiological deterioration in several cassava genotypes over sequential harvests and effect of pruning prior to harvest. *International Journal of Food Science and Technology*, **56**(3), 1322-1332. https://doi.org/10.1111/ijfs.14711
24. **Kelechi Uchendu, Damian Ndubuisi Njoku, Agre Paterne, Ismail Yusuf Rabbi, Daniel Dzidzienyo, Pangirayi Tongoona, Samuel Offei & Chiedozie Egesi** (2021). Genome-wide association study of root mealiness and other texture-associated traits in cassava. *Frontiers in Plant Science*, **12**, e770434. https://doi.org/10.3389/fpls.2021.770434
25. **Layal Dahdouh, Andrés Escobar, Eric Rondet, Julien Ricci, Geneviève Fliedel, Laurent Adinsi, Dominique Dufour, Bernard Cuq & Michèle Delalonde** (2021). Role of dewatering and roasting parameters in the quality of handmade gari. *International Journal of Food Science and Technology*, **56**(3), 1298-1310. https://doi.org/10.1111/ijfs.14745
26. **Lydia Ezenwaka, Dunia Pino Del Carpio, Jean-Luc Jannink, Ismail Rabbi, Eric Danquah, Isaac Asante, Agyemang Danquah, Essie Blay & Chiedozie Egesi** (2021). Genome-wide association study of resistance to cassava green mite pest and related traits in cassava. *Crop Science*, **58**, 1907-1918. https://doi.org/10.2135/cropsci2018.01.0024

27. **Maria A. Ospina, Monica Pizarro, Thierry Tran, Julien Ricci, John Belalcazar, Jorge L. Luna, Luis Londoño, Sandra Salazar, Hernan Ceballos, Dominique Dufour & Luis Augusto Becerra Lopez-Lavalle** (2021). Cyanogenic, carotenoids and protein composition in leaves and roots across seven diverse population found in the world cassava germplasm collection at CIAT, Colombia. *International Journal of Food Science and Technology*, **56**(3), 1343-1355. https://doi.org/10.1111/ijfs.14888
28. **Paula Iragaba, Sophia Hamba, Ephraim Nuwamanya, Michael Kanaabi, Ritah Ann Nanyonjo, Doreen Mpamire, Nicholas Muhumuza, Elizabeth Khakasa, Hale Ann Tufan & Robert Sezi Kawuki** (2021). Identification of cassava quality attributes preferred by Ugandan users along the food chain, *International Journal of Food Science and Technology*, **56**(3), 1184-1192. https://doi.org/10.1111/ijfs.14878
29. **Robert Ndjouenkeu, Franklin Ngoualem Kegah, Béla Teeken, Benjamin Okoye, Tessy Madu, Olamide Deborah Olaosebikan, Ugo Chijioke, Abolore Bello, Adebowale Oluwaseun Osunbade, Durodola Owoade, Hubert Noël Takam Tchuente, Esther Biaton Njeufa, Isabelle Linda Nguiadem Chomdom, Lora Forsythe, Busie Maziya-Dixon & Geneviève Fliedel** (2021). From cassava to gari: mapping of quality characteristics and end-user preferences in Cameroon and Nigeria. *International Journal of Food Science and Technology*, **56**(3), 1223-1238. https://doi.org/10.1111/ijfs.14790
30. **Ugo Chijioke, Tessy Madu, Benjamin Okoye, Amaka Promise Ogunka, Mercy Ejechi, Miriam Ofoeze, Chukwudi Ogbete, Damian Njoku, Justin Ewuziem, Confidence Kalu, Nnaemeka Onyemauwa, Blessing Ukeje, Oluchi Achonwa, Lora Forsythe, Geneviève Fliedel & Chiedozie Egesi** (2021). Quality attributes of fufu in South-East Nigeria: guide for cassava breeders. *International Journal of Food Science and Technology*, **56**(3), 1247-1257. https://doi.org/10.1111/ijfs.14875
31. **Wasiu Awoyale, Emmanuel Oladeji Alamu, Ugo Chijioke, Thierry Tran, Hubert Noël Takam Tchuente, Robert Ndjouenkeu, Ngoualem Kegah & Busie Maziya-Dixon** (2021). A review of cassava semolina (gari and eba) end-user preferences and implications for varietal trait evaluation. *International Journal of Food Science and Technology*, **56**(3), 1206-1222. https://doi.org/10.1111/ijfs.14867
32. **Wasiu Awoyale, Hakeem Oyedele, Ayodele A. Adenitan, Michael Adesokan, Emmanuel O. Alamu & Busie Maziya-Dixon** (2021). Relationship between quality attributes of backslopped fermented gari and the sensory and instrumental texture profile of the cooked dough (eba). *Journal of Food Processing and Preservation*, **46**(1), e16115. https://doi.org/10.1111/jfpp.16115
33. **Bright Boakye Peprah, Elizabeth Y. Parkes, Obed A. Harrison, Angeline van Biljon, Matilda Steiner-Asiedu, & Maryke T. Labuschagne** (2020). Proximate composition, cyanide content, and carotenoid retention after boiling of provitamin A-rich cassava grown in Ghana. *Foods*, **9**(12), 1800. https://doi.org/10.3390/foods9121800
34. **Elizabeth Parkes, Olufemi Aina, Akuwa Kingsley, Peter Iluebbey, Moshood Bakare, Afolabi Agbona, Patrick Akpotuzor, Maryke Labuschagne, & Peter Kulakow** (2020). Combining ability and genetic components of yield characteristics, dry matter content, and total carotenoids in provitamin A cassava F1 cross-progeny. *Agronomy*, **10**(12), 1850. https://doi.org/10.3390/agronomy10121850
35. **Emmanuel Oladeji Alamu, Busie Maziya-Dixon, Consent Sibeso, Elizabeth Parkes & Alfred Gilbert Dixon** (2020). Variations of macro- and microelements in yellow-fleshed cassava (*Manihot esculenta* Crantz) genotypes as a function of storage root portion, harvesting time, and sampling method. *Applied Sciences*, **10**(16), 5396. https://doi.org/10.3390/app10165396
36. **Emmanuel Oladeji Alamu, Busie Maziya-Dixon & Alfred Gilbert Dixon** (2020). Quantitative assessment of trace and macro element compositions of cassava (*Manihot esculenta*) storage roots enriched with β-carotene as influenced by genotypes and growing locations. *Agriculture*, **10**(12), 613. https://doi.org/10.3390/agriculture10120613

37. **Ismail Yusuf Rabbi, Siraj Ismail Kayondo, Guillaume Bauchet, Muyideen Yusuf, Cynthia Idhigu Aghogho, Kayode Ogunpaimo, Ruth Uwugiaren, Ikpan Andrew Smith, Prasad Peteti, Afolabi Agbona, Elizabeth Parkes, Ezenwaka Lydia, Marnin Wolfe, Jean Luc Jannink, Chiedozie Egesi, Peter Kulakow** (2020). Genome-wide association analysis reveals new insights into the genetic architecture of defensive, agro-morphological and quality-related traits in cassava. *Plant Molecular Biology*, **109**, 195–213. https://doi.org/10.1007/s11103-020-01038-3

38. **Paula Iragaba, Robert S. Kawuki, Guillaume Bauchet, Punna Ramu, Hale Ann Tufan, Elizabeth D. Earle, Michael A. Gore & Marnin Wolfe** (2020). Genomic characterization of Ugandan smallholder farmer-preferred cassava varieties. *Crop Science*, **60**(3), 1450-1461. https://doi.org/10.1002/csc2.20152

39. **Laurent Adinsi, Noël Akissoé, Andres Escobar, Laure Prin, Nadège Kougblenou, Dominique Dufour, Djidjoho J. Hounhouigan & Geneviève Fliedel** (2019). Sensory and physicochemical profiling of traditional and enriched gari in Benin. *Food Science & Nutrition*, **7**(10), 3338-3348. https://doi.org/10.1002/fsn3.1201

40. **Andrés Escobar, Layal Dahdouh, Eric Rondet, Julien Ricci, Dominique Dufour, Thierry Tran, Bernard Cuq & Michèle Delalonde** (2018). Development of a novel integrated approach to monitor processing of cassava roots into Gari: macroscopic and mcroscopic scales. *Food and Bioprocess Technology*, **11**, 1370-1380. https://doi.org/10.1007/s11947-018-2106-5

41. **Aurélie Bechoff, Keith Tomlins, Geneviève Fliedel, Luis Augusto Becerra Lopez-lavalle, Andrew Westby, Clair Hershey & Dominique Dufour** (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

42. **Aurélie Bechoff, Ugo Chijioke, Andrew Westby & Keith Ian Tomlins** (2018). 'Yellow is good for you': Consumer perception and acceptability of fortified and biofortified cassava products. *PLoS ONE*, **13**(9), 0203421. https://doi.org/10.1371/journal.pone.0203421

Yam

1. **Laurent Adinsi, Imayath Djibril-Moussa, Laurenda Honfozo, Alexandre Bouniol, Karima Meghar, Emmanuel O. Alamu, Michael Adesokan, Santiago Arufe, Miriam Ofoeze, Benjamin Okoye, Tessy Madu, Francis Hotègni, Ugo Chijioke, Bolanle Otegbayo, Dominique Dufour, Joseph D. Hounhouigan, Hernán Ceballos, Christian Mestres, and Noël Akissoé** (2023). Characterizing quality traits of boiled yam: texture and taste for enhanced breeding efficiency and impact, *Journal of the Science of Food and Agriculture*. https://doi.org/10.1002/jsfa.12589; http://agritrop.cirad.fr/604434/

2. **Asrat Asfaw, Paterne Agre, Ryo Matsumoto, Alice Adenike Olatunji, Alex Edemodu, Theresa Olusola, Oluchi Lawrencia Odom-Kolombia, Michael Adesokan, Emmanuel Oladeji Alamu, Patrick Adebola, Robert Asiedu & Busie Maziya-Dixon** (2023). Genome-wide dissection of the genetic factors underlying food quality in boiled and pounded white Guinea yam, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12816.

3. **Bolanle Otebayo, Oluyinka Oroniran, Abiola Tanimola, Bisi Fawehinmi, Ayomide Alamu, Tomilola Bolaji, Tessy Madu, Benjamin Okoye, Ugo Chijioke, Miriam Ofoeze, Emmanuel Oladeji Alamu, Michael Adesokan, Oluwatoyin Ayetigbo, Alexandre Bouniol, Imayath DJibril-Mousa, Laurent Adinsi, Noël Akissoé, Denis Cornet, Asrat Asfaw, Jude Obidiegwu & Busie Maziya-Dixon** (2023). Food quality profile of pounded yam and implications for Yam breeding, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12835.

4. **Dominique Rinaldo, Agnès Rolland-Sabatéb, David Langea & Dalila Pétroa** (2023). Varietal and environmental influences on organoleptic and cooking quality of water yam

(Dioscorea alata) landraces, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12873.

5. **Gemma Arnau, Lucienne Desfontaines, Adou Emmanuel Ehounou, Carine Marie-Magdeleine, Amani Michel Kouakou, Jocelyne Leinster, Elie Nudol, Erick Maledon, Hâna Chair** (2023). QTLs and candidate genes for physico-chemical traits related to tuber quality in greater yam (*Dioscorea alata* L), *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12822.
6. **Komivi Dossa Angélique Morel, Mahugnon Ezékiel Houngbo, Ana Zotta Mota, Erick Malédon, Jean-Luc Irep, Jean-Louis Diman, Pierre Mournet, Sandrine Causse, Kien Nguyen Van, Denis Cornet, Hâna Chair** (2023). Genome-wide association studies reveal novel loci controlling tuber flesh color and oxidative browning in *Dioscorea alata*, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12721.
7. **Adou Emmanuel Ehounou, Fabien Cormier, Erick Maledon, Elie Nudol, Hélène Vignes, Marie Claire Gravillon, Assanvo Simon Pierre N'guetta, Pierre Mournet, Hâna Chaïr, Amani Michel Kouakou & Gemma Arnau** (2022). Identification and validation of QTLs for tuber quality related traits in greater yam (*Dioscorea alata* L.). *Scientific Reports*, **12**, 8423. https://doi.org/10.1038/s41598-022-12135-2
8. **Dominique Rinaldo, Hélène Sotin, Dalila Pétro, Gildas Le-Bail & Sylvain Guyot** (2022). Browning susceptibility of new hybrids of yam (*Dioscorea alata*) as related to their total phenolic content and their phenolic profile determined using LC-UV- MS. *LWT-Food Science Technology*, **162**, 113410. https://doi.org/10.1016/j.lwt.2022.113410
9. **Emmanuel Oladeji Alamu, Michael Adesokan, Wasiu Awoyale, Oyedele Hakeem, Según Fawole, Asrat Amele, Busie Maziya-Dixon** (2022). Assessment of biochemical, cooking, sensory and textural properties of the boiled food product of white yam (*D. rotundata*) genotypes grown at different locations. *Heliyon*, **8**(12), e11690. https://doi.org/10.1016/j.heliyon.2022.e11690
10. **Liticia Effah-Manu, Faustina D. Wireko-Manu, Jacob K. Agbenorhevi, Busie Maziya-Dixon & Ibok Oduro** (2022) Chemical, functional and pasting properties of starches and flours from new yam compared to local varieties, *CyTA-Journal of Food*, **20**(1), 120-127. https://doi.org/10.1080/19476337.2022.2093401
11. **Adou Emmanuel Ehounou, Denis Cornet, Lucienne Desfontaines, Carine Marie-Magdeleine, Erick Maledon, Elie Nudol, Gregory Beurier, Lauriane Rouan, Pierre Brat, Mathieu Lechaudel, Camille Nous, Assanvo Simon Pierre N'Guetta, Amani Michel Kouakou & Gemma Arnau** (2021). Predicting quality, texture and chemical content of yam (*Dioscorea alata* L.) tubers using near infrared spectroscopy. *Journal of Near Infrared Spectroscopy*, **29**(3), 128-139. https://doi.org/10.1177/09670335211007575; https://hal.inrae.fr/hal-03213799
12. **Asrat Asfaw, Dotun Samuel Aderonmu, Kwabena Darkwa, David De Koeyer, Paterne Agre, Ayodeji Abe, Bunmi Olasanmi, Patrick Adebola, Robert Asiedu (2021).** Genetic parameters, prediction, and selection in a white Guinea yam early-generation breeding population using pedigree information. *Crop Science*, **61**(2), 1038-10511. https://doi.org/10.1002/csc2.20382
13. **Bolanle Otegbayo, Tessy Madu, Oluyinka Oroniran, Ugo Chijioke, Olabisi Fawehinmi, Benjamin Okoye, Abiola Tanimola, Patrick Adebola & Jude Obidiegwu** (2021). End-user preferences for pounded yam and implications for food product profile development. *International Journal of Food Science and Technology*, **56**(3), 1458-1472. https://doi.org/10.1111/ijfs.14770
14. **Lassana Bakayoko, Désiré N'Da Pokou, Abou Bakari Kouassi, Paterne A. Agre, Amani Michel Kouakou, Konan Evrard Brice Dibi, Boni Nzue, Jean M. Mondo, Patrick Adebola, Oluyemi T. Akintayo, Asrat Asfaw & Assanvo Simon Pierre N'Guetta** (2021). Diversity of water yam (*Dioscorea alata* L.) accessions from Côte d'Ivoire based on SNP markers and agronomic traits. *Plants*, **10**, 2562. https://doi.org/10.3390/plants10122562.

15. **Laurenda Honfozo, Laurent Adinsi, Alexandre Bouniol, Sounkoura Adetonah, Lora Forsythe, Ulrich Kleih, Joseph D. Hounhouigan, Geneviève Fliedel & Noël H. Akissoé** (2021). Boiled yam end-user preferences and implications for trait evaluation. *International Journal of Food Science and Technology*, **56**(3), 1447-1457. https://doi.org/10.1111/ijfs.14707
16. **Ryo Matsumoto, Asrat Asfaw, David De Koeyer, Satoru Muranaka, Tadashi Yoshihashi, Haruki Ishikawa, Patrick Adebola, Robert Asiedu (2021)**. Variation in tuber dry matter content and starch pasting properties of white guinea yam (*Dioscorea rotundata*) genotypes grown in three agroecologies of Nigeria. *Agronomy,* **11**(10), 1944. https://doi.org/10.3390/agronomy11101944
17. **Cobes Gatarira, Paterne Agre, Ryo Matsumoto, Alex Edemodu, Victor Adetimirin, Ranjana Bhattacharjee, Robert Asiedu & Asrat Asfaw** (2020). Genome-wide association analysis for tuber dry matter and oxidative browning in water yam (*Dioscorea alata* l.). *Plants*, **9**(8), 969. https://doi.org/10.3390/plants9080969
18. **Dominique Rinaldo** (2020). Carbohydrate and bioactive compounds composition of starchy tropical fruits and tubers, in relation to pre and postharvest conditions: A review. *Journal of Food Science*, **85**, 249-259. https://doi.org/10.1111/1750-3841.15002
19. **Emmanuel Oladeji Alamu, Michael Adesokan, Asrat Asfaw & Busie Maziya-Dixon** (2020). Effect of sample preparation methods on the prediction performances of near infrared reflectance spectroscopy for quality traits of freshyYam (*Dioscorea spp*.). *Applied Sciences*, **10**(17), 6035. https://doi.org/10.3390/app10176035
20. **Marie Umber, Denis Filloux, Suzia Gélabale, Rose-Marie Gomez, Armelle Marais, Séverine Gallet, Franciane Gamiette, Claudie Pavis & Pierre-Yves Teycheney** (2020). Molecular viral diagnosis and sanitation of yam genetic resources: implication for safe yam germplasm exchange. *Viruses*, **12**(10), 1101. https://doi.org/10.3390/v12101101
21. **Wasiu Awoyale, Hakeem A. Oyedele & Busie Maziya-Dixon** (2020). Correlation of the sensory attributes of thick yam paste (amala) and the functional and pasting properties of the flour as affected by storage periods and packaging materials. *Journal of Food Processing and Preservation*, **44**(10), 14732. https://doi.org/10.1111/jfpp.14732

Cooking banana

1. **Gérard Ngoh Newilah, Pascal Wambo, Cédric Kendine Vepowo, Annie Takam Ngouno, Solange Ulrich Manjia Ngoungoure, Jonas Tembe Tembe, Mama Nkouandou, Eric Ngombi Ngombi, Elie Fokou, François Xavier Etoa & Dominique Dufour** (2023). Influence of contrasting cultivation altitudes on the physicochemical, digestive, and functional properties of four *Musa* starches produced in Cameroon, *Journal of the Science of Food and Agriculture*. https://doi.org/10.1002/jsfa.12651
2. **Noël A. Madalla, Rony Swennen, Allan Brown, Sebastien Carpentier, Inge Van den Bergh, Rhiannon Crichton, Pricilla Marimo, Eva Weltzien, Cornel Massawe, Mpoki Shimwela, Daud Mbongo, Grace Kindimba, Jerome Kubiriba, Robooni Tumuhimbise, Asher W. Okurut, Martina Cavicchioli & Rodomiro Ortiz** (2023). Farmers' Preferences for East African Highland Cooking Banana 'Matooke' Hybrids and Local Cultivars. *Agriculture & Food Security*, **12**, 2. https://doi.org/10.1186/s40066-023-00407-7
3. **Cédric Kendine Vepowo, Gérard Ngoh Newilah, Marlyne-Joséphine Mananga, Dallonnes Fangueng Kamgo, Annie Takam Ngouno & Inocent Gouado** (2023). Effect of ripening stage, cooking mode and time on boiled plantain quality, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12785.
4. **Gérard Ngoh Newilah, Cédric Kendine Vepowo, Annie Takam Ngouno, Dallonnes Fangueng Kamgo, Raymonde Nya Nzimi, Jonas Tembe Tembe, Eric Ngombi Ngombi, Inocent Gouado, Zoé Deuscher, Alexandre Bouniol, Oluwatoyin Ayetigbo &, Dominique Dufour** (2023). Relation between quantitative descriptive analysis and textural analysis of boiled plantain, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0315, under review.

5. **Gérard Ngoh Newilah, Cédric Kendine Vepowo, Raymonde Nya Nzimi, Cédric Kuate Kengne, Annie Takam Ngouno, Claudin Karim Nana, Vivien Meli Meli, Inocent Gouado, Geneviève Fliedel, Dominique Dufour & Didier Mbeguie-A-Mbeguie** (2023). User preferences and consumer acceptability of boiled plantain in rural and urban localities in Cameroon, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-22-4111, under review.

6. **Kenneth Akankwasa, Pricilla Marimo, Alexandre Bouniol, Robooni Tumuhimbise, Moureen Asasira, Sarah Kisaakye, Elizabeth Khakasa, Edgar Tinyiro, Yusuf Mukasa, Living Tukashaba, Peter B. Ssenyoga, Dominique Dufour, Wilberforce Tushemereirwe & Kephas Nowakunda** (2023). Predicting quality and consumer acceptability of steamed East Africa Highland Bananas through sensory and laboratory assessment, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0243, under review.

7. **Kephas Nowakunda, Elizabeth Khakasa, Kenneth Akankwasa, Robooni Tumuhimbise Christophe Bugaud, Moureen Asasira, Brigitte Uwimana, Alexandre Bouniol, Ephraim Nuwamanya, Lora Forsythe, Priscilla Marimo, Dominique Dufour & Wilberforce Tushemereirwe** (2023). East African highland cooking banana: towards an efficient selection of hybrids with user-preferred food quality traits, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0244, under review.

8. **Bomoh Catherine Ebah Djedji, Louis Ban Koffi, N'Goran-Haddad Patricia, Koné Kisselminan, Serge Kouakou Kouassi, Traoré Siaka, & Kouakou Amani** (2021). Ability to produce alloco (fried plantain) from some plantain (*Musa paradisiaca* l. 1753) hybrids. *American Journal of Innovative Research and Applied Sciences*, **13**(4), 488-495. https://american-jiras.com/Abstract9_September_2021.html

9. **Brigitte Uwimana, Yasmín Zorrilla-Fontanesi, Jelle van Wesemael, Hassan Mduma, Allan Brown, Sebastien Carpentier & Rony Swennen** (2021). Effect of Seasonal Drought on the Agronomic Performance of Four Banana Genotypes (*Musa spp*.) in the East African Highlands. *Agronomy*, **11**(1), 4. https://doi.org/10.3390/agronomy11010004

10. **Delphine Amah, Esmé Stuart, Djana Mignouna, Rony Swennen & Béla Teeken** (2021). End-user preferences for plantain food products in Nigeria and implications for genetic improvement. *International Journal of Food Science and Technology*, **56**(3), 1148-1160. https://doi.org/10.1111/ijfs.14780

11. **Gérard Ngoh Newilah, Cédric Kendine Vepowo, Annie Takam Ngouno, Alexandre Bouniol, Agnès Rolland-Sabaté, Vivien Meli Meli, Judéon Socrates Yong Lemoumoum, Lora Forsythe, Dominique Dufour & Geneviève Fliedel** (2021). Analysis of consumer-oriented quality characteristics of raw and boiled plantains in Cameroon: implication for breeding. *International Journal of Food Science and Technology*, **56**(3), 1135-1148. https://doi.org/10.1111/ijfs.14812; https://hal.science/hal-03102644v1

12. **Hermann Antonin Kouassi, Emma Fernande Assemand, Olivier Gibert, Isabelle Maraval, Julien Ricci, Deless Edmond Fulgence Thiemele & Christophe Bugaud** (2021). Textural and physicochemical predictors of sensory texture and sweetness of boiled plantain. *International Journal of Food Science and Technology*, **56**(3), 1160-1170. https://doi.org/10.1111/ijfs.14765

13. **Jhon Larry Moreno, Thierry Tran, Borja Cantero-Tubilla, Karina López-López, Luis Augusto Becerra Lopez Lavalle & Dominique Dufour** (2021). Physicochemical and physiological changes during the ripening of Banana (*Musaceae*) fruit grown in Colombia. *International Journal of Food Science and Technology*, **56**(3), 1171-1183. https://doi.org/10.1111/ijfs.14851

14. **Kenneth Akankwasa, Pricilla Marimo, Robooni Tumuhimbise, Moreen Asasira, Elizabeth Khakasa, Innocent Mpirirwe, Uli Kleih, Lora Forsythe, Geneviève Fliedel, Dominique Dufour & Kephas Nowakunda** (2021). The East African highland cooking bananas 'Matooke' preferences of farmers and traders: Implications for variety development. *International Journal of Food Science and Technology*, **56**(3), 1124-1134. https://doi.org/10.1111/ijfs.14813

15. **Aurélie Béchoff, Lora Forsythe, Maria Njau, Adrienne Martin, Gaspar Audifas, Adebayo Abass & Keith Tomlins** (2020). Women Eat More Rice and Banana: The Influence of Gender and Migration on Staple Food Choice in East Africa. *Ecology of Food and Nutrition*, **59**(5), 506-524. https://doi.org/10.1080/03670244.2020.1755278

16. **Fleur BM Kilwinger, Pricilla Marimo, Anne M Rietveld, Conny JM Almekinders & Ynte K van Dam** (2020). Not only the seed matters: Farmers' perceptions of sources for banana planting materials in Uganda. *Outlook on Agriculture*, **49**(2), 119–132. https://doi.org/10.1177/0030727020930731

17. **Gérard Ngoh Newilah, Ngouno Annie Takam, Cédric Kendine Vepowo, Solange Ulrich Manjia Ngoungoure, Bilkissou Njapndounke, Pascal Wambo, Elie Fokou & François-Xavier Etoa** (2020). Formulation of plantain flour-based pasta: process optimization and sensory evaluation. *Food Science and Nutrition Research*, **3**(2), 1 – 11. http://www.doi.org/10.33425/2641-4295.1036

18. **Patchimaporn Udomkun, Cargele Masso, Rony Swennen, Tesfamicheal Wossen, Delphine Amah, Apollin Fotso, Jules Lienou, Michael Adesokan, Emmanuel Njukwe & Bernard Vanlauwe** (2020). Variability of provitamin A carotenoids in plantain: Influence of cultivar, bunch type, maturation stage, and location. *Journal of Food Composition and Analysis*, **94**, 103636. https://doi.org/10.1016/j.jfca.2020.103636

19. **Wasiu Awoyale, Hakeem Oyedele & Busie Maziya-Dixon** (2020). The functional and pasting properties of unripe plantain flour, and the sensory attributes of the cooked paste (amala) as affected by packaging materials and storage periods. *Cogent Food & Agriculture*, **6**(1), 1823595. https://doi.org/10.1080/23311932.2020.1823595

Sweetpotato

1. **Antonate Akinyi Owuor, Antonate Akinyi Owuor, David Jakinda Otieno, Julius Juma Okello & Willis Oluoch-Kosura** (2023). Assessment of consumers' appreciation for orange-fleshed sweetpotato puree chapati: a case of rural and urban consumers in Kenya, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12734.

2. **Jean Hugues Martial Kouassi, Dibi Evrard Brice Konan, Mambé Auguste-Dénise Boye, Brice Sidoine Essis, Amani Michel Kouakou & Boni N'zué** (2023). Sweetpotato cultivation: characteristics, constraints and preferred traits of producers and consumers in Côte d'Ivoire, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0351, under review.

3. **Victor Amankwaah, S. Williamson, B. Olokulo, V-D. Truong, Edward E. Carey, Reuben Ssali & G. Craig Yencho** (2023). Interrelations of α- and β-amylase activity with starch, sugars and culinary and nutritional quality attributes in sweetpotato roots, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12832

4. **Julius J. Okello, Jolien Swanckaert, Daniel Martin-Collado, Bruno Santos, Benard Yada, Robert O. M. Mwanga, Anouk Schurink, Michael Quinn, Graham Thiele, Simon Heck, Timothy J. Byrne, Guy G. Hareau, Hugo Campos** (2022). Market Intelligence and Incentive-Based Trait Ranking for Plant Breeding: A Sweetpotato Pilot in Uganda. *Frontiers in Plant Science*, **13**, e808597. https://doi.org/10.3389/fpls.2022.808597

5. **Mariam Nakitto, Suzanne D. Johanningsmeier, Mukani Moyo, Christophe Bugaud, Henriette de Kock, Layal Dahdouh, Nelly Forestier-Chiron, Julien Ricci, Elizabeth Khakasa, Reuben T. Ssali, Christian Mestres & Tawanda Muzhingi** (2022). Sensory guided selection criteria for breeding consumer-preferred sweetpotatoes in Uganda. *Food Quality and Preference*, **101**, 104628. https://doi.org/10.1016/j.foodqual.2022.104628

6. **Edward E. Carey, Reuben Ssali & Jan W. Low** (2021). Review of knowledge to guide product development and breeding for sweetpotato frying quality in West Africa. *International Journal of Food Science and Technology*, **56**(3), 1410-1418. https://doi.org/10.1111/ijfs.14934

7. **Eric K. Dery, Edward E. Carey, Reuben T. Ssali, Jan W. Low, Suzanne D. Johanningsmeier, Ibok Oduro, Abena Boakye, Rachael M. Omodamiro & Hauwa L.**

Yusuf (2021). Sensory characteristics and consumer segmentation of fried sweetpotato for expanded markets in Africa. *International Journal of Food Science and Technology*, **56**(3), 1419-1431. https://doi.org/10.1111/ijfs.14847

8. **Julius Juma Okello, Felix Mwala Shiundu, Janet Mwende, Carl Johan Lagerkvist, Rose Adhiambo Nyikal, Penina Muoki, John Mburu, Jan Low, Guy Hareau & Simon Heck** (2021). Quality and psychosocial factors influencing purchase of orange-fleshed sweetpotato bread. *International Journal of Food Science and Technology*, **56**(3), 1432-1446. https://doi.org/10.1111/ijfs.14822
9. **Linly Banda, Martina Kyallo, Jean-Baka Domelevo Entfellner, Mukani Moyo, Jolien Swanckaert, Robert O.M. Mwanga, Arnold Onyango, Esther Magiri, Dorcus C. Gemenet, Nasser Yao, Roger Pelle & Tawanda Muzhingi** (2021). Analysis of β-amylase gene (Amyβ) variation reveals allele association with low enzyme activity and increased firmness in cooked sweetpotato (*Ipomoea batatas*) from East Africa. *Journal of Agriculture and Food Research*, **4**, 100121. https://doi.org/10.1016/j.jafr.2021.100121
10. **Martial Jean Huges Kouassi, Gisèle Ahou Yah Koua, Brice Evrad Konan Dibi, Michel Amani Kouakou, Bomoh Catherine Ebah Djedji, Sidoine Brice Essis & Boni N'Zué** (2021). Consumer preferences for boiled and fried sweetpotato in Central and Northern Côte d'Ivoire, West Africa. *Journal of Advances in Biology and Biotechnology*, **24**(8), 33-46. https://doi.org/10.9734/JABB/2021/v24i830231
11. **Reuben Ssali, Edward Carey, Simon Imoro, Jan W. Low, Eric Kuuna Dery, Abena Boakye, Ibok Oduro, Rachel M. Omodamiro, Hauwa Ladi Yusuf, Eunice Etwire, Abigail O. Iyilade, Souleimane Adekambi, Abdullahi Ali, Muhammad Haliru & Prince Maxwell Etwire** (2021). Fried sweetpotato user preferences identifi ed in Nigeria and Ghana and implications for trait evaluation. *International Journal of Food Science and Technology*, **56**(3), 1399-1409. https://doi.org/10.1111/ijfs.14764
12. **Robert O. M. Mwanga, Sarah Mayanja, Jolien Swanckaert, Mariam Nakitto, Thomas zum Felde, Wolfgang Grüneberg, Netsayi Mudege, Mukani Moyo, Linly Banda, Samuel Edgar Tinyiro, Sarah Kisakye, David Bamwirire, Beatrice Anena, Alexandre Bouniol, Damalie Babirye Magala, Benard Yada, Edward Carey, Maria Andrade, Suzanne D. Johanningsmeier, Lora Forsythe, Geneviève Fliedel & Tawanda Muzhingi** (2021). Development of a food product profile for boiled and steamed sweetpotato in Uganda for effective breeding. *International Journal of Food Science and Technology*, **56**(3), 1385-1398. https://doi.org/10.1111/ijfs.14792
13. **Jan W. Low & Graham Thiele** (2020). Understanding innovation: The development and scaling of orange-fleshed sweetpotato in major African food systems. *Agricultural Systems*, **179**, 102770. https://doi.org/10.1016/j.agsy.2019.102770
14. **Roelinda Jongstra, Martin N Mwangi, Gabriela Burgos, Christophe Zeder, Jan W. Low, Glory Mzembe, Reyna Liria, Mary Penny, Maria I. Andrade, Susan Fairweather-Tait, Thomas Zum Felde, Hugo Campos, Kamija S. Phiri, Michael B. Zimmermann & Rita Wegmüller** (2020). Iron absorption from iron-biofortified sweetpotato is higher than regular sweetpotato in Malawian women while iron absorption from regular and iron-biofortified potatoes is high in Peruvian women. *Journal of Nutrition*, **150**(12), 3094-3102. https://doi.org/10.1093/jn/nxaa267
15. **Souleimane A Adekambi, Julius Juma Okello, Srinivasulu Rajendran, Kwabena Acheremu, Edward Carey, Jan Low & Putri Ernawati Abidin** (2020). Effect of varietal attributes on the adoption of an orange-fleshed sweetpotato variety in Upper East and Northern Ghana. *Outlook on Agriculture*, **49**(4) 311–320. https://doi.org/10.1177/0030727020950324

Potato

1. **Judith Nantongo, Samuel Edgar Tinyiro, Mariam Nakitto, Edwin Serunkuma, Prossy Namugga, Oluwatoyin Ayetigbo, Sarah Mayanja, Mukani Moyo, Reuben Ssali & Thiago Mendes** (2023). End users' preferences to enhance prospects for varietal acceptance and

adoption in potato breeding, *Journal of the Science of Food and Agriculture*, accepted manuscript JSFA-23-0357, under review.

2. **Netsayi Noris Mudege, Sarah Mayanja, John Nyaga, Mariam Nakitto, Samuel Edgar Tinyiro, Damali Babirye Magala, Janet Cox Achora, Sarah Kisakye, David Bamwirire, Thiago Mendes & Tawanda Muzhingi** (2021). Prioritising quality traits for gender-responsive breeding for boiled potato in Uganda. *International Journal of Food Science and Technology*, **56**(3), 1362-1375. https://doi.org/10.1111/ijfs.14840
3. **Vivian Bernal-Galeano, George Norton, David Ellis, Noëlle L. Anglin, Guy Hareau, Melinda Smale, Nelissa Jamora, Jeffrey Alwang & Willy Pradel** (2020). Andean potato diversity conserved in the International Potato Center genebank helps develop agriculture in Uganda: the example of the variety 'Victoria'. *Food Security*, **12**, 959–973. https://doi.org/10.1007/s12571-020-01037-8
4. **Wayne L. Morris & Mark A. Taylor** (2019). Improving flavor to increase consumption. American Journal of Potato Research, **96**(2), 195-200. https://doi.org/10.1007/s12230-018-09702-7

Tools & Methods

1. **Bolanle Otebayo, Thierry Tran, Julien Ricci & Olivier Gibert** (2023). In situ dynamic rheological evaluation of raw yam tuber: a potential phenotyping tool for quality evaluation, *Journal of the Science of Food and Agriculture*. https://doi.org/10.1002/jsfa.12662
2. **Elizabeth Khakasa, Charles Muyanja, Robert Mugabi, Christophe Bugaud, Nelly Forestier-Chiron, Brigitte Uwimana, Ivan Kabiita Arinaitwe & Kephas Nowakunda** (2023). Sensory characterization of the perceived quality of East African Highland Cooking Bananas (Matooke), *Journal of the Science of Food and Agriculture*. https://doi.org/10.1002/jsfa.12606; http://agritrop.cirad.fr/604431/
3. **Karima Meghar, Thierry Tran, Luis Fernando Delgado, Maria Alejandra Ospina, Jhon Larry Moreno, Jorge Luna, Luis Londoño, Dominique Dufour & Fabrice Davrieux** (2023). Hyperspectral imaging for the determination of relevant cooking quality traits of boiled cassava, *Journal of the Science of Food and Agriculture*. https://doi.org/10.1002/jsfa.12654
4. **Michael Adesokan, Emmanuel Oladeji Alamu, Segun Fawole & Busie Maziya-Dixon** (2023). Prediction of functional characteristics of gari (cassava flakes) using near-infrared reflectance spectrometry, *Frontiers in Chemistry*. **11**. https://doi.org/10.3389/fchem.2023.1156718
5. **Santiago Arufe, Oluwatoyin Ayetigbo, Romain Domingo, Laurent Adinsi, Imayath Djibril Moussa, Laurenda Honfozo, Noël Akissoé, Alexandre Bouniol & Christian Mestres** (2023). Instrumental procedures to assess the extensibility of pounded yam and relationship with sensory stretchability and consumer preferences, *Journal of the Science of Food and Agriculture*. https://doi.org/10.1002/jsfa.12598; http://agritrop.cirad.fr/604435/
6. **Alexandre Bouniol, Hernan Ceballos, Bello Abolore, Béla Teeken, Deborah Olamide Olaosebikan, Durodola Owoade, Agbona Afolabi, Fotso Kuate Apollin, Tessy Madu, Benjamin Okoye, Miriam Ofoeze, Solomon Nwafor, Nnaemeka nyemauwa, Laurent Adinsi, Geneviève Fliedel, Lora Forsythe & Dominique Dufour** (2023). Potential of new genotypes to address drudgery for women in the processing of roots, tubers and bananas, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0347, under review.
7. **Aurélie Bechoff, Laurent Adinsi, Gérard Ngoh Newilah, Mariam Nakitto, Zoé Deuscher, Reuben Saali, Ugo Chijioke, Elizabeth Khakasa, Kephas Nowakunda, Alexandre Bouniol, Dominique Dufour & Christophe Bugaud** (2023). Combined use of sensory methods for the selection of root, tuber and banana varieties acceptable to end-users, *Journal of the Science of Food and Agriculture*, Early view. https://doi.org/10.1002/jsfa.12723.
8. **Christian Mestres, Mark Taylor, Gordon Mcdougall, Santiago Arufe, Thierry Tran, Ephraim Nuwamanya, Dominique Dufour, Mariam Nakitto, Karima Meghar, Dominique**

Rinaldo, Lea Ollier, Romain Domingo, Jhon Larry Moreno, Luis Fernando Delgado, Hermann Antonin Kouassi, N'Nan Affoué Sylvie Diby, Didier Mbeguie-A-Mbeguie & Agnes Rolland-Sabate (2023). Contrasting effects of polysaccharides components on the cooking properties of root, tuber and bananas RTBs, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0335, under review.

9. **Elizabeth Arnaud, Naama Menda, Amos Asiimwe, Karima Meghar, Thierry Tran, Lora Forsythe, Marie-Angélique Laporte, Afolabi Agbona, Robert Kawuki, Michael Kanaabi, Bryan Ellebrock, Xiaofei Zhang, Reuben Ssali, Asrat Asfaw Amele, Ismail Siraj Kayondo, Brigitte Uwimana, Chukwudi Ogbete, Godwill Makunde, Thiago Mendes, Mariam Nakitto, Isabelle Maraval, Lukas Muller, Alexandre Bouniol, Eglantine Fauvelle & Dominique Dufour** (2023). Connecting data for consumer preferences, food quality and breeding in support of market-oriented breeding of root, tuber, and banana crops, *Journal of the Science of Food and Agriculture*. Early view, https://doi.org/10.1002/jsfa.12710.

10. **Ephraim Nuwamanya, Enoch Wembabazi, Michael Kanaabi, Fatumah Babirye Namakula, Arnold Katungisa, Ivan Lyatumi, Williams Esuma, Emmanuel Oladeji Alamu, Dominique Dufour, Fabrice Devrieux & Robert Kawuki** (2023). Development of near-infrared spectroscopy procedures for prediction of root dry matter and amylose contents in Ugandan cassava germplasm, *Journal of the Science of Food and Agriculture*, accepted manuscript JSFA-23-0334, under review.

11. **Lora Forsythe, Deborah Olamide Olaosebikan, Béla Teeken, Gérard Ngoh Newilah, Sarah Mayanja, Ann Ritah Nanyonjo, Paula Iragaba, Benjamin Okoye, Pricilla Marimo, Kenneth Akankwasa, Laurent Adinsi, Cédric Kendine Vepowo, Adetonah Sounkoura, Edgar Tinyiro, Alexandre Bouniol, Genevieve Fliedel, Dominique Dufour, Noël Akissoé & Tessy Madu** (2023). A case of inter/transdisciplinarity and collaborative decision making: the co-construction of Gendered Food Product Profiles, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0282, under review.

12. **Mahugnon Ezekiel Houngbo, Lucienne Desfontaines, Jean-Louis Diman, Gemma Arnau, Christian Mestres, Fabrice Davrieux, Lauriane Rouan, Gregory Beurier, Carine Marie-Magdeleine, Karima Meghar, Emmanuel Oladeji Alamu, Bolanle Otegbayo, Denis Cornet** (2023). Convolutional neural network allows amylose content prediction in yam (*Dioscorea alata L*) flour using near infrared spectroscopy, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12825.

13. **Mahugnon Ezekiel Houngbo, Lucienne Desfontaines, Jean-Luc Irep, Konan Evrard Brice Dibi, Pauline Mell, Maritza Couchy, Bolanle Otegbayo, Denis Cornet** (2023). Starch granule size and shape characterization of root, tuber and banana crop flour using automated image analysis: a case of yam (*Dioscorea spp*.), *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12832.

14. **Mariam Nakitto, Reuben Ssali, Suzanne D. Johnningsmeier, Mukani Moyo, Henriette de Kock, Ingunn Berget, Julius J. Okello, Sarah Mayanja, Samuel Edgar Tinyiro, Thiago Mendes & Christophe Bugaud** (2023). Decision tree scoring system to guide selection for consumer preference in sweetpotato breeding trials, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12883.

15. **Olamide Olaosebikan, Bello Abolore, Kauê De Sousa, Robert Ndjouenkeu, Michael Adesokan, Emmanuel Alamu, Afolabi Agbona, Jacob Van Etten, Franklin Ngoualem Kégah, Dominique Dufour, Alexandre Bouniol & Béla Teeken** (2023). Drivers of consumer acceptability of cassava gari - eba food products across cultural and environmental settings, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12867

16. **Oluwatoyin Ayetigbo, Santiago Arufe, Antonin Kouassi, Laurent Adinsi, Michael Adesokan, Andres Escobar, Luis Fernando Delgado, Abiola Tanimola, Oluyinka Oroniran, Cedric Kendine Vepowo, Mariam Nakitto, Elizabeth Khakasa, Ugo Chijioke, Kephas Nowakunda, Gérard Ngoh Newilah, Bolanle Otegbayo, Noël Akissoé, Mathieu Lechaudel, Thierry Tran, Busie Maziya-Dixon, Christian Mestres & Dominique Dufour** (2023). Review of instrumental texture measurements as breeding tools to assess phenotypic

diversity for quality of root, tuber and banana food products, *Journal of the Science of Food and Agriculture*, submitted manuscript JSFA-23-0322, under review.

17. **Victor Amankwaah, S. Williamson, R. Ibrahem, K. Pecota, B. Olokulo, V-D. Truong, Edward E. Carey, T.T. Felde, Reuben Ssali & G. Craig Yencho** (2023). Development of NIRS calibration curves for sugars in baked sweetpotato, *Journal of the Science of Food and Agriculture*, https://doi.org/10.1002/jsfa.12800.
18. **Edwige Gaby Nkouaya Mbanjo, Jenna Hershberger, Prasad Peteti, Afolabi Agbona, Andrew Ikpan, Kayode Ogunpaimo, Siraj Ismail Kayondo, Racheal Smart Abioye, Kehinde Nafiu, Emmanuel Oladeji Alamu, Michael Adesokan, Busie Maziya-Dixon, Elizabeth Parkes, Peter Kulakow, Michael A. Gore, Chiedozie Egesi & Ismail Yusuf Rabbi** (2022). Predicting starch content in cassava fresh roots using near-infrared spectroscopy. *Frontiers in Plant Science*, **13**, e990250. https://doi.org/10.3389/fpls.2022.990250
19. **Giovanny Covarrubias-Pazaran, Zelalem Gebeyehu, Dorcus Gemenet, Christian Werner, Marlee Labroo, Solomon Sirak, Peter Coaldrake, Ismail Rabbi, Siraj Ismail Kayondo, Elizabeth Parkes, Edward Kanju, Edwige Gaby Nkouaya Mbanjo, Afolabi Agbona, Peter Kulakow, Michael Quinn & Jan Debaene** (2022). Breeding schemes: What are they, how to formalize them, and how to improve them? *Frontiers in Plant Science*, **12**, e791859. https://doi.org/10.3389/fpls.2021.791859
20. **Ireti Balogun, Elisabeth Garner, Peter Amer, Peter Fennessy, Béla Teeken, Olamide Olaosebikan, Bello Abolore, Tessy Madu, Benjamin Okoye, Bruno Santos, Tim Byrne, Daniel Martin-Collado, Chiedozie Egesi, Peter Kulakow & Hale Ann Tufan** (2022). From traits to typologies: Piloting new approaches to profiling trait preferences along the cassava value chain in Nigeria. *Crop Science*, **62**(1), 269-274. https://doi.org/10.1002/csc2.20680
21. **José Francisco Valle, Elizabeth Arnaud, Pricilla Marimo, Jacob van Etten** (2022). Enabling cumulative learning in user-oriented research for root, tuber and banana crop breeding. *Experimental Agriculture*, **58**, e58. https://doi:10.1017/S0014479722000539
22. **Nicolas Morales, Alex C. Ogbonna, Bryan J. Ellerbrock, Guillaume J. Bauchet, Titima Tantikanjana, Isaak Y. Tecle, Adrian F. Powell, David Lyon, Naama Menda, Christiano C. Simoes, Surya Saha, Prashant Hosmani, Mirella Flores, Naftali Panitz, Ryan S. Preble, Afolabi Agbona, Ismail Rabbi, Peter Kulakow, Prasad Peteti, Robert Kawuki, Williams Esuma, Micheal Kanaabi, Doreen M. Chelangat, Ezenwanyi Uba, Adeyemi Olojede, Joseph Onyeka, Trushar Shah, Margaret Karanja, Chiedozie Egesi, Hale Tufan, Agre Paterne, Asrat Asfaw, Jean-Luc Jannink, Marnin Wolfe, Clay L. Birkett, David J. Waring, Jenna M. Hershberger, Michael A. Gore, Kelly R. Robbins, Trevor Rife, Chaney Courtney, Jesse Poland, Elizabeth Arnaud, Marie-Angélique Laporte, Heneriko Kulembeka, Kasele Salum, Emmanuel Mrema, Allan Brown, Stanley Bayo, Brigitte Uwimana, Violet Akech, G. Craig Yencho, Bert de Boeck, Hugo Campos, Rony Swennen, Jeremy D. Edwards & Lukas A. Mueller** (2022). Breedbase: A digital ecosystem for modern plant breeding, *G3 Genes|Genomes|Genetics*, **12**(7), jkac078. https://doi.org/10.1093/g3journal/jkac078
23. **Edwige Gaby Nkouaya Mbanjo, Ismail Yusuf Rabbi, Morag Elizabeth Ferguson, Siraj Ismail Kayondo, Ng Hwa Eng, Leena Tripathi, Peter Kulakow & Chiedozie Egesi** (2021). Technological Innovations for improving cassava production in Sub-Saharan Africa. *Frontiers in Genetics*, **11**, 623736. https://doi.org/10.3389/fgene.2020.623736
24. **Emmanuel Oladeji Alamu, Ephraim Nuwamanya, Denis Cornet, Karima Meghar, Michael Adesokan, Thierry Tran, John Belalcazar, Lucienne Desfontaines & Fabrice Davrieux** (2021). Near-infrared spectroscopy applications for high-throughput phenotyping for cassava and yam: A review. *International Journal of Food Science and Technology*, **56**(3), 1491-1446. https://doi.org/10.1111/ijfs.14773; https://hal.science/hal-02947924v1
25. **Linly Banda, Mukani Moyo, Mariam Nakitto, Jolien Swanckaert, Arnold Onyango, Esther Magiri, Gordon J Mcdougall, Laurence Ducreux, Mark Taylor, Tawanda Muzhingi** (2021). Application of wedge fracture test for texture analysis in boiled sweetpotato (*Ipomoea batatas*). *African Journal of Food Science*, **15**(4), 145-151. https://doi.org/10.5897/AJFS2020.2054

26. **Mukani Moyo, Reuben Ssali, Sam Namanda, Mariam Nakitto, Eric K. Dery, Daniel Akansake, Joseph Adjebeng-Danquah, Jacob van Etten, Kauê de Sousa, Hannele Lindqvist-Kreuze, Edward Carey & Tawanda Muzhingi** (2021). Consumer preference testing of boiled sweetpotato using crowdsourced citizen science in Ghana and Uganda. *Frontiers in Sustainable Food Systems*, **5**, e620363. https://doi.org/10.3389/fsufs.2021.620363
27. **Thierry Tran, Xiaofei Zhang, Hernan Ceballos, Jhon L. Moreno, Jorge Luna, Andrés Escobar, Nelson Morante, John Belalcazar, Luis Augusto Becerra López-Lavalle & Dominique Dufour** (2021). Correlation of cooking time with water absorption and changes in relative density during boiling of cassava roots. *International Journal of Food Science and Technology*, **56**(3), 1193-1205. https://doi.org/10.1111/ijfs.14769
28. **Wilfred Abincha, Ugochukwu N. Ikeogu, Robert Kawuki, Chiedozie Egesi, Ismail Rabbi, Elizabeth Parkes, Peter Kulakow, Richard Edema, Paul Gibson & Betty-Elizabeth Owor** (2021). Portable spectroscopy calibration with inexpensive and simple sampling reference alternatives for dry matter and total carotenoid contents in cassava roots. *Applied Sciences*, **11**, 1714. https://doi.org/10.3390/app11041714
29. **Dorcus C. Gemenet, Mercy N. Kitavi, Maria David, Dorcah Ndege, Reuben T. Ssali, Jolien Swanckaert, Godwill Makunde, G. Craig Yencho, Wolfgang Gruneberg, Edward Carey, Robert O. Mwanga, Maria I. Andrade, Simon Heck & Hugo Campos** (2020). Development of diagnostic SNP markers for quality assurance and control in sweetpotato (*Ipomoea batatas* (L.) Lam.) breeding programs. *PLoS ONE*, **15**(4), e0232173. https://doi.org/10.1371/journal.pone.0232173
30. **Ernest Baafi, Mavis Akom, Adelaide Agyeman, Cynthia Darko & Ted Carey** (2020). Breeding farmer and consumer preferred sweetpotatoes using accelerated breeding scheme and mother–baby trials. *Open Agriculture*, **5**(1), 548-557. https://doi.org/10.1515/opag-2020-0055
31. **Kwabena Darkwa, Bunmi Olasanmi, Robert Asiedu & Asrat Asfaw** (2020). Review of empirical and emerging breeding methods and tools for yam (*Dioscorea spp*.) improvement: Status and prospects. *Plant Breeding*, **139**(3), 474-497. https://doi.org/10.1111/pbr.12783
32. **Guanghui Shen, Matthieu Lesnoff, Vincent Baeten, Pierre Dardenne, Fabrice Davrieux, Hernan Ceballos, John Belalcazar, Dominique Dufour, Zengling Yang, Lujia Han & Juan Antonio Fernández Pierna** (2019). Local Partial Least Square based on global PLS Scores. *Journal of Chemometrics*, **33**(5), e3117. https://doi.org/10.1002/cem.3117
33. **Paula Iragaba, Ephraim Nuwamanya, Enoch Wembabazi, Baguma Y., Dominique Dufour, Elizabeth D. Earle, Rachel Bezner Kerr, Hale Ann Tufan, Michael A. Gore & Robert S. Kawuki** (2019). Estimates for heritability and consumer-validation of a penetrometer method for phenotyping softness of cooked cassava roots. *African Crop Science Journal*, **27**(2),147-163. https://doi.org/10.4314/acsj.v27i2.3

Gender

1. **Béla Teeken, Elisabeth Garner, Afolabi Agbona, Ireti Balogun, Olamide Olaosebikan, Abolore Bello, Tessy Madu, Benjamin Okoye, Chiedozie Egesi, Peter Kulakow & Hale Ann Tufan** (2021). Beyond “Women's Traits”: exploring how gender, social difference, and household characteristics influence trait preferences. *Frontiers in Sustainable Food Systems*, 5, e740926. https://doi.org/10.3389/fsufs.2021.740926
2. **Nozomi Kawarazuka, Elias Damtew, Sarah Mayanja, Joshua Sikhu Okonya, Anne Rietveld, Vanya Slavchevska & Béla Teeken** (2020). A gender perspective on pest and disease management from the cases of roots, tubers and bananas in Asia and Sub-Saharan Africa. *Frontiers in Agronomy*, **2**(7). https://doi.org/10.3389/fagro.2020.00007
3. **Pricilla Marimo, Cynthia Caron, Inge Van Den Bergh, Rhiannon Crichton, Eva Weltzien, Rodomiro Ortiz & Robooni Tumuhimbise** (2020). gender and trait preferences for banana

cultivation and use in Sub-Saharan Africa: A Literature Review. *Economic Botany*, **74**(2), 226–241. https://doi.org/10.1007/s12231-020-09496-y

4. **Béla Teeken, Olamide Olaosebikan, Joyce Haleegoah, Elizabeth Oladejo, Tessy Madu, Abolore Bello, Elizabeth Parkes, Chiedozie Egesi, Peter Kulakow, Holger Kirscht & Hale Ann Tufan** (2018). Cassava trait preferences of men and women farmers in Nigeria: implications for breeding. *Economic Botany*, **72**(3), 263-277. https://doi.org/10.1007/s12231-018-9421-7

7.5.2 Book chapters & working papers

1. **Afolabi Agbona, Prasad Peteti, Béla Teeken, Olamide Olaosebikan, Abolore Bello, Elizabeth Parkes, Ismail Rabbi, Lukas Mueller, Chiedozie Egesi & Peter Kulakow** (2022). Data management in multi-disciplinary African RTB Crop Breeding Programs. *In*. H.F. Williamson & S. Leonelli (eds.). Towards Responsible Plant Data Linkage: Data Challenges for Agricultural Research and Development, Springer, Cham. pages 85–103. https://doi.org/10.1007/978-3-031-13276-6_5

2. **Vincent Baeten & Pierre Dardenne** (2021) Application of NIR in Agriculture. *In:* Ozaki Y., Huck C., Tsuchikawa S., Engelsen S.B. (eds) Near-Infrared Spectroscopy, Theory, Spectral Analysis, Instrumentation and Applications. Springer, Singapore. pages 331-345. https://doi.org/10.1007/978-981-15-8648-4_14

3. **Vivian Polar, Béla Teeken, Janet Mwende, Pricilla Marimo, Hale Ann Tufan, Jacqueline A. Ashby, Steven Cole, Sarah Mayanja, Julius J. Okello, Peter Kulakow & Graham Thiele** (2022). Building demand-led and gender-responsive breeding programs. *In*: Thiele, G., Friedmann, M., Campos, H., Polar, V., Bentley, J.W. (eds). Root, Tuber and Banana Food System Innovations, Springer International Publishing. pages 483–509. https://doi.org/10.1007/978-3-030-92022-7_16

4. **Ida Arff Tarjem, Catherine Ragasa, Vivian Polar, Almamy Sylla, Béla Teeken, Eileen Nchanji, Gaudiose Mujawamariya, Netsayi Mudege & Priscilla Marimo.** (2021). Tools and methods on gendered design, deployment and evaluation of agricultural technologies. CGIAR GENDER Platform Working Paper #003. Nairobi, Kenya: CGIAR GENDER Platform. https://cgspace.cgiar.org/handle/10568/116887

5. **Vivian Polar, Rohini Ram Mohan, Cynthia McDougall, Béla Teeken, Annet Abenakyo Mulema, Pricilla Marimo & Jummai Othniel Yila** (2021). Examining choice to advance gender equality in breeding research. Book Chapter 2, *In:* Pyburn Rhiannon, & Van Eerdewijk Anouka (eds). Advancing Gender Equality through Agricultural and Environmental Research: Past, Present, and Future. Washington, DC: International Food Policy Research Institute, pages 77-111. https://doi.org/10.2499/9780896293915_02 direct PDF link: https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/134688/filename/134900.pdf

6. **Deborah Rubin, Brenda Boonabaana & Cristina Manfre** (2019). Building an inclusive agriculture: strengthening gender equality in agricultural value. *Resakss Annual Trends and Outlook Report 2019*. International Food Policy Research Institute, pages 83–96. http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/133475/filename/133674.pdf

7. **Pricilla Marimo, Deborah Karamura, Robooni Tumuhimbise, Mpoki M Shimwela, Inge Van den Bergh, Michael Batte, Cornel R.S. Massawe, Asher W. Okurut, Daudi B. Mbongo & Rhiannon Crichton**. (2019). Post-harvest use of banana in Uganda and Tanzania: Product characteristics and cultivar preferences of male and female farmers. Lima (Peru). CGIAR Research Program on Roots, Tubers and Bananas (RTB). *RTB Working Paper*. No. 3. https://cgspace.cgiar.org/handle/10568/106275

7.5.3 International conference presentations

1. **Dallonnes Ruth Fangueng Kamgo** (2022). Impact of cooking mode and ripening stage on boiled plantain pulp firmness. [Oral presentation], *Cameroon annual conference Biosciences: Bioscience and Innovation for Sustainable Development, Cameroon, 1–5 December 2022.*

2. **Laurenda F. Honfozo, Imayath M. Djibril Moussa, Laurent Adinsi, Alexandre Bouniol, Sounkoura Adetonah & Noël H. Akissoe** (2022). Screening des critères de qualité pour une meilleure valorisation du manioc bouilli [Oral présentation], *Scientifique International de l'Université Nationale d'Agriculture, Sakété, Bénin, 28-30 novembre 2022.*

3. **Abolore Bello, Afolabi Agbona, Olamide Olaosebikan, Edughaen, G., Dominique Dufour, Alexandre Bouniol, Peter Iluebbey, Robert Ndjouenkeu, Ismail Rabbi & Béla Teeken** (2022). Processing Performance and drivers of gari acceptability from Improved cassava in Cameroon: Focus on women's drudgery and implication for breeding. [Abstract and oral presentation], *The 19th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Nairobi, Kenya, 21 – 25 November 2022*. https://istrc.aatf-africa.org/

4. **Bolanle Otegbayo, Oluyinka Oroniran, Abiola Tanimola, Oluwatomilola Bolaji, Ayomide Alamu, Oluwatoyin Ayetigbo** (2022). Instrumental texture profile analyses of pounded yam produced from yam genotypes of contrasting pounding quality. [Oral presentation], *Tropentag 2022. International research on food security, natural resource management and rural development: Can agroecological farming feed the world? Farmers' and academia's views., Prague, République tchèque, 14 -16 Septembre 2022.* Book of abstracts: Eric Tielkes (ed.). Witzenhausen: Cuvillier Verlag, Diaporama, ISBN 978-3-7369-7671-9 Tropentag 2022 - Can agroecological farming feed the world? Farmers' and academias' views, p 410-411. https://www.tropentag.de/

5. **Oluwatoyin Ayetigbo, Sajid Latif, Waill Idris, Joachim Müller** (2022). Physical properties of foam powder produced from white-fleshed and yellow-fleshed cassava (*Manihot esculenta*) varieties. [Oral presentation], *Tropentag 2022. International research on food security, natural resource management and rural development: Can agroecological farming feed the world? Farmers' and academia's views., Prague, République tchèque, 14 -16 Septembre 2022.* Book of abstracts: Eric Tielkes (ed.). Witzenhausen: Cuvillier Verlag, Diaporama, ISBN 978-3-7369-7671-9 Tropentag 2022 - Can agroecological farming feed the world? Farmers' and academias' views, p 406. https://www.tropentag.de/

6. **Graham Thiele, Enrico Boniauti, Vivian Polar & Michael Friedmann** (2022). CGIAR research program on roots tubers bananas: theory and learning of scaling for impact [Oral presention-Keynote speaker], *The 12th Triennial African Potato Association Conference (APA 2022 Conference), Lilongwe, Malawi*, *June 27 - July 1, 2022.* Book of abstracts: Harnessing potato and sweetpotato, innovations for resilient, healthier agri-food systems, p 116. https://africanpotatoassociation.org/abstract-book/

7. **Konan Evrard Brice Dibi, Jean Hugues Martial Kouassi, Brice Sidoine Essis, Ahou-Yah Gisèle Koua, Bomo-Ebah Cathérine Djedji, Amani Michel Kouakou, Boni N'zué, Dominique Dufour & Jan Low** (2022). Consumer preferences for boiled and fried sweetpotato in central and northern Côte d'Ivoire. [Oral presentation], *The 12th Triennial African Potato Association Conference (APA 2022 Conference), Lilongwe, Malawi*, *June 27 - July 1, 2022.* Book of abstracts: Harnessing potato and sweetpotato, innovations for resilient, healthier agri-food systems, p 9. https://africanpotatoassociation.org/abstract-book/

8. **Konan Evrard Brice Dibi, Jean Hugues Martial Kouassi, Mambé Auguste-Dénise Boye, Brice Sidoine Essis, Amani Michel Kouakou, Boni N'zué, Dominique Dufour & Jan Low** (2022). Identification of the preferred traits of sweetpotato producers and consumers in central and northern Côte d'Ivoire. [Poster presention], *The 12th Triennial African Potato Association Conference (APA 2022 Conference), Lilongwe, Malawi*, *June 27 - July 1, 2022.* Book of abstracts: Harnessing potato and sweetpotato, innovations for resilient, healthier agri-food systems, p 141. https://africanpotatoassociation.org/abstract-book/

9. **Mariam Nakitto, Christophe Bugaud, Henriette de Kock, Ingunn Berget, Mukani Moyo, Suzanne D. Johanningsmeier, Benard Yada & Reuben Ssali** (2022). Developing threshold values of analytical laboratory measures to guide screening for consumer preference in sweetpotato breeding trials. [Oral presentation], *The 12th Triennial African Potato Association Conference (APA 2022 Conference), Lilongwe, Malawi*, *June 27 - July 1, 2022.* Book of abstracts: Harnessing potato and sweetpotato, innovations for resilient, healthier agri-food systems, p 107. https://africanpotatoassociation.org/abstract-book/

10. **Reuben Ssali, Mukani Moyo, Mariam Nakitto, Bwire Girisom, Edwin Serunkuma, Judith Nantongo, Edgar Tinyiro, Benard Yada, Florence Osaru, Doreen Chelangat, Arnold Katungusa, Bonny Oloka & Agnes Alajo** (2022). Textural and physicochemical predictors of sensory texture of boiled sweetpotato. [Oral presentation#9116], *The 12th Triennial African Potato Association Conference (APA 2022 Conference), Lilongwe, Malawi*, *June 27 - July 1, 2022.* Book of abstracts: Harnessing potato and sweetpotato, innovations for resilient, healthier agri-food systems, p 20. https://africanpotatoassociation.org/apa-2022-presentations/

11. **Samuel Edgar Tinyiro, Reuben Ssali, Sarah Mayanja, Mariam Nakitto, Pieter Wauters, Ogwal Martin, Prossy Namugga, Hossam Ssebbanja, Lora Forsythe & Thiago Mendes** (2022). Developing a gendered boiled potato product profile to support breeding initiatives in Uganda. [Oral presentation], *The 12th Triennial African Potato Association Conference (APA 2022 Conference), Lilongwe, Malawi*, *June 27 - July 1, 2022.* Book of abstracts: Harnessing potato and sweetpotato, innovations for resilient, healthier agri-food systems, p 8. https://africanpotatoassociation.org/abstract-book/

12. **Samuel Edgar Tinyiro, Sarah Mayanja, Mariam Nakitto, Judith Nantongo, Martin Ogwal, Benard Yada, Bonny Oloka, Arnold Katungisa, Doreen Chelangat, Agnes Alajo, Florence Osaru, Lora Forsythe & Reuben Ssali** (2022). Gendered analysis for prioritization of boiled & steamed sweetpotato characteristics for breeders in Uganda. [Poster presention], *The 12th Triennial African Potato Association Conference (APA 2022 Conference), Lilongwe, Malawi*, *June 27 - July 1, 2022.* Book of abstracts: Harnessing potato and sweetpotato, innovations for resilient, healthier agri-food systems, p 150. https://africanpotatoassociation.org/abstract-book/

13. **Samuel Edgar Tinyiro, Sarah Mayanja, Sarah Kisakye, Charity K. Kibooga & Diego Naziri** (2022). Gendered food mapping and consumer preferences of boiled/steamed sweetpotato – the urban consumers context. [Poster presention], *The 12th Triennial African Potato Association Conference (APA 2022 Conference), Lilongwe, Malawi*, *June 27 - July 1, 2022.* Book of abstracts: Harnessing potato and sweetpotato, innovations for resilient, healthier agri-food systems, p 150. https://africanpotatoassociation.org/abstract-book/

14. **Dominique Dufour, Gérard Ngoh Newilah, Bomoh Catherine Ebah Djedji, Delphine Amah, Brigitte Uwimana, Kephas Nowakunda, Oluwatoyin Ayetigbo & Eglantine Fauvelle** (2022). Cooking Bananas Food Product Profile Development. [Oral presentation], *Accelerated Breeding of Better Bananas (ABBB), Nelson Mandela - African Institution of Science & Technology, Arusha, Tanzania, 23-25 May 2022.*

15. **Aliénor Dutheil De La Rochere, Christophe Bugaud, Antonin Hermann Kouassi & Agnès Rolland-Sabaté** (2022). Influence de la composition des parois de plantains sur leurs propriétés organoleptiques et leur comportement à lacuisson. [Oral presentation], *jRFP2022, The 13th journées du Réseau Français des Parois, Versailles, France, 17-20 Mai 2022.*

16. **Aliénor Dutheil de la Rochère, Dominique Rinaldo & Agnès Rolland-Sabaté** (2022). Role of cell wall polysaccharideson yam cooking behaviour. [Poster presentation], *jRFP2022, The 13th journées du Réseau Français des Parois, Versailles, France, 17-20 Mai 2022.*

17. **Gérard Ngoh Newilah** (2022). Analysis of consumer-oriented quality characteristics of raw and boiled plantains in Cameroon. [Oral presentation], *Conférence scientifique des doctorants et jeunes chercheurs des universités d'état/instituts prives de l'enseignement supérieur et recherche: La Recherche Universitaire au service du développement et du bien-être en contexte de pandémie, Cameroon, 25 March - 2 April 2022.* Related article: https://doi.org/10.1111/ijfs.14812

18. **Aliénor Dutheil de la Rochère, Dominique Rinaldo, & Agnès Rolland-Sabaté** (2021). Impact of non-starch polysaccharides on the textural behavior of processed yam. [Oral presentation], *The 7th International Polysaccharide Conference of the European Polysaccharide Network of Excellence (EPNOE) - EPNOE2021, Nantes, France, 11-15 October 2021.* https://hal.science/hal-03380728v1

19. **Agnès Rolland-Sabaté, Buergy, A., Leca, A., Liu, X., Le Bourvellec, X. & Renard, C.M.G.C**. (2021). Pectin degradation during thermomechanical processes of fruits: relation with tissue fragmentation and texture. [Oral presentation], *The 7th International Polysaccharide Conference of the European Polysaccharide Network of Excellence (EPNOE) - EPNOE2021, Nantes, France, 11-15 October 2021.*

20. **Emmanuel Oladeji Alamu, Michael Adesokan, Asrat Asfaw & Busie Maziya-Dixon** (2021). Evaluation of boiled white yam (*Dioscorea rotundata*) for optimum cooking time, sensory and textural properties. [Abstract #NRF016], *The 14th Symposium of the International Society of Tropical Root Crops -Africa Branch (ISTRC-AB), Lusaka, Zambia, 20-24 September 2021.* https://istrc-ab.org/14th-symposium-of-the-istrc-ab-zambia-2021/#nrf016

21. **Thierry Tran, Xiaofei Zhang, Hernan Ceballos, Jhon Larry Moreno, Jorge Luna, Maria Alejandra Ospina, Andrés Escobar, Sandra Salazar, Nelson Morante, John Belalcazar, Dominique Dufour & Luis Augusto Becerra Lopez-Lavalle** (2021). Medium-throughput methods to predict cooking quality of boiled cassava for genotypes screening and selection. [Oral presentation], *The 14th Symposium of the International Society of Tropical Root Crops - Africa Branch (ISTRC-AB), Lusaka, Zambia, 20-24 September 2021.* https://istrc-ab.org/14th-symposium-of-the-istrc-ab-zambia-2021/#pht002; https://agritrop.cirad.fr/600086/

22. **Laurenda Honfozo, Laurent Adinsi, Djibril Moussa I., Alexandre Bouniol, Sounkoura Adetonah, Sègla Wilfrid Padonou, Chadare F.J., Joseph Hounhouigan & Noël Akissoe** (2021). Cartographie sensorielle de l'igname bouillie, piste d'amélioration de la qualité. *International du Centre Suisse de Recherches Scientifiques, Abidjan, Côte d'Ivoire. 9-11 Septembre 2021.*

20. **Bello Abolore, Bela Teeken, Olaosebikan, Owoade Durodola, Oluwaseun Osunbade, Amiebhor Blessings, Bussie-Maxiya Dixon, Adeline Muheebwa & Peter Kulakow** (2020). Prioritization of cassava stakeholders' preferences and its implications for breeding. [Vitual], *GREAT Symposium on gender-responsive crop breeding: sharing evidence and experience from the field, Cameroon, 23-24 November 2020*. https://www.youtube.com/watch?v=49xZmwQEIYs

23. **Gérard Ngoh Newilah** (2020). Plantain traits preferred by men and women in two regions of Cameroon. [Vitual], *GREAT Symposium on gender-responsive crop breeding: sharing evidence and experience from the field, Cameroon, 23-24 November 2020*. https://rtbfoods.cirad.fr/news/plantain-traits-gender-cameroun-great-symposium; https://www.youtube.com/watch?v=APp7II6t1Os&t=5s

24. **Lora Forsythe** (2020). Insights & lessons from gender-responsive RTB food product profile studies in East & West Africa. [Vitual], *GREAT Symposium on gender-responsive crop breeding: sharing evidence and experience from the field, Cameroon, 23-24 November 2020*. B.1.2A_Insights & lessons from gender-responsive RTB food product profile studies in East & West Africa_GREAT Symposium_2020.

25. **Béla Teeken, Olamide Olaosebikan, Abolore Bello, Adebowale Osunbade, Durodola Owoade, Geneviève Fliedel, Lora Forsythe, Peter Kulakow & Busie Maziya-Dixon** (2019). Smallholders' preferred cassava characteristics with regards to fresh root, processing, gari and eba characteristics in Benue and Osun states Nigeria. [Poster presentation], *The African Plant Breeders Association (APBA) conference, Accra, Ghana, 23-25 October 2019.*

26. **Denis Cornet, Lucienne Desfontaines, Fabien Cormier, Carine Marie-Magdeleine, Gemma Arnau, Karima Meghar, Fabrice Davrieux & Gregory Beurier** (2019). Assembler la diversité des modèles classiques et « deep learning » pour développer unpipeline de calibration SPIR performant et générique [Oral presentation]. *In: Livret des résumés des 20èmes Rencontres HélioSPIR. HélioSPIR. Montpellier: HélioSPIR, Résumé, p. 15-16.*

Rencontres HélioSPIR. 20, Montpellier, France, 14-15 Octobre 2019. https://cdn.heliospir.net/wp-content/uploads/2019/10/20RENC.Resumes.pdf; https://hal.science/hal-02958421v1

27. **Adou Emmanuel Ehounou, Fabien Cormier, Denis Cornet, Erick Maledon, Lucienne Desfontaines, Carine Marie-Magdeleine, Elie Nudol, Marie Claire Gravillon, Amani Michel Kouakou, Hâna Chaïr & Gemma Arnau** (2019). Development of NIRS and molecular markerto improve breeding efficiency in Greater Yam (*Dioscorea alata* L.) for key quality traits. [Oral presentation], *The 2nd International Conference on Applied Biochemistry and Biotechnology (ABB2019-1103), Macau, China, 21-24 July 2019*. https://hal.science/hal-02958437v1

28. **Adou Emmanuel Ehounou, Erick Maledon, Fabien Cormier, Denis Cornet, Elie Nudol, Amani Michel Kouakou, Hana Chair & Gemma Arnau** (2018). Breeding for improved tuber quality in yam *Dioscorea alata* L. [Poster presentation], *The 18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Cali, Colombia, 22-25 October 2018*.

29. **Maria Alejandra Ospina, Thierry Tran, Monica Pizarro, Jorge Luna Melendez, William Trivino-Palacios, John Eiver Belalcazar Martinez, Sandra Salazar, Dominique Dufour & Luis Augusto Becerra Lopez Lavalle** (2018). Phenotyping postharvest physiological deterioration (PPD) in cassava: Implications for selection. *The 18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Cali, Colombia, 22-25 October 2018*.

30. **Jorge Luna Melendez, Thierry Tran, Monica Pizarro, Maria Alejandra Ospina, William Trivino-Palacios, John Eiver Belalcazar Martinez, Sandra Salazar, Dominique Dufour & Luis Augusto Becerra Lopez Lavalle** (2018). Diversity of post-harvest phenotypic traits among the CIAT cassava germplasm collection. *The 18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Cali, Colombie, 22-25 October 2018*.

31. **Monica Pizarro, Maria Alejandra Ospina, Jorge Luna Melendez, John Eiver Belalcazar Martinez, Sandra Salazar, Thierry Tran, Luis Augusto Becerra Lopez Lavalle & Dominique Dufour** (2018). Cyanide content and distribution in cassava plants, in association with physiological age. *The 18th Triennial Symposium of the International Society for Tropical Root Crops (ISTRC), Cali, Colombia, 22-25 October 2018*.

32. **Agnès Rolland-Sabaté** (2018). Multi-scale structural features of starches and starch products [Oral presentation], *The 12th International Conference on Agrophysics 2018, Lublin, Poland, 17-19 September 2018*. Related article: https://hal.science/hal-02622187v1

33. **Dominique Dufour, Geneviève Fliedel, Alexandre Bouniol, Fabrice Davrieux & Thierry Tran** (2018). Cassava traits and end-user preference. [Oral presentation], *The IVth International Cassava Conference - GCP21, Cotonou, Bénin, 11-15 June 2018*. https://gcp21.org/BeninConference/index.html

34. **Maria Alejandra Ospina, Thierry Tran, Monica Pizarro, Jorge Luna Melendez, William Trivino-Palacios, John Eiver Belalcazar Martinez, Sandra Salazar, Dominique Dufour & Luis Augusto Becerra Lopez Lavalle** (2018). Diversity of post-harvest phenotypic traits among the CIAT cassava germplasm collection. [Oral presentation], *The IVth International Cassava Conference - GCP21, Cotonou, Bénin, 11-15 June 2018*. https://gcp21.org/BeninConference/index.html

35. **Agnès Rolland-Sabaté** (2018). The structural characterization of starches: a key to understand various cassava functionalities [Plenary invited lecture], *The IVth International Cassava Conference – GCP21, Cotonou, Benin, 11-15 June 2018*. https://gcp21.org/BeninConference/index.html

36. **Denis Cornet, Fabien Cormier, Gemma Arnau, Pauline Mell, Claude Pavis, Lucienne Desfontaines & Régis Tournebize** (2018). Recent advances in yam crop physiology and perspectives for breeding strategies. [Oral presentation], *The 2nd International Yam Crop Science Workshop (IYCSW), Tokyo University of Agriculture (Tokyo NODAI). Tokyo, Japan, Mar 2018*. https://hal.science/hal-02791432v1

37. **Denis Cornet, Fabien Cormier, Régis Tournebize, Jorge Sierra & Pauline Mell.** Yam interplant variability causes and consequences for breeding strategies. [Oral presentation], *Annual Meeting of the Japanese Society for Tropical Agriculture, Japanese Society for Tropical Agriculture (JSTA). Tokyo, Japan Mar 2018*. https://hal.inrae.fr/hal-02791166

7.6 Annex 6: RTBfoods dashboard open access deliverables

List of tables

Ref	Title & link
Table 1	RTBfoods annual reports
Table 2	Reports from preliminary studies on RTB consumption habits & preferences, Step 1
Table 3	Reports from preliminary studies on RTB consumption habits & preferences, Step 2
Table 4	Reports on participatory processing diagnosis with RTB processors, Step 3
Table 5	Reports on consumer testing with RTB consumers, Step 4
Table 6	Preferred quality characteristics per RTB food products at the 3 stages of processing, Step 2 to Step 4
Table 7	Gendered Food Product Profiles, Step 5
Table 8	Standard Operating Procedures developed for Biophysical & Biochemical characterization of RTB crops
Table 9	Biophysical & Biochemical Proofs of Concepts to decipher the role of starch and parietal compounds in end-product quality
Table 10	Standard Operating Procedures developed for Color characterization of RTB crops
Table 11	Standard Operating Procedures developed for Textural characterization of RTB food products
Table 12	Standard Operating Procedures developped for Sensory characterization of RTB food products
Table 13	Tutorials developed for Sensory characterization of RTB food products
Table 14	Standard Operating Procedures for Mid and High-throughput measurements on RTB crops & products
Table 15	Calibrations developed for Mid and High-throughput prediction of quality traits of RTB crops & products
Table 16	Suitability of new genotypes to RTB users' needs & preferences
Table 17	Survey datasets (Step 2)
Table 18	Survey datasets (Step 3)
Table 19	Dictionaries developed for traits related to the processing and the quality of RTB food products
Table 20	Laboratory textural datasets
Table 21	Laboratory sensory analysis datasets
Table 22	Spectral datasets
Table 23	Scientific webinars organized by the PMU between May 2020 and December 2022
Table 24	WP Achievement Reports (Period 1 to 5)

Ref	Title & link
Table 25	Institute Achievement Reports (Period 1 to 5)

Table 1 RTBfoods annual reports

Title of Report	Link
RTBfoods annual report period 1 (2019)	https://doi.org/10.18167/agritrop/00760
RTBfoods annual report period 2 (2020)	https://doi.org/10.18167/agritrop/00761
RTBfoods annual report period 3 (2021)	https://doi.org/10.18167/agritrop/00763
RTBfoods annual report period 4 (2022)	https://doi.org/10.18167/agritrop/00762
RTBfoods annual report period 5 (2023)	https://doi.org/10.18167/agritrop/00764
RTBfoods Results-Tracker (2018-2023)	https://mel.cgiar.org/reporting/download/report_file_id/36681

Table 2 Reports from preliminary studies on RTB consumption habits & preferences, Step 1

		Step 1. State of knowledge (SoK)	
		Step 1 Guidance: State of Knowledge (SoK)	https://doi.org/10.18167/agritrop/00568
RTB Crops	**Food Products**	**List of Countries (Responsible Institutes)**	**DOI**
Cassava	**Boiled cassava**	Uganda (NaCRRI)	https://doi.org/10.18167/agritrop/00695
	Gari/Eba	Nigeria (IITA/NRCRI)	https://doi.org/10.18167/agritrop/00694
	Gari	Cameroon (ENSAI/ CIRAD)	https://doi.org/10.18167/agritrop/00699
	Attiéké	Côte d'Ivoire (CNRA)	https://doi.org/10.18167/agritrop/00698
	Fufu	Nigeria (NRCRI)	-
Cooking bananas	**Boiled plantain**	Cameroon (CARBAP)	https://doi.org/10.18167/agritrop/00700
	Matooke	Uganda (NARL/ Bioversity)	https://doi.org/10.18167/agritrop/00696
	Fried plantain Aloco	Nigeria (IITA)	https://doi.org/10.18167/agritrop/00702
Sweetpotato	**Boiled sweetpotato**	Uganda (CIP)	https://doi.org/10.18167/agritrop/00701
	Fried sweetpotato	Nigeria & Ghana (CIP)	https://doi.org/10.18167/agritrop/00703
Yam	**Boiled yam**	Benin (UAC-FSA/ IITA)	https://doi.org/10.18167/agritrop/00697
	Pounded yam	Nigeria (Bowen U.)	https://doi.org/10.18167/agritrop/00692
		Nigeria (NRCRI)	https://doi.org/10.18167/agritrop/00693
		Côte d'Ivoire (CNRA)	https://doi.org/10.18167/agritrop/00737

Table 3 Reports from preliminary studies on RTB consumption habits & preferences, Step 2

		Published methodology paper	Step 2. Gendered food mapping	
		https://doi.org/10.1111/ijfs.14680	Step 2 Guidance: Gendered food mapping	https://doi.org/10.18167/agritrop/00569
RTB Crops	**Food Products**	**Manuscripts published in the IJFST special issue**	**List of Countries (Responsible Institutes)**	**DOI**
Cassava	**Boiled cassava**	https://doi.org/10.1111/ijfs.14878	Uganda (NaCRRI)	https://doi.org/10.5281/zenodo.7054581
			Benin (UAC-FSA)	https://doi.org/10.18167/agritrop/00681
	Gari/Eba	https://doi.org/10.1111/ijfs.14867	Nigeria (IITA)	https://doi.org/10.5281/zenodo.7056977
			Nigeria (NRCRI)	https://doi.org/10.5281/zenodo.7057374
	Gari		Cameroon (ENSAI/ CIRAD)	https://doi.org/10.5281/zenodo.7057307
	Attiéké	-	Côte d'Ivoire (CNRA)	https://doi.org/10.5281/zenodo.7092746
	Fufu	https://doi.org/10.1111/ijfs.14875	Nigeria (NRCRI)	https://doi.org/10.5281/zenodo.7092727
Cooking bananas	**Boiled plantain**	https://doi.org/10.1111/ijfs.14812	Cameroon (CARBAP)	https://doi.org/10.5281/zenodo.7056662
	Matooke	https://doi.org/10.1111/ijfs.14813	Uganda (NARL/ Bioversity)	https://doi.org/10.5281/zenodo.7057519
	Fried plantain Aloco	https://doi.org/10.1111/ijfs.14780	Nigeria (IITA)	https://doi.org/10.5281/zenodo.7057027
Sweetpotato	**Boiled sweetpotato**	https://doi.org/10.1111/ijfs.14792	Uganda (CIP)	https://doi.org/10.5281/zenodo.7056734
	Fried sweetpotato	https://doi.org/10.1111/ijfs.14764	Ghana (CIP)	https://doi.org/10.5281/zenodo.7584307
			Nigeria (CIP)	https://doi.org/10.5281/zenodo.7840214
			Nigeria (CIP)	https://doi.org/10.5281/zenodo.7840818
Yam	**Boiled yam**	https://doi.org/10.1111/ijfs.14707	Benin (UAC-FSA/IITA)	https://doi.org/10.18167/agritrop/00680
			Nigeria (NRCRI)	https://doi.org/10.5281/zenodo.7056864
	Pounded yam	https://doi.org/10.1111/ijfs.14770	Nigeria (Bowen U.)	https://doi.org/10.5281/zenodo.7092784
			Nigeria (NRCRI)	https://doi.org/10.5281/zenodo.7092692
		-	Côte d'Ivoire (CNRA)	https://doi.org/10.5281/zenodo.7543572
Potato	**Boiled potato**	-	Uganda (CIP)	https://doi.org/10.5281/zenodo.7092806

Table 4 Reports on participatory processing diagnosis with RTB processors, Step 3

		Step 3. Participatory processing diagnosis	
		Step 3 Guidance: Participatory processing diagnosis and quality characteristics	https://doi.org/10.18167/agritrop/00570
RTB Crops	**Food Products**	**List of Countries (Responsible Institutes)**	**DOI**
Cassava	**Boiled cassava**	Uganda (NaCRRI)	https://doi.org/10.18167/agritrop/00625
		Benin (UAC-FSA/IITA)	https://doi.org/10.18167/agritrop/00624
	Gari/Eba	Nigeria (IITA)	https://doi.org/10.18167/agritrop/00621
		Nigeria (NRCRI)	https://doi.org/10.18167/agritrop/00614
	Attiéké	Côte d'Ivoire (CNRA)	https://doi.org/10.18167/agritrop/00724
	Fufu	Nigeria (NRCRI)	https://doi.org/10.18167/agritrop/00620
Cooking bananas	**Boiled plantain**	Cameroon (CARBAP)	https://doi.org/10.18167/agritrop/00626
	Matooke	Uganda (NARL/Bioversity)	https://doi.org/10.18167/agritrop/00615
Sweetpotato	**Boiled sweetpotato**	Uganda (CIP)	https://doi.org/10.18167/agritrop/00623
	Fried sweetpotato	Nigeria & Ghana (CIP)	https://doi.org/10.18167/agritrop/00617
Yam	**Boiled yam**	Benin (UAC-FSA)	https://doi.org/10.18167/agritrop/00627
		Nigeria (NRCRI)	https://doi.org/10.18167/agritrop/00619
	Pounded yam	Nigeria (Bowen U.)	https://doi.org/10.18167/agritrop/00616
		Nigeria (NRCRI)	https://doi.org/10.18167/agritrop/00618
Potato	**Boiled potato**	Uganda (CIP)	https://doi.org/10.18167/agritrop/00622

Table 5 Reports on consumer testing with RTB consumers, Step 4

		Step 4. Consumer testing	
		Step 4 Guidance: Consumer testing in rural and urban areas	https://doi.org/10.18167/agritrop/00571
		Data analysis & reporting	https://doi.org/10.18167/agritrop/00660
RTB Crops	**Food Products**	**List of Countries (Responsible Institutes)**	**DOI**
Cassava	**Boiled cassava**	Uganda (NaCRRI)	https://doi.org/10.18167/agritrop/00629
		Benin (UAC-FSA/IITA)	https://doi.org/10.18167/agritrop/00630
	Gari/Eba	Nigeria (IITA)	https://doi.org/10.18167/agritrop/00631
		Nigeria (NRCRI)	https://doi.org/10.18167/agritrop/00632
	Attiéké	Côte d'Ivoire (CNRA)	https://doi.org/10.18167/agritrop/00643
	Fufu	Nigeria (NRCRI)	https://doi.org/10.18167/agritrop/00637

		Step 4. Consumer testing	
		Step 4 Guidance: Consumer testing in rural and urban areas	https://doi.org/10.18167/agritrop/00571
		Data analysis & reporting	https://doi.org/10.18167/agritrop/00660
RTB Crops	**Food Products**	**List of Countries (Responsible Institutes)**	**DOI**
Cooking bananas	**Boiled plantain**	Cameroon (CARBAP)	https://doi.org/10.18167/agritrop/00636
	Matooke	Uganda (NARL/Bioversity)	https://doi.org/10.18167/agritrop/00634
Sweetpotato	**Boiled sweetpotato**	Uganda (CIP)	https://doi.org/10.18167/agritrop/00633
	Fried sweetpotato	Nigeria (CIP)	https://doi.org/10.18167/agritrop/00640
		Ghana (CIP)	https://doi.org/10.18167/agritrop/00641
Yam	**Boiled yam**	Benin (UAC-FSA)	https://doi.org/10.18167/agritrop/00628
		Nigeria (NRCRI)	https://doi.org/10.18167/agritrop/00635
	Pounded yam	Nigeria (Bowen U.)	https://doi.org/10.18167/agritrop/00639
		Nigeria (NRCRI)	https://doi.org/10.18167/agritrop/00638
Potato	**Boiled potato**	Uganda (CIP)	https://doi.org/10.18167/agritrop/00642

Table 6 Preferred quality characteristics per RTB food products at the 3 stages of processing, Step 2 to Step 4

RTB crops	**Food products**	**List of preferred quality characteristics generated from Step 2 to Step 4**		
		Raw product	**During processing**	**Final / ready-to-eat product**
Cassava	Boiled cassava	Cracked and clear peel, white flesh, big roots/ roots size, red/pink/dark/black peel; Sweet taste; Easy to peel; White flesh	White flesh, cracked flesh, easy to peel, easy to cut, crumbly/easy to break/soft cassava, good smell; Sweet taste; Easy to peel; White flesh	Crumbly/easy to break/soft, white color, good smell, without fibers, sweet taste; Mealiness; Softness; Sweet taste & Aroma
	Gari/Eba	High dry matter, High yield, Multiple uses, Root size, Root color, Root Shape	Process drudgery, No discoloration of pulp, Food Product yield Intermediate product (Gari): Color (bright, shiny, and white), Heavy dry Gari (bulk density), Swelling power	Ready-to-eat (Eba): Color (bright, shiny, white), Texture (mouldability, stretchability, non-sticky, less lump, hardness/softness), Swelling power (volume increase when making eba from Gari)
	Attiéké	White flesh, Hard flesh, White skin, Cassava with less water, Striated skin	Hard flesh, Crushed pulp with less water, 3 days ferment, Cassava easily	Slightly sweet, Non-sticky granules no sour taste, Hard

RTB crops	Food products	List of preferred quality characteristics generated from Step 2 to Step 4		
		Raw product	During processing	Final / ready-to-eat product
			peeled, Dry flesh	granules, Round granules, No or less fibers
	Fufu	Smooth skin, heavy weight, and white color	Easy to ferment (retting ability), easy to peel, high mash yield, and white/cream color	White/cream color, easy to form dough and drawability/mouldability, moderately soft and stretchability
Cooking bananas	Boiled plantain	Pulp colour	Easiness to peel, Cooking time	Pulp color, Plantain aroma, Firmness, Sweetness
	Matooke	Big bunch, Big fingers, Yellowish/creamish color, Shiny light green finger color, Disease free/spotless	Yellowish/creamish pulp, Easy to peel, Big fingers, Soft peel, Soft pulp, Straight/slightly curved fingers, Relatively little sap	Soft texture, Good smell, Yellow colour, Good Matooke taste, Holds together when mashed
	Fried plantain Aloco	Bunch size, No of fingers, Finger size, Peel color, Pulp color, Tip color, Maturity, Peel appearance	None	Color, Softness, Firmness, Stickiness, Taste, Odor, Absorption Capacity
Sweet-potato	Boiled sweet-potato	None	None	Firmness, Taste, Mealiness, Aroma, Sweet taste, Good sweetpotato smell, non-fibrousness
	Fried sweet-potato	None	None	Mealiness, Crispness, Crunchiness, Good sweetpotato smell, non-fibrousness
Yam	Boiled yam	Smooth, size, heavy weight and tuber shape	No discoloration, No spots, Cooking time, viscosity of cooking water, Easy to peel	No discoloration, No black spots, stable White/yellowish, Crumbly/mealy, Sticky, Yam flavored, Sweet
	Pounded yam	Shape of the tuber (regular), High dry matter/low water content, Smooth skin, Colour of the flesh (white, off white,cream, yellow)	Easy to peel, No discoloration during peeling, Short cooking time, Easy to form dough	Colour (white, off white, cream, yellow), Mouldability, Stretchability, Smoothness, Moderately hard or soft, Slightly sticky
Potato	Boiled	None	Cooking time	Firmness, Taste, Flesh

RTB crops	Food products	List of preferred quality characteristics generated from Step 2 to Step 4		
		Raw product	During processing	Final / ready-to-eat product
	potato			color

Table 7 Gendered Food Product Profiles, Step 5

		Step 5. Target Food Product Profile	
		Step 5 Guidance: Finalization of the food product profile	https://doi.org/10.18167/agritrop/00661
		Guidance for G+ Assessment of Food Product Profiles: Drivers of trait preferences	https://doi.org/10.5281/zenodo.7565647
RTB Crops	**Food Products**	**List of Countries (Responsible Institutes)**	**Gendered Food Product Profile**
Cassava	**Boiled cassava**	Uganda (NaCRRI)	https://doi.org/10.18167/DVN1/AJNOH8
		Benin (UAC-FSA/IITA)	https://doi.org/10.18167/DVN1/IPZ74N
	Gari/Eba	Nigeria (IITA)	https://doi.org/10.18167/DVN1/BFO2VU
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/BLP3WP
	Gari	Cameroon (ENSAI/CIRAD)	https://doi.org/10.18167/agritrop/00647
	Fufu	Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/ZIVLOH
Cooking bananas	**Boiled plantain**	Cameroon (CARBAP)	https://doi.org/10.18167/DVN1/BHMPZE
	Matooke	Uganda (NARL/Bioversity)	https://doi.org/10.18167/DVN1/HQX13V
Sweet-potato	**Boiled sweetpotato**	Uganda (CIP)	https://doi.org/10.18167/DVN1/WWJVSX
Yam	**Boiled yam**	Benin (UAC-FSA)	https://doi.org/10.18167/DVN1/COAEIP
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/VJX3Z6
	Pounded yam	Nigeria (Bowen U.)	https://doi.org/10.18167/DVN1/FKFPOS
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/F2GBV3
Potato	**Boiled potato**	Uganda (CIP)	https://doi.org/10.18167/DVN1/TEMWZA

Table 8 Standard Operating Procedures developed for Biophysical & Biochemical characterization of RTB crops

RTB crops	List of SOPs for Biophysical & Biochemical Characterization of RTB food products	DOI
Cassava	SOP Water absorption & Closing angle from Boiled Cassava	https://doi.org/10.18167/agritrop/00683
	SOP Extraction & quantification of phenol acid components	https://doi.org/10.18167/agritrop/00744

RTB crops	List of SOPs for Biophysical & Biochemical Characterization of RTB food products	DOI
	SOP Determination of Ease of Peel of Cassava Root	https://doi.org/10.18167/agritrop/00736
Cooking bananas	SOP Sample preparation for cell wall polysaccharides analysis from Yam & Plantain	https://doi.org/10.18167/agritrop/00608
	SOP Analysis of Cell Wall Polysaccharides Yam & Plantain	https://doi.org/10.18167/DVN1/RC9LIS
Sweetpotato	SOP Preparation of Cell Wall Material	https://doi.org/10.18167/agritrop/00609
	SOP Analysis of Cell Wall Monosaccharides	https://doi.org/10.18167/agritrop/00704
	SOP Determination of Pectin Methylesterase Activity	https://doi.org/10.18167/DVN1/ULJZXA
	SOP Fourier Transform Infra-Red Spectroscopy Analysis of Cell Walls	https://doi.org/10.18167/agritrop/00610
Yam	SOP Sample preparation for cell wall polysaccharides analysis from Yam & Plantain	https://doi.org/10.18167/agritrop/00608
	SOP Analysis of Cell Wall Polysaccharides from Yam & Plantain	https://doi.org/10.18167/DVN1/RC9LIS
All	SOP Dry Matter Content	https://doi.org/10.18167/DVN1/66IEOZ
	SOP Starch & Sugar - acid hydrolysis	https://doi.org/10.18167/DVN1/MMTANC
	SOP Sugars - HPLC	https://doi.org/10.18167/DVN1/OOHETH
	SOP Amylose - DSC	https://doi.org/10.18167/DVN1/MBB1CT
	SOP Galacturonic Content	https://doi.org/10.18167/agritrop/00605

Table 9 Biophysical & Biochemical Proofs of Concepts to decipher the role of starch and parietal compounds in end-product quality

RTB Crops	List of Biochemical & Biophysical Proofs of concept	DOI or MEL link to access	Embargo (if any)
Cassava	Biophysical bases of processing & cooking ability of boiled cassava	https://doi.org/10.18167/agritrop/00712	
Cooking Bananas	Impact of cell wall composition on texture of boiled plantains	https://mel.cgiar.org/reporting/download/report_file_id/33039	(Under embargo until 15-03-2024)
	Influence de la composition des parois de plantains sur leurs propriétés organoleptiques et leur comportement à la cuisson	https://mel.cgiar.org/reporting/download/report_file_id/33039	(Under embargo until 01-06-2024)
	Extraction de polysaccharides à partir de banane plantain à cuire	https://mel.cgiar.org/reporting/download/report_file_id/36662	(Under embargo until 01-06-2024)
Sweetpotato	Biophysical bases of processing & cooking ability of boiled sweetpotato	https://doi.org/10.18167/agritrop/00711	
	Tentative correlation between cell wall composition & textural properties of sweetpotato roots	https://doi.org/10.18167/agritrop/00713	

RTB Crops	List of Biochemical & Biophysical Proofs of concept	DOI or MEL link to access	Embargo (if any)
Yam	Relation entre l'évolution de la texture de l'igname et les comportements de l'amidon et des pectines au cours de la cuisson (Master student report)	https://mel.cgiar.org/reporting/download/report_file_id/33032	
	Validation d'une méthode analytique par analyseur de flux automatisé. Cas spécifique du dosage des pectines (Masters student report)	https://mel.cgiar.org/reporting/download/report_file_id/33034	
	Etude de l'aptitude à la cuisson de diverses variétés d'ignames par mesures texturales et biochimiques (Master student report)	https://mel.cgiar.org/reporting/download/report_file_id/33036	
	Impact of cell wall composition on texture of boiled yams	https://mel.cgiar.org/reporting/download/report_file_id/33038	(Under embargo until 15-03-2024)
	Role of cell wall polysaccharides on yam cooking behavior	https://mel.cgiar.org/reporting/download/report_file_id/33038	(Under embargo until 01-06-2024)
	Processing ability and textural properties of boiled yam as related to the species and variety	https://mel.cgiar.org/reporting/download/report_file_id/33040	(Under embargo until 15-03-2024)
	Transformations during processing and final texture of starchy products: The case of yam- (Master student report)	https://mel.cgiar.org/reporting/download/report_file_id/36655	
Yam & Plantain	Influence of cell wall and tannins on the cooking behavior of yam and banana plantain	https://mel.cgiar.org/reporting/download/report_file_id/36663	(Under embargo until 01-06-2024)

Table 10 Standard Operating Procedures developed for Color characterization of RTB crops

RTB crops	SOP for Color Characterization	DOI
Cassava	Fresh Color Fresh Cassava through chromameter	https://doi.org/10.18167/agritrop/00664
Yam	SOP Color Fresh Yam through chromameter	https://doi.org/10.18167/agritrop/00664
All	SOP Color measurement of RTB foods through image analysis	https://doi.org/10.18167/agritrop/00663
	SOP Creation of a color reference chart for RTB foods colour characterization	https://doi.org/10.18167/agritrop/00673
	SOP Colour Change During Time	https://doi.org/10.18167/agritrop/00672

Table 11 Standard Operating Procedures developed for Textural characterization of RTB food products

RTB crops	Food products	List of SOPs for Textural Characterization of RTB food products	DOI
Cassava	Boiled cassava	SOP Texture Boiled Cassava - extrusion	https://doi.org/10.18167/agritrop/00594

RTB crops	Food products	List of SOPs for Textural Characterization of RTB food products	DOI
		SOP Texture Boiled Cassava - extrusion, TPA, penetrometry	https://doi.org/10.18167/agritrop/00723
	Gari/Eba	SOP Texture Eba	https://doi.org/10.18167/agritrop/00604
	Fufu	SOP Texture Fufu	https://doi.org/10.18167/agritrop/00612
		SOP Firmness of Cassava genotypes during Retting using the hand-held Penetrometer	https://doi.org/10.18167/agritrop/00734
Cooking bananas	Boiled plantain	SOP Texture Boiled Plantain	https://doi.org/10.18167/agritrop/00685
	Matooke	SOP Texture Matooke - double compression	https://doi.org/10.18167/agritrop/00602
	Fried plantain Aloco	SOP Texture Fried Plantain	In progress by UNA/CNRA Côte d'Ivoire
Sweetpotato	Boiled sweetpotato	SOP Texture Boiled Sweetpotato - TPA (version A)	https://doi.org/10.18167/agritrop/00611
		SOP Texture Boiled Sweetpotato - TPA (version B)	https://doi.org/10.18167/agritrop/00749
Yam	Boiled yam	SOP Texture Boiled Yam	https://doi.org/10.18167/agritrop/00603
	Pounded yam	SOP Texture Pounded Yam	https://doi.org/10.18167/agritrop/00613
		SOP Extensibility Pounded Yam	https://doi.org/10.18167/agritrop/00684
		SOP Bi-extensional viscosity Pounded Yam - Lubricated Squeezing Flow (LSF)	https://doi.org/10.18167/agritrop/00686
Potato	Boiled potato	SOP Texture Boiled Potato	In progress by CIP Uganda

Table 12 Standard Operating Procedures developed for Sensory characterization of RTB food products

RTB crops	Food products	List of SOPs for Sensory Characterization of RTB food products	DOI
Cassava	Boiled cassava	SOP Sensory Boiled Cassava Benin	https://doi.org/10.18167/agritrop/00598
		SOP Sensory Boiled Cassava Uganda	https://doi.org/10.18167/agritrop/00599
	Gari/Eba	SOP Sensory Eba Nigeria	https://doi.org/10.18167/agritrop/00596
	Attiéké	SOP Sensory Attiéké Côte d'Ivoire	https://doi.org/10.18167/agritrop/00607
	Fufu	SOP Sensory Fufu Nigeria	https://doi.org/10.18167/agritrop/00595
Cooking bananas	Boiled plantain	SOP Sensory Boiled Plantain Abidjan	https://doi.org/10.18167/agritrop/00606
	Matooke	SOP Sensory Matooke Uganda	https://doi.org/10.18167/agritrop/00593

RTB crops	Food products	List of SOPs for Sensory Characterization of RTB food products	DOI
	Fried plantain Aloco	SOP Sensory Fried Plantain Côte d'Ivoire	https://doi.org/10.18167/agritrop/00709
Sweetpotato	Boiled sweetpotato	SOP Sensory Boiled Sweetpotato Uganda	https://doi.org/10.18167/agritrop/00601
Yam	Boiled yam	SOP Sensory Boiled Yam Benin	https://doi.org/10.18167/agritrop/00600
	Pounded yam	SOP Sensory Pounded Yam Nigeria	https://doi.org/10.18167/agritrop/00597
Potato	Boiled potato	SOP Sensory Boiled Potato Uganda	https://doi.org/10.18167/agritrop/00705

Table 13 Tutorials developed for Sensory characterization of RTB food products

Tutorials developed for Sensory Characterization of RTB food products	DOI
RTBfoods Manual – Part 1 - Sensory Analysis. Training a panel in sensory analysis and implementing descriptive tests, Tutorial: How to process data in sensory analysis	https://doi.org/10.18167/agritrop/00573
RTBfoods Manual - Part 2 - Tutorial. Monitoring panel performance and cleaning data from descriptive sensory panels for statistical analysis Panel Performance and Cleaning Data from Descriptive Sensory Panels for Statistical Analysis	https://doi.org/10.18167/agritrop/00582
RTBfoods Manual - Part 3 - Tutorial, Statistical Analyses (PCA and multiple regression) to Visualise the Sensory Analysis Data and Relate it to the Instrumental Data	https://doi.org/10.18167/agritrop/00710

Table 14 Standard Operating Procedures for Mid and High-throughput measurements on RTB crops & products

RTB crops	Food products	Technique	List of SOPs for Mid-throughput and high-throughput measurement on RTB crops & products	DOI
Cassava	Boiled cassava	NIRS	SOP MIRS on cassava cell walls & flours	https://doi.org/10.18167/agritrop/00675
			SOP NIRS on Fresh Intact and Mashed Cassava Roots (using portable ASD Quality Spec)	https://doi.org/10.18167/agritrop/00678
			SOP NIRS on Intact Cassava Roots & Yam Tubers (using benchtop FOSS)	https://doi.org/10.18167/agritrop/00665
			SOP NIRS on Blended Cassava & Yam (using benchtop FOSS)	https://doi.org/10.18167/agritrop/00706
			Variation: SOP NIRS on fresh ground cassava	https://doi.org/10.18167/agritrop/00676
			Variation: SOP NIRS on fresh cassava roots and relating spectra to root dry matter content by oven method (using ASD Quality Spec)	https://doi.org/10.18167/agritrop/00668

RTB crops	Food products	Technique	List of SOPs for Mid-throughput and high-throughput measurement on RTB crops & products	DOI
			Variation: SOP NIRS on fresh cassava roots and relating spectra to root dry Matter content by oven method (using benchtop NIRS FOSS DS2500)	https://doi.org/10.18167/agritrop/00669
			Variation: SOP NIRS on fresh cassava roots and relating spectra to fresh HCN content by picrate method (using FOSS DS2500 & ASD Quality Spec)	https://doi.org/10.18167/agritrop/00747
	Gari/Eba	NIRS	SOP NIRS on Milled & Un-milled Gari	https://doi.org/10.18167/agritrop/00674
	Fufu	NIRS	SOP NIRS on Wet Fufu Mash (using portable ASD Quality Spec)	https://doi.org/10.18167/agritrop/00677
Cooking bananas	Matooke	NIRS	SOP NIRS on Fresh Matooke Fingers (using benchtop NIRS FOSS)	https://doi.org/10.18167/agritrop/00679
Sweetpotato	Boiled sweetpotato	NIRS	SOP NIRS on Sweetpotato Roots & Potato Tubers	https://doi.org/10.18167/agritrop/00708
		DigiEye	SOP DigiEye Calibration	https://doi.org/10.18167/agritrop/00722
			SOP Image capture in sweetpotato and potato, and sensory attribute prediction	https://doi.org/10.18167/agritrop/00721
Yam	Boiled yam	NIRS	SOP NIRS on Intact Cassava Roots & Yam Tubers (using benchtop FOSS)	https://doi.org/10.18167/agritrop/00665
	Pounded yam		SOP NIRS on Blended Cassava & Yam (using benchtop FOSS)	https://doi.org/10.18167/agritrop/00706
Potato	Boiled potato	NIRS	SOP NIRS on Sweetpotato Roots & Potato Tubers	https://doi.org/10.18167/agritrop/00708
All	All	NIRS	SOP for Feasibility of Bad-Good Genotypes Screening using NIRS	https://doi.org/10.18167/agritrop/00671
		Imaging	SOP characterization of RTB starch grain size and shape through imaging	https://doi.org/10.18167/agritrop/00670
		HSI	Operating mode & configuration of hyperspectral camera Specim FX17	https://doi.org/10.18167/agritrop/00667
			SOP hyperspectral imaging of fresh RTB crops	https://doi.org/10.18167/agritrop/00666

Table 15 Calibrations developed for Mid and High-throughput prediction of quality traits of RTB crops & products

RTB crops	Technique	States of knowledge	DOI
All	NIRS	Spectroscopic techniques applied to Roots, Tubers and Cooking Bananas	https://doi.org/10.18167/agritrop/00739
	HSI	Hyperspectral imaging applied to Roots, Tubers and Cooking Bananas	https://doi.org/10.18167/agritrop/00740

RTB crops	Technique	Calibrations reports on high-throughput prediction models for quality traits	DOI
Cassava *Cassava*	NIRS	Biophysical analyses & cooking properties of boiled cassava (year 1)	http://doi.org/10.18167/agritrop/00717
		Biophysical analyses & cooking properties of boiled cassava (year 2)	http://doi.org/10.18167/agritrop/00715
		Cassava Cooking Properties characterization using NIRS on fresh ground cassava (year 3)	https://doi.org/10.18167/agritrop/00732
		Amylose quantification in fresh grated cassava clones using NIRS	https://doi.org/10.18167/agritrop/00730
		Dry matter quantification in fresh grated cassava clones using NIRS	https://doi.org/10.18167/agritrop/00731
		Quantification of dry matter, pH, amylose, swelling power and solubility of Fufu flour using ASD Quality Spek portable NIRS	https://doi.org/10.5281/zenodo.7550194
		Calibration Models for the Prediction of Textural Attributes of Eba using NIRS	https://doi.org/10.5281/zenodo.7548163
	HSI	Prediction of cassava cooking quality traits using hyperspectral imaging	https://doi.org/10.1002/jsfa.12654
Cooking bananas	NIRS	Tentative prediction of Matooke texture properties	http://doi.org/10.18167/agritrop/00714
Sweetpotato	NIRS	NIRS Analyses of sensory & textural traits in sweetpotato based on spectra collected on raw-intact roots	https://doi.org/10.18167/agritrop/00725
		NIRS Analyses of sensory & textural traits in sweetpotato based on spectra collected on raw-mashed roots	https://doi.org/10.18167/agritrop/00726
		NIRS Analyses of sensory & textural traits in sweetpotato based on spectra collected on cooked mashed roots	https://doi.org/10.18167/agritrop/00727
		NIRS Analyses of sensory & textural traits in sweetpotato based on spectra collected on raw freeze-dried roots	https://doi.org/10.18167/agritrop/00728
		NIRS Analyses of sensory & textural traits in sweetpotato based on spectra collected on cooked freeze-dried roots	https://doi.org/10.18167/agritrop/00729
	DigiEye	Predicting Sweepotato Sensory Attributes Using Image Analysis	https://doi.org/10.18167/agritrop/00733
Yam	NIRS	NIRS Prediction of physico-chemical & textural properties of yam	http://doi.org/10.18167/agritrop/00719
		NIRS Prediction of boiled hardness of yam tubers	http://doi.org/10.18167/agritrop/00718
		NIRS Calibration Model for Evaluating Boiled Yam Texture (Hardness)	https://doi.org/10.5281/zenodo.7547930
		Testing calibration of yam poundability using deep learning classification algorithm (Webinar)	https://mel.cgiar.org/reporting/download/report_file_id/25564
		Use of convolutional neural network to predict yam (D. alata) tuber amylose content from near infrared spectra (Scientific Conference presentation)	https://mel.cgiar.org/reporting/download/report_file_id/33110

RTB crops	Technique	Calibrations reports on high-throughput prediction models for quality traits	DOI
	HSI	Visualization of dry matter on intact yam tuber through HSI	http://doi.org/10.18167/agritrop/00716
		Quantification of Dry Matter in Yam Tuber During Storage, Using Hyperspectral Imaging (Webinar)	https://mel.cgiar.org/reporting/download/report_file_id/33109
		Visualization of cooking degree of boiled yam through HSI	http://doi.org/10.18167/agritrop/00720
		Prediction of yam cooking behavior using hyperspectral imaging	https://doi.org/10.18167/agritrop/00707
Potato	NIRS	NIRS Analyses of sensory & biochemical traits in potato based on spectra collected on cooked mashed tubers	https://doi.org/10.18167/agritrop/00742
		NIRS Analyses of sensory & biochemical traits in potato based on spectra collected on raw intact tubers	https://doi.org/10.18167/agritrop/00743

Table 16 Suitability of new genotypes to RTB users' needs & preferences

Activity Type	Title	DOI
Assessment of New Genotypes	Evaluation of the Suitability of New Cassava Genotypes to RTB Users' Needs and Preferences, at the National Crops Resources Research Institute (NaCRRI) in Uganda	https://doi.org/10.5281/zenodo.7584230
Assessment of New Genotypes	Evaluation of the Suitability of New Cassava Genotypes to RTB Users' Needs and Preferences regarding Gari-Eba, IITA in Nigeria	https://doi.org/10.5281/zenodo.7584242
Assessment of New Genotypes	Evaluation of the Suitability of New Cassava Genotypes to RTB Users' Needs and Preferences regarding Gari-Eba at NRCRI in Nigeria	https://doi.org/10.18167/agritrop/00766
Assessment of New Genotypes	Evaluation of the Suitability of New Cassava Genotypes to RTB Users' Needs and Preferences regarding Fufu, at NRCRI in Nigeria	https://doi.org/10.18167/agritrop/00765
Assessment of New Genotypes	Evaluation of the Suitability of New Yam Genotypes to RTB Users' Needs and Preferences, at UAC-FSA in Benin	https://doi.org/10.18167/agritrop/00746
Assessment of New Genotypes	On-farm participatory assessment of elite yam clones for yield and food quality in Nigeria	https://doi.org/10.18167/agritrop/00750
Assessment of New Genotypes	Evaluation of the suitability of new Yam Genotypes to RTB Users Needs and Preferences regarding Boiled Yam at NRCRI in Nigeria	Validating in Progress
Assessment of New Genotypes	Evaluation of the suitability of new Yam Genotypes to RTB Users Needs and Preferences regarding Pounded Yam at NRCRI in Nigeria	Validating in Progress
Assessment of New Genotypes	Evaluation of the Plantains Genotypes to RTB Users' Needs and Preferences regarding Matoke at NARL in Uganda	https://doi.org/10.18167/agritrop/00767
Assessment of New Genotypes	Evaluation of the Plantains Genotypes to RTB Users' Needs and Preferences regarding Fried Plantain at CNRA in Côte d'Ivoire	Validating in Progress

Activity Type	Title	DOI
Guidance / Methodological Manuals	A Guidance for the evaluation of processing and obtaining food products with crop users. Gender equitable positioning, promotion and performance, WP5. RTBfoods Methodological Report	https://doi.org/10.18167/agritrop/00584

Table 17 Survey datasets (Step 2)

These datasets are stored on CIRAD Dataverse, and which will be on open access after a 2-years embargo, as committed in the RTBfoods Global Access Strategy (embargo ending date: 15 March 2025)

		Step 2. **Gendered food mapping**	
RTB Crops	**Food Products**	**Countries (Responsible Institutes)**	**DOI**
Cassava	**Boiled cassava**	Uganda (NaCRRI)	https://doi.org/10.18167/DVN1/H53NIW
		Benin (UAC-FSA/IITA)	https://doi.org/10.18167/DVN1/NKWWSR
	Gari/Eba	Nigeria (IITA)	https://doi.org/10.18167/DVN1/YKERFG
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/ICTC6U
	Gari	Cameroon (IITA/ENSAI)	https://doi.org/10.18167/DVN1/FP4QU7
	Attiéké	Côte d'Ivoire (CNRA)	https://doi.org/10.18167/DVN1/R8L1GB
	Fufu	Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/WXOOF4
Cooking bananas	**Boiled plantain**	Cameroon (CARBAP)	https://doi.org/10.18167/DVN1/X6THL0
	Matooke	Uganda (NARL /Bioversity)	https://doi.org/10.18167/DVN1/KQNSFG
	Fried plantain Aloco Dodo	Nigeria (IITA)	https://doi.org/10.18167/DVN1/OV00NM
Sweetpotato	**Boiled sweetpotato**	Uganda (CIP)	https://doi.org/10.18167/DVN1/6TEM3B
Yam	**Boiled yam**	Benin (UAC-FSA/IITA)	https://doi.org/10.18167/DVN1/YGRF6A
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/SEU3CS
	Pounded yam	Nigeria (Bowen U.)	https://doi.org/10.18167/DVN1/CIJID5
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/SEU3CS

Table 18 Survey datasets (Step 3)

These datasets are stored on CIRAD Dataverse, and which will be on open access after a 2-years embargo, as committed in the RTBfoods Global Access Strategy (embargo ending date: 15 March 2025)

		Step 3. **Participatory processing diagnosis**	
RTB Crops	**Food Products**	**Countries (Responsible Institutes)**	**DOI**
Cassava	**Boiled cassava**	Uganda (NaCRRI)	https://doi.org/10.18167/DVN1/DACROD
		Benin (UAC-FSA)	https://doi.org/10.18167/DVN1/9ZWIDR
	Gari/Eba	Nigeria (IITA)	https://doi.org/10.18167/DVN1/HZ17P7

		Step 3. Participatory processing diagnosis	
RTB Crops	**Food Products**	**Countries (Responsible Institutes)**	**DOI**
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/X2AQAQ
	Attiéké	Côte d'Ivoire (CNRA)	https://doi.org/10.18167/DVN1/EWUUXA
	Fufu	Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/50OL9R
Cooking bananas	**Boiled plantain**	Cameroon (CARBAP)	https://doi.org/10.18167/DVN1/ZRHYDN
	Matoke	Uganda (NARL/ Bioversity)	https://doi.org/10.18167/DVN1/YPXDKO
Sweetpotato	**Boiled sweetpotato**	Uganda (CIP)	https://doi.org/10.18167/DVN1/NUAPBX
	Fried sweetpotato	Nigeria (CIP)	https://doi.org/10.18167/DVN1/RSZRAN
		Ghana (CIP)	https://doi.org/10.18167/DVN1/S2FA7M
Yam	**Boiled yam**	Benin (UAC-FSA)	https://doi.org/10.18167/DVN1/HQQ2VQ
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/P9FL5S
	Pounded yam	Nigeria (Bowen U.)	https://doi.org/10.18167/DVN1/1YK6S7
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/BDU94C
Potato	**Boiled potato**	Uganda (CIP)	https://doi.org/10.18167/DVN1/40HEAQ

Table 19 Dictionaries developed for traits related to the processing and the quality of RTB food products

RTB Crops	Product Profile	Processing Techniques	Sensory Descriptors	Textural Parameters
Cassava	Boiled cassava	https://mel.cgiar.org/reporting/download/report_file_id/25523	in Benin: https://mel.cgiar.org/reporting/download/report_file_id/25521 in Uganda: https://mel.cgiar.org/reporting/download/report_file_id/33063	https://mel.cgiar.org/reporting/download/report_file_id/25519
	Gari/Eba	https://mel.cgiar.org/reporting/download/report_file_id/33067	https://mel.cgiar.org/reporting/download/report_file_id/33058	https://mel.cgiar.org/reporting/download/report_file_id/36722
	Attiéké	-	https://mel.cgiar.org/reporting/download/report_file_id/33061	-
	Fufu	https://mel.cgiar.org/reporting/download/report_file_id/33070	https://mel.cgiar.org/reporting/download/report_file_id/33059	https://mel.cgiar.org/reporting/download/report_file_id/36723
Cooking bananas	Boiled plantain	https://mel.cgiar.org/reporting/download/report_file_id/33064	https://mel.cgiar.org/reporting/download/report_file_id/36719	https://mel.cgiar.org/reporting/download/report_file_id/36720
	Matooke	https://mel.cgiar.org/reporting/download/report_file_id/33068	https://mel.cgiar.org/reporting/download/report_file_id/25520	-
Sweetpotato	Boiled sweetpotato	https://mel.cgiar.org/reporting/download/report_file_id/33066	https://mel.cgiar.org/reporting/download/report_file_id/25522	-
Yam	Boiled yam	https://mel.cgiar.org/reporting/download/report_file_id/25524	https://mel.cgiar.org/reporting/download/report_file_id/25525	https://mel.cgiar.org/reporting/download/report_file_id/36721

RTB Crops	Product Profile	Processing Techniques	Sensory Descriptors	Textural Parameters
	Pounded yam	https://mel.cgiar.org/reporting/download/report_file_id/33069	https://mel.cgiar.org/reporting/download/report_file_id/33060	https://mel.cgiar.org/reporting/download/report_file_id/36724
Potato	Boiled potato	https://mel.cgiar.org/reporting/download/report_file_id/33065	https://mel.cgiar.org/reporting/download/report_file_id/33062	-

Table 20 Laboratory textural datasets

These datasets are stored on CIRAD Dataverse, and which will be on open access after a 2-years embargo, as committed in the RTBfoods Global Access Strategy (embargo ending date: 15 March 2025)

		Instrumental textural datasets	
RTB crops	**Food products**	**List of Countries (Responsible Institutes)**	**DOI**
Cassava	**Boiled cassava**	Uganda (NaCRRI)	https://doi.org/10.18167/DVN1/NTSVAI
		Benin (UAC-FSA)	https://doi.org/10.18167/DVN1/IIEZKS
		Colombia (CIAT)	https://doi.org/10.18167/DVN1/XORP54
	Gari/Eba	Nigeria (IITA)	https://doi.org/10.18167/DVN1/2RY73P by LSF: https://doi.org/10.18167/DVN1/FMKA7H
	Fufu	Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/RFZMLC
			by LSF: https://doi.org/10.18167/DVN1/QNI0CH
			retting ability: https://doi.org/10.18167/DVN1/KJPIPD
			uni-axial extensiblity: https://doi.org/10.18167/DVN1/USQ3U5
Cooking bananas	**Boiled plantain**	Côte d'Ivoire (UNA/CNRA)	https://doi.org/10.18167/DVN1/NZZHDZ
		Cameroon (CARBAP)	https://doi.org/10.18167/DVN1/UUIRVI
	Matooke	Uganda (NARL)	https://doi.org/10.18167/DVN1/UZWRTL
Sweetpotato	**Boiled sweetpotato**	Uganda (CIP)	https://doi.org/10.18167/DVN1/X43VRP
	Fried sweetpotato	Uganda (CIP)	https://doi.org/10.18167/DVN1/YBB44W
Yam	**Boiled yam**	Benin (UAC-FSA)	https://doi.org/10.18167/DVN1/HJBO5K
		Nigeria (IITA)	https://doi.org/10.18167/DVN1/8ZHOIX
		Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/WXBNPJ
		Guadeloupe (CIRAD)	https://doi.org/10.18167/DVN1/0G4G28
	Pounded yam	Nigeria (Bowen University)	https://doi.org/10.18167/DVN1/M9RYBD
			uni-axial extensiblity: https://doi.org/10.18167/DVN1/KLXCJQ
Potato	**Boiled potato**	Uganda (CIP)	https://doi.org/10.18167/DVN1/UZLI7O

Table 21 Laboratory sensory analysis datasets

These datasets are stored on CIRAD Dataverse, and which will be on open access after a 2-years embargo, as committed in the RTBfoods Global Access Strategy (embargo ending date: 15 March 2025)

		Quantitative descriptive sensory analysis datasets	
RTB crops	**Food products**	**List of Countries (Responsible Institutes)**	**DOI**
Cassava	**Boiled cassava**	Uganda (NaCRRI)	https://doi.org/10.18167/DVN1/VFKFUR
		Benin (UAC-FSA)	https://doi.org/10.18167/DVN1/3ROQIK
	Gari/Eba	Nigeria (IITA)	https://doi.org/10.18167/DVN1/BCNG5K
	Attiéké	Côte d'Ivoire (CNRA)	https://doi.org/10.18167/DVN1/YPPYJO
	Fufu	Nigeria (NRCRI)	https://doi.org/10.18167/DVN1/SZKUF2
Cooking bananas	**Boiled plantain**	Côte d'Ivoire (CNRA)	https://doi.org/10.18167/DVN1/DQA1ZV
		Cameroon (CARBAP)	https://doi.org/10.18167/DVN1/X9C6JG
	Matooke	Uganda (NARL)	https://doi.org/10.18167/DVN1/XGTNOL
Sweetpotato	**Boiled sweetpotato**	Uganda (CIP)	https://doi.org/10.18167/DVN1/WG5YOT
	Fried sweetpotato	Uganda (CIP)	https://doi.org/10.18167/DVN1/P0R0HG
Yam	**Boiled yam**	Benin (UAC-FSA)	https://doi.org/10.18167/DVN1/6UMNFF
		Nigeria (IITA)	https://doi.org/10.18167/DVN1/KYSGDG
	Pounded yam	Nigeria (Bowen University)	https://doi.org/10.18167/DVN1/QFDIQK

Table 22 Spectral datasets

These datasets are stored on CIRAD Dataverse, and which will be on open access after a 2-years embargo, as committed in the RTBfoods Global Access Strategy (embargo ending date: 15 March 2025)

RTB crops	**Technique**	**List of Spectral Databases developed over 5 years**	**DOI**
Cassava	NIRS	NIRS Database on Fresh Cassava for Dry Matter Calibration at NaCRRI, Uganda	https://doi.org/10.18167/DVN1/K7XOQO
		NIRS Database on Dried Grounded Cassava Flour for Moisture, Ash, Fat, Protein, Sugar, Starch & Amylose Calibrations at IITA, Nigeria	https://doi.org/10.18167/DVN1/SH5FG7
		NIRS Database on Fresh Grounded Cassava for Dry Matter Calibration at IITA, Nigeria	https://doi.org/10.18167/DVN1/H83HHX
		NIRS Database on Fresh Grounded Cassava for Starch Calibration at IITA, Nigeria	https://doi.org/10.18167/DVN1/VJ0NTP
		NIRS Database on Fresh Intact Cassava for Dry Matter Calibration at IITA, Nigeria	https://doi.org/10.18167/DVN1/6LEFW6
		NIRS Database on Fresh Intact Cassava for cooking time to texture calibration at CIAT, Colombia	https://doi.org/10.18167/DVN1/65WYS6

RTB crops	Technique	List of Spectral Databases developed over 5 years	DOI
		NIRS Database on Fresh Intact Cassava for Dry Matter to texture Calibration at CIAT, Colombia	https://doi.org/10.18167/DVN1/GV1JCN
		NIRS Database on Fresh Cassava, Wet Mashed Fufu & Dried Fufu Flour for Dry matter, Starch & Amylose Calibrations at NRCRI, Nigeria	https://doi.org/10.18167/DVN1/PLJ2MH
		NIRS Database on fresh blended yellow cassava for DM, HCN, TCC, TBC & cooking time at CIAT, Colombia	https://doi.org/10.18167/DVN1/Q1UFHR
		NIRS Database on fresh blended cassava for DM, Water absorption, texture parameters & cooking time (OCT) at CIAT, Colombia	https://doi.org/10.18167/DVN1/EORNI1
		NIRS Database on intact fresh cassava roots for DM at IITA, Nigeria	https://doi.org/10.18167/DVN1/H7LUYC
		NIRS Database on fresh blended cassava for DM at IITA, Nigeria	https://doi.org/10.18167/DVN1/M1YPXB
		NIRS Database on Dried Grounded Cassava Flour for Ash & Protein at IITA, Nigeria	https://doi.org/10.18167/DVN1/PHBQUY
		NIRS Database on fresh grated cassava for softness at NaCRRI, Uganda	https://doi.org/10.18167/DVN1/UENRG6
		NIRS Database on intact fresh cassava using portable device for DM at NRCRI, Nigeria	https://doi.org/10.18167/DVN1/REPRPU
		NIRS Database on intact fresh cassava using portable device for starch at NRCRI, Nigeria	https://doi.org/10.18167/DVN1/ULYT6J
		NIRS Database on fresh blended cassava for Dry Matter, Water absorption, Texture & cooking Time at CIAT, Colombia	https://doi.org/10.18167/DVN1/4SQDRB
		NIRS Database on intact fresh cassava for Dry Matter & Starch at IITA, Nigeria	https://doi.org/10.18167/DVN1/S1A3KY
		NIRS Database on fresh blended cassava for Dry Matter & Starch at IITA, Nigeria	https://doi.org/10.18167/DVN1/AKG1L7
		NIRS Database on intact fresh cassava for Dry Matter at NRCRI, Nigeria	https://doi.org/10.18167/DVN1/LQZQA1
		NIRS Database on cassava flour for Dry Matter, starch, amylose, amylopectin, sugar and fiber at NRCRI, Nigeria	https://doi.org/10.18167/DVN1/PU6HJ9
		NIRS Database on cassava flour for Dry Matter & starch at NRCRI, Nigeria	https://doi.org/10.18167/DVN1/3H6LKU
		NIRS Calibration Database on fresh grated cassava for amylose at NaCRRI Uganda	https://doi.org/10.18167/DVN1/NRVIWV
		NIRS Calibration Database on fresh grated cassava for DM at NaCRRI Uganda	https://doi.org/10.18167/DVN1/B6XDTA
		NIRS Database on unmilled Gari for Water Absorption Capacity, Bulk Density, Dispersibility, Titratable Acidity Calibrations at IITA, Nigeria	https://doi.org/10.18167/DVN1/VY9EFE
		NIRS Database on milled Gari for Water Absorption Capacity, Bulk Density, Dispersibility, Titratable Acidity Calibrations at IITA, Nigeria	https://doi.org/10.18167/DVN1/RP9EOS
		NIRS Database on cassava milled Gari at IITA, Nigeria	https://doi.org/10.18167/DVN1/0ZRLOY

RTB crops	Technique	List of Spectral Databases developed over 5 years	DOI
		NIRS Database on cassava un-milled Gari at IITA, Nigeria	https://doi.org/10.18167/DVN1/FLOLCC
		NIRS Database on wet fufu (intermediate) using portable device for DM at NRCRI, Nigeria	https://doi.org/10.18167/DVN1/BJWPV4
		NIRS Database for Biophysical & Functional Properties of Gari at IITA, Nigeria	https://doi.org/10.18167/DVN1/W7LVH1
		NIRS Database for Textural Properties of Gari-Eba at IITA, Nigeria	https://doi.org/10.18167/DVN1/CLYMRQ
		NIRS Calibration Database on Fufu flour for dry matter, pH, amylose, swelling power & solubility at NRCRI Nigeria	https://doi.org/10.18167/DVN1/OORGFT
		NIRS Calibration Database on Eba for textural properties at IITA Nigeria	https://doi.org/10.18167/DVN1/PNFU8N
		NIRS Calibration Database for WA at 30' on fresh ground cassava puree at CIAT Colombia	https://doi.org/10.18167/DVN1/XVJVB8
	MIRS	on cassava cell wall to predict cooking time at CIAT, Colombia	https://doi.org/10.18167/DVN1/WUOJSL
	HSI	HSI Calibration Database on raw fresh cassava for DM at CIAT Colombia	https://doi.org/10.18167/DVN1/3AIOHE
		HSI Calibration Database on raw fresh cassava for WAB (at 30') at CIAT Colombia	https://doi.org/10.18167/DVN1/VHJ0NX
		HSI Calibration Database on boiled cassava for DM at CIAT Colombia	https://doi.org/10.18167/DVN1/FP4SDB
Cooking bananas	NIRS	NIRS Database on fresh Matooke fingers at NaCRRI & IITA, Uganda	https://doi.org/10.18167/DVN1/GYZ9AP
		NIRS Database on boiled Matooke mash at NaCRRI & IITA, Uganda	https://doi.org/10.18167/DVN1/QMQRBB
		NIRS Database on raw Matooke flour for DM & RVA at NaCRRI & IITA, Uganda	https://doi.org/10.18167/DVN1/PVTIFK
		NIRS Database on fresh Matooke for Dry Matter & Texture at NaCRRI & IITA, Uganda	https://doi.org/10.18167/DVN1/DQSIVZ
		NIRS calibration database on fresh mashed Matooke for color & texture at NaCRRI & IITA Uganda	https://doi.org/10.18167/DVN1/OQ13EV
Sweetpotato	NIRS	NIRS Database on Raw Dried Sweetpotato at CIP, Uganda	https://doi.org/10.18167/DVN1/5BGFHM
		NIRS Database on Cooked Dried Sweetpotato at CIP, Uganda	https://doi.org/10.18167/DVN1/HRT07J
		NIRS Database on raw intact sweetpotato at CIP, Uganda	https://doi.org/10.18167/DVN1/02BMIZ
		NIRS Database on raw fresh grated sweetpotato at CIP, Uganda	https://doi.org/10.18167/DVN1/CJYERZ
		NIRS Database on raw freeze dried sweetpotato at CIP, Uganda	https://doi.org/10.18167/DVN1/EGUO0W
		NIRS Database on raw fresh sweetpotato for texture & cooking time at CIP, Uganda	https://doi.org/10.18167/DVN1/LNJXDO
		NIRS Database on cooked sweetpotato for texture & cooking time at CIP, Uganda	https://doi.org/10.18167/DVN1/FK6FKH

RTB crops	Technique	List of Spectral Databases developed over 5 years	DOI
		NIRS Database on cooked sweepotato for DM & sugars at CIP, Uganda	https://doi.org/10.18167/DVN1/GYTMSO
		NIRS Database on cooked freeze dried sweetpotato for sugars at CIP, Uganda	https://doi.org/10.18167/DVN1/KSYFSU
		NIRS Calibration Database on raw intact sweetpotato for Sensory Descriptors, Texture, DM, OCT & Water absorption at CIP Uganda	https://doi.org/10.18167/DVN1/IZCKYC
		NIRS Calibration Database on raw mashed sweetpotato for Sensory Descriptors, Texture, DM, OCT & Water absorption at CIP Uganda	https://doi.org/10.18167/DVN1/BQEF0O
		NIRS Calibration Database on cooked mashed sweetpotato for Sensory Descriptors, Texture, DM, OCT & Water absorption at CIP Uganda	https://doi.org/10.18167/DVN1/KNQFPF
		NIRS Calibration Database on raw freeze-dried ground sweetpotato for Sensory Descriptors, Texture, DM, OCT & Water absorption at CIP Uganda	https://doi.org/10.18167/DVN1/UMQFBV
		NIRS Calibration Database on cooked freeze-dried ground sweetpotato for Sensory Descriptors, Texture & DM at CIP Uganda	https://doi.org/10.18167/DVN1/J6UUTY
	DigiEye	DigiEye image reference base on raw intact sweetpotato	https://doi.org/10.18167/DVN1/ZHVGBM
		DigiEye image reference base on boiled sweetpotato	https://doi.org/10.18167/DVN1/UOTPIZ
Yam	NIRS	NIRS Database on Fresh Intact Yam for Total Sugars & Polyphenols Calibrations at CIRAD, France	https://doi.org/10.18167/DVN1/HXFVVS
		NIRS Database on Fresh Yam tuber for Dry Matter & Starch Calibrations at NRCRI, Nigeria	https://doi.org/10.18167/DVN1/2QXNVU
		NIRS Database on Dried Yam for DM, Protein, Starch, Sugar, Hardness, Cohesiveness, Adhesiveness, Springiness, Extensibility Calibrations at INRAe-CIRAD, Guadeloupe	https://doi.org/10.18167/DVN1/IWJAGU
		NIRS Database on fresh blended yam for color at IITA, Nigeria	https://doi.org/10.18167/DVN1/LWV4EQ
		NIRS Database on fresh blended Yam for good and bad genotypes for pounded yam at IITA, Nigeria	https://doi.org/10.18167/DVN1/RDNUYF
		NIRS Database on yam flour for protein, starch & sugar at INRAe, Guadeloupe	https://doi.org/10.18167/DVN1/JIQLFY
		NIRS Database on intact fresh yam for Dry Matter & Texture at CIRAD, Guadeloupe	https://doi.org/10.18167/DVN1/AIKPJV
		NIRS Database on Fresh Blended Yam for good and bad genotypes for pounded yam at IITA, Nigeria	https://doi.org/10.18167/DVN1/RDNUYF
		NIRS Database on fresh blended yam for Dry Matter & Starch at IITA, Nigeria	https://doi.org/10.18167/DVN1/FAJIOG
		NIRS Database on fresh blended yam at IITA, Nigeria	https://doi.org/10.18167/DVN1/RLUEFV,
		NIRS Database on fresh blended yam for Cooking Time, Water absorption & Hardness at IITA, Nigeria	https://doi.org/10.18167/DVN1/SSZRIB

RTB crops	Technique	List of Spectral Databases developed over 5 years	DOI
		NIRS Database on intact fresh yam for Dry Matter at IITA, Nigeria	https://doi.org/10.18167/DVN1/KUYHDR
		NIRS Database on intact fresh yam for Dry Matter at NRCRI, Nigeria	https://doi.org/10.18167/DVN1/OOVUVL
		NIRS Calibration Database on boiled yam for texture (hardness) at IITA Nigeria	https://doi.org/10.18167/DVN1/QI2D6S
		NIRS calibration database on fresh yam for texture at CIRAD, Guadeloupe	https://doi.org/10.18167/DVN1/G3DUZE
	HSI	HSI Database on fresh yam slices for the prediction and visualisation of dry matter at CIRAD, France (year 1)	https://doi.org/10.18167/DVN1/VAW4DW
		HSI Database on fresh yam slices for dry matter at CIRAD, France (year 2)	https://doi.org/10.18167/DVN1/2A1IU2
		HSI Calibration Database on raw fresh yam for DM at CIRAD France	https://doi.org/10.18167/DVN1/JUV9IY
		HSI Calibration Database on raw fresh yam for pectin & starch at CIRAD France	https://doi.org/10.18167/DVN1/JPAH2A
		HSI Calibration Database on raw fresh yam for texture (hardness) at CIRAD France	https://doi.org/10.18167/DVN1/UP4ND3
Potato	NIRS	NIRS calibration database on cooked mashed potato for sensory descriptors, moisture content, DM, crude fiber and starch at CIP Uganda	https://doi.org/10.18167/DVN1/EDZQG5
		NIRS calibration database on raw intact potato for sensory descriptors, moisture content, DM, crude fiber and starch at CIP Uganda	https://doi.org/10.18167/DVN1/M7S10V
All	NIRS	ExSSPIR Reference database in order to improve standardization & interoperability between spectrometer using deep learning	https://doi.org/10.18167/DVN1/NQV9TM

Table 23 Scientific webinars organized by the PMU between May 2020 and December 2022

Webinar Title	Presenter (First Name NAME)	Discipline	Institute	Country	Crop(s)	Link to RTBfoods YouTube channel
Cooking a Protocol: Developing a Facilitated Approach to Assess Cooking Time in Cassava Roots	Hernan CEBALLOS	Cassava Breeder	CIAT	Colombia	Cassava	https://youtu.be/LQTXV7fGXnU
Visualization of Water Distribution in Fresh Yam and Cassava during Oven Drying by Hyperspectral Imaging	Karima MEGHAR	Chimiome-trician	CIRAD	France	Cassava; Yam	https://youtu.be/RKJqBsdVnME
From Field Surveys on Matooke Quality Characteristics to Key Priority Analyses for Trait Dissection at Lab Level	Kephas NOWA-KUNDA	Food-Technologist	NARL	Uganda	Matooke	https://youtu.be/6bT6UxnkyhM
Quality Characteristics of Pounded Yam & Priority Laboratory Analyses for Dissection of Quality Traits	Bolanle OTEGBAYO	Food-Technologist	Bowen Univ.	Nigeria	Yam	https://youtu.be/xfjRHzX7CLI

Webinar Title	Presenter (First Name NAME)	Discipline	Institute	Country	Crop(s)	Link to RTBfoods YouTube channel
From Field Surveys on Boiled Plantain Quality Characteristics to Key Priority Analyses for Trait Dissection at Lab Level	Gérard NGOH NEWILAH	Food-Technologist	CARBAP	Cameroon	Plantain	https://youtu.be/2c7gpf_hB5I
From Field Surveys on Boiled Yam Quality Characteristics to Key Priority Analyses at Lab Level	Noël AKISSOE	Food-Technologist	UAC-FSA	Benin	Yam	https://youtu.be/YHVZ_VCuUVw
Institutional and Organizational Factors Determining the Utilization of Improved Cassava Varieties in Cameroon	Hubert Noël TAKAM TCHUENTE	PhD in Social-Science	IITA	Cameroon	Cassava	https://youtu.be/rPlv_cwW8Gg
Recent Advances in Deep Learning NIRS Calibration from RTB Product Composition to Functional Traits Prediction	Denis CORNET	Plant physiologist	CIRAD	France	All	https://youtu.be/mqcBsMESXdI
Boiled Sweetpotato Quality Traits: Main Learnings from the IJFST and 1st PPID Discussion	Jolien SWAN-CKAERT	Sweetpotato Breeder	CIP	Uganda	Sweet-potato	https://youtu.be/G9CiV2FWQ2w
Biochemistry of Textural Traits in Potato Tubers	Mark TAYLOR	Molecular physiologist	JHI	United-Kingdom	Potato	https://youtu.be/idnJL5z_2ZE
Cell Wall Polysaccharides' Impact on Textural Properties & How to Study Them	Aliénor DUTHEIL DE LA ROCHERE	Analytical chemist	INRAE	France	Yam; Plantain	https://youtu.be/Tpg452XQoyM
Methodological Insights from Pair-wise Ranking in "Mother & Baby Trials" with Farmer-processors in Nigeria	Béla TEEKEN	Social-Scientist	IITA	Nigeria	Cassava	https://youtu.be/yeTClzFbs3o
Development of a Procedure to Assess Pectins in RTBs: Relationship Between Pectin Types & Cassava Cooking Ability	Christian MESTRES	Food-Technologist	CIRAD	France	Cassava; Yam	https://www.youtube.com/watch?v=_egp-4qjkHY
Prediction of sensory attributes of boiled plantain by instrumental parameters	Antonin KOUASSI	PhD in Food-Technology	CIRAD	Côte d'Ivoire	Plantain	https://youtu.be/JG3exvR-0qs
Protocols Development for Gari production, and instrumental & sensory textural profile analysis of Eba (cooked Gari dough)	Michael ADESOKAN	Food & Nutrition Laboratory Manager	IITA	Nigeria	Cassava	https://youtu.be/foiipXtNngA
Development of Quality Trait Dictionaries for RTB food products for data collect and storage in Breedbases	Amos ASIIMWE	MSC student in Human Nutrition at Makerere University	intern at Alliance-Bioversity	Uganda	All	https://youtu.be/P4UiF9DZMOc
Plantain Food Products in Southern Nigeria; Insights from Quality Preferences & Implications for breeding	Delphine AMAH	Banana Breeder	IITA	Nigeria	Plantain	https://youtu.be/zfSWwxwJ1Cg
Accelerating breeding of yam Dioscorea alata L. through genotyping-by-sequencing	Gemma ARNAU	Yam Breeder	CIRAD	France-Guadeloupe	Yam	https://youtu.be/AWW1pWLSo_M
NIRS Sampling, Catch Me If You Can: How to Be Representative?	Fabrice DAVRIEUX	Spectroscopy Expert	CIRAD	France-La Réunion	All	https://youtu.be/T8arsu5s5cU

Webinar Title	**Presenter (First Name NAME)**	**Discipline**	**Institute**	**Country**	**Crop(s)**	**Link to RTBfoods YouTube channel**
Quantification of Dry Matter in Yam Tuber During Storage, Using Hyperspectral Imaging	Karima MEGHAR	Chemome-trician	CIRAD	France	Yam	https://youtu.be/wtcdhobtEyQ
Consumer Preference Testing of Boiled Sweetpotato using the TRICOT Approach in Uganda & Ghana	Mukani MOYO & Reuben SSALI	Food chemist & breeder	CIP	Uganda		https://youtu.be/fwuCjDUzaEs
Relationships between sensory texture attributes & uni-axial texture parameters	Imayath DJIBRIL-MOUSSA	Food technologist	UAC-FSA	Benin	Cassava	https://youtu.be/afQwyRsJIPY
Effects of Storage Root Biochemistry & Preparation Methods on Sweetpotato Product Quality	Suzanne JOHAN-NINGS-MEIER	Research food technologist & Associate professor	USDA	United-States	Sweet-potato	https://youtu.be/fZk1wNEPKE4
RTBfoods WP1 Food Product Profiles Methodology	Lora FORSYTHE	Gender specialist	NRI	United-Kingdom	All	https://youtu.be/0zsBOg4UEYY
A Guidance for Food Product Evaluation From Advanced RTB Clones with Crop Users	Gérard NGOH NEWILAH	Food Technologist	CARBAP	Cameroon	All	https://youtu.be/o91Rltk7JL8
An Attempt to Differentiate Cassava Genotypes by their Retting Behavior using some Biophysical Indicators	Germaine WAKEM	PhD student in Food Science	CIRAD	Cameroon	Cassava	https://youtu.be/t90B63eRkwk
Relationships Between Yam Texture Changes and Starch & Pectins Behavior During Cooking	Tiéba SIMONIS	MSc student in Food Science	CIRAD	France	Yam	https://youtu.be/Kzufhcsgy_U
Steps Taken to Develop an Optimized Texture Analysis SOP for Boiled Sweetpotato	Mariam NAKITTO	Food Technologist	CIP	Uganda	Sweet-potato	https://youtu.be/wFqgBB69Ep4
Do pectins play a role in the texture of RTB products? Case study on boiled yam & cassava	Christian MESTRES	Food-Technologist	CIRAD	France	Cassava; Yam	https://youtu.be/OJw6lQTTPpQ
Assessing Gender Impact for the WP1 Food Product Profiles Using adapted G+ tools	Jacqueline ASHBY	Development Sociologist	Consultant	United-States		https://youtu.be/M2YOviisXtg
Heritability and segregation of water absorption in a multi-parental cassava population	Xiaofei ZHANG	Cassava Breeder	CIAT	Colombia	Cassava	https://youtu.be/9wgm7VdrLoU
Acceptability Thresholds: Strategy for their Evaluation	Christophe BUGAUD	Food Scientist - Sensory Expert	CIRAD	France	All	https://youtu.be/bUebQKd1xpI
The Triadic comparison of technologies (TRICOT) method applied to consumer testing	Béla TEEKEN	Socio-economist & gender specialist	IITA	Nigeria	All	https://youtu.be/K9ST9jXMcLo
Detection of Dynamic QTLs for Fruit Quality Traits During Banana Ripening	Sébastien RICCI	Banana Breeder & Geneticist	CIRAD	France	All	https://youtu.be/PMxqscbQZoY
Main steps for the estimation of repeatability and representativeness of NIRS and	Karima MEGHAR	Chemome-trician	CIRAD	France	All	https://youtu.be/O3qADG1vhkI

Webinar Title	Presenter (First Name NAME)	Discipline	Institute	Country	Crop(s)	Link to RTBfoods YouTube channel
hyperspectral imaging measurements						
Calibration of portable NIRS (QualitySpec) with intact roots can predict DM of cassava in the field	Luis LONDONO	Food Scientist	CIAT	Colombia	Cassava	https://youtu.be/70kE0ctQ4P4
Standard Operating Protocol for Determination of Extensibility of Pounded Yam	Oluwatoyin AYETIGBO	Food Scientist	CIRAD	France	Yam	https://youtu.be/dQaJuatkJoo
Mattson cooker to replace the subjective fork method	Luis Fernando DELGADO	Food Scientist	CIAT	Colombia	Cassava	https://youtu.be/lfdarLZkFto
Browning susceptibility of new hybrids of yam as related to their total phenolic content and their phenolic profile	Dominique RINALDO	Food Scientist	INRAe	France-Guadeloupe	Yam	https://youtu.be/0b-DXEO_hUQ
Predicting sweetpotato sensory attributes using image analysis	Joyce NABENDE	Computer Science	Makerere University	Uganda	Sweetpotato	https://youtu.be/gm8yGWi7CAQ
Upload of Sensory Panel Data on Breeding Material in Breedbase	Amos ASIIMWE	Data Management	CIRAD	France	All	https://youtu.be/SbmxclvrMwE

Table 24 WP Achievement Reports (Period 1 to 5)

WP Short Name	Title of Report	Link
Surveys on Trait Preferences	WP1 Scientific Progress Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13430
	WP1 Scientific Progress Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/34341
	WP1 Scientific Progress Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25528
	WP1 Scientific Progress Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33076
	WP1 Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36682
Biophysical Characterization	WP2 Scientific Progress Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13431
	WP2 Scientific Progress Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/34342
	WP2 Scientific Progress Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25529
	WP2 Scientific Progress Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33077
	WP2 Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36683
High Throughput Prediction	WP3 Scientific Progress Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13432
	WP3 Scientific Progress Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/34343

WP Short Name	Title of Report	Link
	WP3 Scientific Progress Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25530
	WP3 Scientific Progress Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33078
	WP3 Scientific Progress Report in Period 5	https://mel.cgiar.org/reporting/download/report_file_id/36684
Breeding & Genetics	WP4 Scientific Progress Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13433
	WP4 Scientific Progress Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/34338
	WP4 Scientific Progress Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25531
	WP4 Scientific Progress Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33079
	WP4 Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36685
Participatory Evaluation	WP5 Scientific Progress Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13434
	WP5 Scientific Progress Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/34339
	WP5 Scientific Progress Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25532
	WP5 Scientific Progress Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33080
	WP5 Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36686
Management	WP6 Final Results-Tracker from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36681
	WP6 Outcome evaluation of the RTBfoods project	https://doi.org/10.18167/agritrop/00748

Table 25 Institute Achievement Reports (Period 1 to 5)

Partner Institute	Title of Report	Link
Bioversity Interna-tional	Bioversity Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13438
	Bioversity Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36701
	Bioversity Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25533
	Bioversity Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33082
	Bioversity Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36667
Bowen University	Bowen University Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13439

Partner Institute	Title of Report	Link
	Bowen University Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36702
	Bowen University Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25534
	Bowen University Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33083
	Bowen University Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36696
CARBAP	CARBAP Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13440
	CARBAP Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36703
	CARBAP Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25535
	CARBAP Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33084
	CARBAP Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36687
CIAT	CIAT Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13441
	CIAT Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36704
	CIAT Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25536
	CIAT Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33085
	CIAT Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36700
CIP	CIP Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13442
	CIP Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36705
	CIP Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25537
	CIP Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33086
	CIP Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36688
CIRAD	CIRAD Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13443
	CIRAD Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36706
	CIRAD Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25538
	CIRAD Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33087

Partner Institute	Title of Report	Link
	CIRAD Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36699
CNRA	CNRA Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13444
	CNRA Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36707
	CNRA Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25539
	CNRA Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33088
	CNRA Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36697
IITA	IITA Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13445
	IITA Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36708
	IITA Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25540
	IITA Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33089
	IITA Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36698
INRAe	INRAe Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13446
	INRAe Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36709
	INRAe Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25541
	INRAe Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33090
	INRAe Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36689
JHI	JHI Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13447
	JHI Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36710
	JHI Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25542
	JHI Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33091
	JHI Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36690
NaCRRI	NaCRRI Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13448
	NaCRRI Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36711

Partner Institute	Title of Report	Link
	NaCRRI Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25543
	NaCRRI Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33092
	NaCRRI Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36691
NARL	NARL Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13449
	NARL Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36712
	NARL Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25544
	NARL Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33093
	NARL Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36692
NRCRI	NRCRI Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13450
	NRCRI Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36713
	NRCRI Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25545
	NRCRI Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33094
	NRCRI Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36693
NRI	NRI Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13451
	NRI Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36714
	NRI Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25546
	NRI Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33095
	NRI Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36694
UAC-FSA	UAC-FSA Activity Report in Period 1	https://mel.cgiar.org/reporting/download/report_file_id/13452
	UAC-FSA Activity Report in Period 2	https://mel.cgiar.org/reporting/download/report_file_id/36715
	UAC-FSA Activity Report in Period 3	https://mel.cgiar.org/reporting/download/report_file_id/25547
	UAC-FSA Activity Report in Period 4	https://mel.cgiar.org/reporting/download/report_file_id/33096
	UAC-FSA Achievement Report from Period 1 to 5	https://mel.cgiar.org/reporting/download/report_file_id/36695

Institute: Cirad – UMR QualiSud

Address: C/O Cathy Méjean, TA-B95/15 - 73 rue Jean-François Breton - 34398 Montpellier Cedex 5 - France

Tel: +33 4 67 61 44 31

Email: rtbfoodspmu@cirad.fr

Website: https://rtbfoods.cirad.fr/