Partner Activity Report

NARL Activities & Achievements for RTBfoods Project in Period 3 (Jan-Dec 2020)

Kampala, Uganda, 18th December, 2020

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

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

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ABSTRACT

This report highlights progress made at NARL in the implementation of the RTBfoods project during period III (November, 2019 – November, 2020). During this period, NARL activities focussed on completing data collection for activity 4 and 5, publishing results of WP1 (activity 3), data analysis and writing reports-activity 3, 4 and 5. The two studies -Gendered food mapping and market surveys were completed all the reports were submitted to the WP1 leader. The results from this study were also published (ttps://doi.org/10.1111/ijfs.14813). Data collection and analysis for activity 4 were completed and a report will be ready at the end of January, 2021. Data collection, analysis and repot writing for activity 5 is complete. During this period, a list of traits to dissect in WP2 were identified and prioritized. Bunch characteristics that emerged as important to users-bunch weights, finger sizes, compactness pulp and peel colour were quantified in metric terms and can be used by breeders to screen acceptable hybrids. On WP2, NARL focussed on biophysical analyses for the selected traits-texture-instrumental penetration/compression, dry matter, total starch, amylose content, carotenoids, pasting properties and sensory profiles using routine methods. This data has been generated for 62 genotypes (covering the highly preferred landraces, intermediates and the less preferred). Under WP3, NIRS spectra were acquired for all the 62 genotypes. WP5 is integrated with on-going four evaluation trials with 91 genotypes. *However, 65 genotypes from on-station trials were evaluated, resulting showing that 2 of them had a potential for advancement to multi-location evaluation. Participatory evaluation is planned for period 4, if the COVID situation stabilizes.* The NARL team participated in the annual review meeting in Kampala, presented a webnar on characteristics identified by work pack 1 and attended several webnars organised by PMU

Staff commitment, activities performed & perspectives

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1 PRODUCT PROFILE INVOLVEMENT (BY COUNTRY)

Partner institute	Product (Country) – Main PP in bold
NARL	**1- Matooke (Uganda) with Bioversity, IITA & NaCRRI** 2- Boiled Cassava (Uganda) for NaCRRI 3- Boiled Sweetpotato (Uganda) for CIP

2 NARL SUMMARY NARRATIVE

Tell us the story of your Institute in Period 3 focusing on main Activities & Achievements (Dec. 2019 to Dec 2020) by Product Profile (1-page max). (NB: This section will be copied & pasted in the body of the RTBfoods Annual Report for Period 3).

During period 3, **NARL prioritised completion of WP1 activities** since results of this work package feed and guide activities in other work packages. During period 3, NARL WP1 activities focused on completing data analysis and report writing for the gendered food mapping (part of activity 3), **conducting a market study** (part of activity 3), **participatory processing diagnosis** (activity 4) and **consumer testing** (activity 5). The gendered food mapping (activity 3) was completed and submitted to the WP1 leader. The **results from this study were also published in the International Journal of Food Science and Technology** (https://doi.org/10.1111/ijfs.14813. Market surveys whose objective was to capture Matooke banana traits market actors prefer was completed. Participatory Matooke processing diagnosis (activity4) to understand important characteristics during Matooke processing, data analysis and reporting have been completed. Activity 5, which objective was to capture the traits important during the eating of Matooke was also completed. All the activities under WP1 are therefore completed and a **list of traits for dissection in WP2 were identified and prioritized in consultation with WP2 teams: texture, colour and Matooke taste**. Bunch characteristics that emerged as important to users -bunch weights, finger sizes, compactness, pulp and peel colour- were also converted into metrics so that the information can be used in hybrid selection. All **WP1 datasets have been uploaded on RTBfoods platform**. A **complete Matooke profile table is being developed** using WP1 data generated and will be available for review and use by March, 2021.

In WP2, the Matooke team **completed the development of a standardised protocol for preparation of Matooke in the laboratory, for sensory evaluation including** sensory lexicon **and for texture analysis of Matooke**. During period 3, the team **focused on proof concept analyses for the selected traits-texture-instrumental though penetration/compression, dry matter, total starch, amylose content, carotenoids, pasting properties and sensory profiles**. This data has been generated for **62 genotypes obtained from breeding and evaluation trials at NARL-Kawanda and IITA-Sendusu** covering the highly preferred landraces, intermediates and the less preferred. The team had planned to purchase a rheometer to further characterize the texture of Matooke but due to COVID, the team was unable to liase with CIRAD counterparts to facilitate the purchase, delivery and installation. **COVID-19, greatly affected progress at the laboratory mainly because the team was unable to host a sensory panel** (12-15 members). Since all physical, chemical, sensory and NIRS data is taken on the same samples, the **whole laboratory activity was pended for about four months**.

Under WP3, NIRS spectra were acquired by NaCRRI for all the 62 genotypes.

NARL team contributed to WP5 through 4 on-going evaluation trials (established at the beginning of period 2) **with 91 genotypes** in the different agro-ecological zones of Uganda. These WP5 activities are **linked to the hybrid evaluation activities under the Banana Breeding Program**. **Field activities and participatory evaluations were limited by COVID-19.** However, **65 genotypes from on-station trials were evaluated,** resulting showing that **2 of them had a**

potential for advancement to multi-location evaluation. Participatory evaluation is planned for period 4, if the COVID situation stabilizes.

The NARL team participated in 2020 RTBfoods annual meeting in Kampala and presented a **webinar on Matooke quality characteristics** identified within WP1. **NARL hosted one online and one physical inter-work package meetings**. The participants included IITA-Uganda, Bioversity International-Uganda and NARL and NaCRRI. The meetings were to (1) discuss WP1 results and plan publication of the results (2) **identify traits for dissection in laboratory (3) identity traits ready for use by WP4**. Four potential publications were identified (based on activity 3, 5 and 4), in addition to the one already published in special issue (**https://doi.org/10.1111/ijfs.14813).** On traits for dissection, the meetings agreed on **yellow colour, soft texture and taste** (using sensory methods) **as priority traits to be investigated**. It was also recommended that preferred matooke bunch characteristics such as 'big bunch' 'long fingers' should be quantified in metrics (Kgs and cm) so that they can be used in phenotyping of hybrids. **WP4 picked colour and texture for use in phenotyping** while waiting for the WP2 and WP3 to generate tools usable in the field (by WP4 and WP5).

With regard to capacity strengthening, **NARL and Bioversity jointly supported the training of two Msc. students** (Nelson Kisenyi attached to WP2 and Moureen Asasira attached to WP1). Nelson has completed his training while Moureen has submitted her report for examination.

Note: In this report, the mentions to WP1 activities correspond to the three successive steps adapted and implemented in the RTBfoods framework to identify RTB users' preferences.

Activities 3 refers to **RTBfoods Step 2: Gendered food mapping. CIRAD-RTBfoods Project, 74 p. (Forsythe *et al.; 2018*)** https://doi.org/10.18167/agritrop/00569

Activity 4 refers to **RTBfoods Step 3: Participatory processing diagnosis and quality characteristics. CIRAD-RTBfoods Project, 29 p. (Fliedel *et al.; 2018*)** https://doi.org/10.18167/agritrop/00570

Activity 5 refers to **RTBfoods Step 4: Consumer testing in rural and urban areas. CIRAD-RTBfoods Project, 29 p. New version (Fliedel *et al.; 2018*)** https://doi.org/10.18167/agritrop/00571

3 NARL STAFF INVOLVEMENT BY WP & PRODUCT PROFILE

Should be aligned with financial reporting (cf Excel spreadsheet 'PERSONNEL COSTS').

First Name	Country of residence	Permanent, student OR contractual	WP1	WP2	WP3	WP4	WP5	Matooke (Uganda)
Kephas NOWAKUNDA	Uganda	Permanent	☒	☒	☒	☐	☐	☐
Kenneth AKANKWASA	Uganda	Permanent	☒	☐	☐	☐	☒	☐
Moses MATOVU	Uganda	Permanent	☐	☒	☒	☐	☐	☐
Elizabeth KHAKASA	Uganda	Permanent	☒	☒	☒	☐	☐	☐
Sarah KISAKYE	Uganda	Part-time	☒	☐	☐	☐	☐	☐
Yusuf MUKASA	Uganda	Permanent	☐	☒	☐	☐	☐	☐
Kenneth BIGIRA	Uganda	Part- time	☒	☒	☐	☐	☐	☐
Martha MBABAZI	Uganda	Part - time	☒	☒	☐	☐	☐	☐
Rogers MWEBEMBEZI	Uganda	Part - time	☒	☐	☐	☐	☐	☐
Daphine OWOMUGISHA	Uganda	Part - time	☒	☒	☐	☐	☐	☐
Loyce KATUSIIME	Uganda	Part - time	☒	☐	☐	☐	☐	☐

List of students involved in RTBfoods activities in Period 3 (including student exchange).

First Name NAME (+ Institute if not from NARL)	**Master student or PhD or Post-Doc**	**Subject title**	**WP**	**University of affiliation**	**Fellowship starting date**	**Fellowship ending date**	**Co-funding** (ex: NextGen, AfricaYam, BBB, SweetGAINS, CRP RTB)	**Tutor(s) in RTBfoods project**
Moreen ASASIRA	Master	Consumer preferences for cooking banana attributes. A case for urban consumers	1	Makerere University	Nov, 2018	Dec, 2020		Kenneth AKANKWASA
Nelson KISENYI	Msc	Physico-chemical and sensory properties of selected local and hybrid bananas in Uganda	2	Kyambogo University	Jan, 2019	Jan, 2020	BBB/ABBB	Moses MATOVU

Note: Nelson KISENYI has graduated. The thesis has been submitted to PMU.

Moureen has also submitted her thesis for examination (Report submitted to PMU).

4 NARL ACTIVITIES & ACHIEVEMENTS ON MATOOKE (UGANDA)

Product champion: K. NOWAKUNDA (NARL)

10 lines summary Narrative on major point of complementarity between RTBFOODS and ABBB projects in your Institute:

The process to breed and release a Matooke hybrid often takes over 10 years and most of the hybrids are often rejected by end-user, making the process costly. The ABBB project aims to increase efficiency in generation, evaluation and selection of East African highland cooking bananas (Matooke) hybrids, acceptable by end-users. Selecting acceptable Matooke hybrids requires knowledge of what the end-users want. **The end-user preferred traits in Matooke are poorly defined and this is the gap the RTBfoods project is filling**. Thus, the **RTBfoods activities at NARL are closely linked with the ABBB activities.** The RTBfoods aims to define the end-users-preferred traits of Matooke and develop high throughput tools for selecting the hybrids with the preferred traits which will enable the breeding program to select for these traits during early evaluation stages.

4.1 WP1 – Matooke (Uganda)

NARL key contact for WP1 on Matooke in Uganda: Kenneth AKANKWASA

15-20 lines Narrative on Activities performed & Progress in report writing by Activity including Challenges faced & Covid-19 impact (if relevant). Please mention co-funding program(s) (if any). NB: Sub-sections below can be increased or deleted if not relevant.

During period 3, NARL WP1 activities focused on **completing data analysis and report writing** for the gendered food mapping (part of activity 3), **conducting a market study** (part of activity 3), **participatory processing diagnosis** (activity 4) and **consumer testing** (activity 5). NARL also planned to develop the Matooke product profile table, upload all the WP1 data on the RTBfoods platform website and publish at least one paper. *The gendered food mapping (activity 3) was completed and submitted to the WP1 leader.* The **results from this study were also published in the International Journal of food science and Technology** (https://doi.org/10.1111/ijfs.14813). Market surveys whose objective was to capture Matooke banana traits market actors prefer were completed. A draft report has also been submitted to the Work Package Leader. Therefore, all the activities under activity 3 have been complete*d*. *Participatory Matooke processing diagnosis (activity4) to understand important characteristics during Matooke processing was completed. Data analysis is also complete and the report will be by end of January 2021*. Activity 5, whose objective was capturing the traits important during the eating of Matooke was also completed. A report was submitted to the Work Package Leader. All the activities under Work package 1 are nearly complete, and, therefore, **traits to dissect in WP2 were identified and prioritized in consultation with WP2 teams as texture, colour and Matooke taste**. Bunch characteristics that emerged as important to users -namely bunch weights, finger sizes, compactness, pulp and peel colour- were also converted into metrics so that the information can be used in hybrid selection. **All the WP1 data has been uploaded on RTBfoods online platform**. **A complete Matooke profile table is being developed using all WP1 generated knowledge** and will be available for review and use by March, 2021.

Activity 3 achievements – Gendered product mapping and user profiles:

The objectives of activity 3 were to understand the characteristics of Matooke that producers (as farmers, handlers and processors) and market actors prefer. These were achieved in two studies- (i) gendered food mapping and (ii) Market interviews. Both studies are complete. The studies were

conducted in 2 banana producing regions of Uganda (Western and Central) and major banana urban markets. Famers and traders in the western Uganda give priority to characteristics that influence market acceptance. **In the central region, consumers attach less importance to food colour compared to the western region.** Generally, traders look for characteristics that buyers ask for when purchasing the banana bunches. **Women and men mention the same characteristics with minimal differences** in the proportions reporting certain characteristics and in the assigned rankings. More **women mention characteristics related to the preparation process** for example ease of peeling, thin peel and soft peel as they are mostly responsible for food preparation. Colour of the peel-shiny light green fruits, and sap content are also important attributes for women. **Farmers and traders of Matooke prefer local landraces because of their superior quality attributes compared with hybrids**. However, these landraces are susceptible to pests and diseases and their productivity is low. **Soft texture, good aroma, yellow colour, good Matooke taste and Matooke that holds together when mashed are generally important characteristics for Matooke end-users**. Indeed, varieties that lack these characteristics are often rejected. Characteristics that are not liked include; hard texture, too soft or watery Matooke, pale yellow colour and flat taste. Varieties with such characteristics are often rejected.

Activity 4 achievements – Processing diagnosis:

The objective activity 4 were to understand processors' demand for quality characteristics of the Matooke while processing Matooke bananas into steamed Matooke. The Matooke **processing unit operations were identified** as peeling, washing, wrapping in banana leaves, preparation of the saucepan by lining with trimmed pieces of the peduncle and leaves, steaming, pressing/mashing, simmering and serving. **Characteristics and sensory properties of the raw, intermediate and final Matooke product were assessed** and were also used in activity 5. The important characteristics of the raw Matooke were straight fingers or slightly curved fingers, big or medium fingers, medium and long fingers. **At peeling, the preferred characteristics were easy to peel, straight fingers or slightly curved, soft peel, soft pulp and low sap content. During washing, having low sap** was a preferred characteristic. During preparation of the pan, steaming mashing and simmering, no specific characteristic was mentioned.

Activity 5 achievements – Consumer testing:

The objective of this activity was to understand what good Matooke for local consumers is, which helps to understand the demand for quality characteristics in cooked Matooke bananas. The sensory and perception descriptors of Matooke that were made by processors in activity 4 and chosen for their very different sensory properties, were related to their acceptance by **256 consumers**. While tasting, the consumers selected the sensory and perception descriptors of steamed Matooke from among the list of descriptors collected during activities 3 and 4 above. Consumers were selected from rural and urban user segments.

The **consumer tests were conducted, data analysed and reporting completed**. The results indicated that **good Matooke should be deep yellow, not harden quickly when served, have a uniform and soft texture, feel smooth in the mouthfeel and hand, mouldable in hand and have a 'good Matooke smell/aroma' and taste**. The quality characteristics that the consumers do not like or that good Matooke should not have: hard texture, quick cooling and hardening, pale yellow colour, astringent taste.

4.2 WP2 – Matooke (Uganda)

NARL key contact for WP2 on Matooke in Uganda: K. NOWAKUNDA

20-30 lines Summary Narrative on Activities performed & Progress done including Proofs of Concept & Method development, writing of Standard Operating Procedures (SOPs), Sensory & Textural Profiling, Equipment purchase – Please make sure to mention Nb of analyses done & Nb of WP4 genotypes characterized for each of the sub-sections below. Refer to co-funding program(s) & Covid-19 impact on the implementation of institute activities (if any). NB: Sub-sections below can be increased or deleted if not relevant.

Under WP2, the Matooke team completed the **development of a standardised protocol for preparation of Matooke in the laboratory**. The team also **completed the protocols for sensory evaluation and texture analysis of steamed Matooke**. The team had developed the sensory lexicon for Matooke during period 2. During period 3, the team **focused on proof concept analyses for the selected traits-texture-instrumental penetration/compression, dry matter, total starch, amylose content, carotenoids, pasting properties and sensory profiles**. This data has been generated for **62 genotypes (covering the highly preferred landraces, intermediates and the less preferred)**. COVID-19, greatly affected progress at the laboratory mainly because the team was **unable to host a sensory panel** (12-15 members). **Since all physical, chemical, sensory and NIRS data is taken on the same samples, the whole operation was pended for about 4 months**.

Proofs of concept / Method development:

During period 3, NARL focused on **proof of concept analysis for texture using penetrometry and compression** (TMS Food testing system), **dry matter using the oven drying methods**, **pasting properties using a rapid viscosity analyser** and **colour using chromametry**. A total of 62 genotypes have been analysed (with 3 replicates).

SOP development for biochemical characterization:

At NARL laboratory, we are using routine procedures.

Sensory characterization & SOP development:

A sensory panel was recruited and trained during period 2 and is being used by all product profile teams (cassava, Matooke, potatoes/sweet potatoes) in Uganda. The team also developed a sensory SOP for Matooke in Period 2 which has already been uploaded on the RTBfoods platform. A total of **sixty-seven (67) Matooke genotypes** (ie 29 in period 2 and 38 in period 3) **from on-station breeding and evaluation fields at NARL-Kawanda and IITA-Sendusu** (including most preferred, medium and those not liked by consumers) **have been characterised though sensory panel.**

Textural characterization & SOP development:

Texture analysis using a TMS-Pilot Texture analyzer was been performed on 67 Matooke genotypes obtained from from on-station breeding and evaluation fields at NARL-Kawanda and IITA-Sendusu. The Cooked Matooke were analyzed for three textural parameters; instrumental hardness, cohesiveness, and adhesiveness. A SOP for texture assessment was developed in Period 2 and has already been uploaded on the RTBfoods platform. The **pasting characteristics** (peak viscosity, peak time, pasting temperature, breakdown, holding strength, set back, and final viscosity) **of 62 genotypes were also assessed at NaCRRI** (The samples from the remaining 5 were not enough for this analysis. They are very low yielding hybrids).

Biochemical routine analyses & WP2 data mngt:

Routine procedures used at NARL include: oven drying for **dry matter,** penetrometry for texture, **chromometery** - L.a.b for colour and sensory tools for taste. **Data is stored on one central computer, which is managed by Elizabeth Khakasa and Kenneth Akankwasa**. Data analysis is currently done using Excel Stat. The data will be collated and submitted to work package 2 coordinators and PMU at the end of period 4.

Others (e.g. equipment purchase):

No equipment was purchased during period 3. The team had **planned to purchase a rheometer to further characterize the texture of Matooke but due to COVID, the team was unable to liase with our counterparts at CIRAD** to facilitate the purchase, delivery and installation.

4.3 WP5 – Matooke (Uganda)

NARL key contact for WP5 on Matooke in Uganda: Kenneth AKANKWASA

15-20 lines Narrative on Activities performed (fieldwork, data analysis, report writing) by Activity including Challenges faced & Covid-19 impact (if relevant). Please mention co-funding program(s) (if any). NB: Sub-sections below can be increased or deleted if not relevant.

Four field trials (in four agro-ecologies of Uganda), each with **91 Matooke genotypes had been planted in previous periods**. Activities in Period 3 had planned to **focus on participatory selection of preferred genotypes for mass multiplication** on plant farmer-managed trials. It is at farmer-managed trials that genotypes for release are identified and submitted to the National variety release committee. Participatory selection methods involve participation of many farmers (consumers) in affective tests. The activities were therefore **greatly affected by COVID-19 situation**. Limited field activities have just started and will continue during period 4. **So far, 65 out of the 91 clones from the trials in Central Uganda (located on-station) have been assessed,** with **2 of them showing potential for acceptance**.

4.4 Interactions with other institutes working on Matooke

Brief Narrative on cross-institute interactions for Staff, Equipment, Protocols &/or Results share. Please mention the WP(s) in which these interactions take place. NB: Sub-sections below can be increased or deleted if not relevant.

Bioversity (Uganda):

NARL teams work with the Alliance CIAT/Bioversity teams on **mainly WP1 activities**. All the WP1 activities – planning, field surveys, data processing and writing of reports are **done jointly**. The teams also use the same sensory panel at NARL.

NaCRRI (Uganda):

NARL works with NaCRRI **on sensory profiling and physico-chemical analyses**. The sensory profiling work on boiled cassava is done at NARL while some of the physico-chemical analyses **including pasting properties on Matooke and NIRS** are done at NaCRRI by NARL and NaCRRI staff Note that the **biophysical data done at NaCCRI** (with exception of NIRS) **is handled by NARL staff and is stored at NARL**.

IITA (Uganda):

NARL works with IITA Uganda on Matooke sensory profiles and physico-chemical analyses. The IITA-Uganda breeding team also **avails some of the Matooke hybrids that are used at NARL to generate physico-chemical and sensory profiles**.

Others: CIP-Uganda:

NARL works with CIP on sweet potato sensory and physico-chemical analyses. A NARL scientist, **Edgar Tinyiro has been attached to CIP to assist with WP1 reporting. Sensory profiling of CIP sweetpotatoes is done at NARL.**

Main Conclusions from the Product Profile Inclusive Discussion (PPID) on Matooke organized in Period 3 (if any). Make sure to mention Date, Duration, Participants, Institutes & WPs represented.

NARL **hosted one online (15/05/2020) and one physical (12/10/2020) inter-work package discussions.** The participants included **IITA-Uganda, Bioversity International-Uganda, NARL and NaCRRI. All the work packages were represented.** The meetings were to (1) **discuss WP1 results** and plan publication of the results (2) **identify traits for dissection in laboratory** (3) **identity traits ready for use by WP4**. Four potential publications were identified (based on WP1 activity 3, 4 and 5), in addition to the one already published in special issue (**https://doi.org/10.1111/ijfs.14813**). On traits for dissection, the meetings **agreed on yellow colour, soft texture and taste** (using sensory methods) **as priority traits to be investigated**. It was also recommended that preferred matooke bunch characteristics such as **'big bunch' 'long fingers' should be quantified in metrics** (Kgs and cm) so that they can be used in hybrid phenotyping. **WP4 picked colour and texture for use in phenotyping** while waiting for the WP2 and WP3 to generate tools usable in the field (WP4 and WP5).

5 NARL CROSS-WP INTERACTIONS AT PRODUCT PROFILE LEVEL

Describe communication / coordination between WP1 & WP2 within your institute. Frequency of interactions? Any Roadblocks & Challenges?

The Matooke team in Uganda plans and **operates together.** Activity planning is coordinated at NARL via physical meetings, online meeting, emails and often telephone calls. Some members of WP2 participated in WP1 surveys and are participating in writing report. During period 3, WP1 and WP2 teams were in more **regular contact since the teams had to discuss and agree on the product profile and the traits for dissection**.

Is it planned to characterize at lab level (through WP2 sensory panel & other WP2 biophysical analyses) the varieties scored through hedonic tests within WP1 Activity 5 (Consumer testing)? Necessary step to be in capacity to determine target values of consumer acceptability on key quality characteristics.

For Matooke (Uganda), the **banana genotypes used for sensory profiling and biophysical analysis include all the genotypes used for WP1 activities 4 and 5**.

What is the laboratory sampling & codification strategy in practice to ensure that WP2 texture analyses, WP2 biochemical analyses & WP2 sensory profiling are performed on the same samples?

The team that is conducting all RTBfoods activities is one and operates together. At sampling time, the team divides itself into two (biophysical and sensory). **Sampling is, therefore done at the same**

time for all the analyses. However, NARL does not have NIRS equipment and transports samples to NaCRRI, 15KM away for NIRS.

Do you freeze dry or lyophilize sub-samples in the perspective of new methods coming in to characterize quality traits (based on WP1 findings)?

For Matooke, yes.

6 DATA MANAGEMENT & ONTOLOGY DEVELOPMENT AT NARL

NARL RTBfoods data manager: Elizabeth Khakasa

Coordination of Lab Data Management with NaCRRI: How do you coordinate data management & data sharing with NaCRRI to be in capacity to make correlations between parameters measured on the same genotypes and develop NIRS calibrations (within WP3).

Our planning and coordination ensure that **sensory, bio-physical and NIRS data are taken from the same samples**. I**n most cases, the same personnel are involved in the analyses at NARL and NaCRRI.** For analyses where different persons are involved, **data is recorded on tablets and shared.** Where laboratory books are used, data is computerised and shared by e-mail. **All the data is stored at NARL** and will be submitted to PMU and work package coordinators at the end of period 4. Analyses are done using Excel stat.

Ontology Development:

Vocabulary was developed for both descriptive sensory evaluation and for the 5 Point hedonic scale (affective testing).

Descriptive Sensory Evaluation:

The Matooke lexicon (appendix 1) was generated and descriptive terms used for sensory profiling of Cooked Matooke on a 5-point hedonic scale developed (appendix 2). **67 Matooke genotypes have characterised using the descriptive sensory evaluation tools as part of WP2** sensory profiling with a trained panel at NARL.

Summary brief on institute activities & level of progress in the development of ontologies for post-harvest quality traits. Make sure to list quality traits & RTB crop(s) or product(s) concerned and institute staff involved - Also mention partner collaborations/contributions within RTBfoods framework (if relevant).

The biophysical and biochemical traits for Matooke

1. **Biophysical attributes**

i) ***Bunch weight (kg)***

Bunch weight was determined by weighing individual bunches with a balance according to Dadzie and Orchad 1997.

ii) ***Fruit length (cm)***

Fruit length was determined according to Dadzie and Orchad 1997 by measuring the outer curve of individual fruit with a tape from the distal end to the point at the proximal end where the pulp was judged to terminate.

iii) ***Fruit girth or circumference (cm)***

Fruit girth or circumference was determined by measuring individual fruit with a tape at the widest midpoint of each fruit according to Dadzie and Orchad 1997.

iv) ***Peel and pulp colour***

The peel and pulp colour were measured using a Minolta chromameter (CR-100 or CR-200) with an 8 mm measuring head. The measuring head of the chromameter was placed on the fruit surface (peel surface) and 2 readings on each fruit surface were taken and the mean calculated. To measure pulp colour, the fruit was transversely cut at the midpoint and the measuring head placed at the centre or locule and a single reading was taken according to Dadzie and Orchad 1997. Colour measurements were recorded using Hunter L*, a* and b* scale.

v) ***Pulp firmness***

Pulp firmness of banana was determined as the force required to penetrate the 1 cm of pulp tissue with a 6 mm diameter cylindrical probe mounted on a bench-top firmness tester fitted with a 0-10 kg Salter electronic force gauge. The value recorded was the maximum force required for the pulp to yield to the tip of the probe and was reported in kilogram force (kgf).

2. Biochemical attributes

i) Total soluble solids

Was measured using a refractometer. 30 g of pulp tissue was blended in a kitchen blender in 90 ml distilled water for 2 min and filtered using a cheese cloth. A single drop of the filtrate was placed on the prism of a refractometer and the refractometer pointed towards a light source and the percentage total soluble solids read. The recorded value was multiplied by three because the initial pulp sample was diluted three times with distilled water.

ii) pH and total titratable acidity

pH values give a measure of the acidity or alkalinity of a product, while titratable acidity gives a measure of the amount of acid present.

Measurement of pH of pulp juice

pH of banana juice was measured as follows: 30 g of banana pulp was weighed into a kitchen blender and 90 ml of distilled water added and blended for 2 mins then filtered through a cheese cloth as described by Dadzie and Orchad 1997. A digital pH meter was placed in the filtrate and pH value of the filtrate recorded.

Measurement of total titratable acidity

Total titratable acidity of banana is measured as follows: 30 g of pulp tissue is weighed into a kitchen blender and 90 ml of distilled water added, then blended for 2 mins and filtered. 25 ml of the filtrate was transferred into a 125 ml conical flask and 25 ml of distilled water added. 4-5 drops of phenolphthalein indicator were then added. A 25 ml burette was filled with 0.1N sodium hydroxide (NaOH) and adjusted to the zero mark after eliminating the bubbles. It was then titrated with 0.1N sodium hydroxide until the indicator changed to pink/red and the titre

volume of NaOH recorded. The results were expressed (e.g. as milliequivalent per 100 g sample) in terms of the predominant acid present.

iii) Dry matter Content

The moisture content and dry matter contents of banana were measured as follows:

The empty container was weighed on a Mettler balance (A). Approximately 30-50 g of chopped fresh peel or pulp samples was added to the container and weight recorded (B). Samples were placed in a hot air oven at 100^0C for 24 hours. They were then transferred from the oven into a desiccator to allow cooling at room temperature. The samples were again weighed after drying (C). Percentage moisture and dry matter content of the sample are calculated as follows:

Wet weight of sample (D) = B - A

Weight of dry sample (E) = C - A

Moisture content (%) = D - E x 100

Dry matter content (%) = 100 - (% moisture content)

NARL team involved in ontology developed;

1. Khakasa Elizabeth, National Agricultural Research Laboratories, NARL, Uganda
2. Kisakye Sarah, National Agricultural Research Laboratories, NARL, Uganda
3. Aguti Gloria Grace, National Agricultural Research Laboratories, NARL, Uganda

They are all **part of the banana group stimulated by Bioversity**.

Collaborators

1. NaCRRI
2. CIRAD
3. Bioversity International

7 ETHICAL CLEARANCE

Describe process implemented in Uganda for ethical clearance of RTBfoods activities: responsible institute, institutions contacted & material provided (ex: methodological manuals), next steps.

Ethical approval in Uganda was finalized and reported during period 2.

8 NARL TRAVELS PARTICIPATION IN RTBFOODS MEETINGS AND INTERNATIONAL EVENTS ON RTBFOODS BUDGET

Fill-in the table below paying attention to the alignment with financial reporting (cf Excel spreadsheet 'TRAVEL COSTS').

	Title /Training objective	WP	City, Country	NAME(S) of Participants
RTBfoods meetings	RTBfoods Annual meeting	All	Kampala, Uganda	Elizabeth KHAKASA Mose MATOVU Kephas NOWAKUNDA Kenneth AKANKWASA Moureen ASASIRA
RTBfoods trainings				
International / Regional conferences				
Scientist exchanges				

9 NARL CAPITAL EQUIPMENT OR INVESTMENT (CO-INVESTMENT)

Synthetic list of equipment purchased on RTBfoods budget (ex: texturometer, RVA, pHmeter, etc.). Should be aligned with financial reporting (cf Excel spreadsheet 'EQUIPMENT COSTS')

No equipment was purchased during period 3

10 COMPLEMENTARY SOURCES OF SUPPORT FOR RTBFOODS ACTIVITIES

Synthesis on complementarity between RTBfoods & partner programs activities in Period 3 (e.g. NextGen, AfricaYam, BBB, SweetGAINS, CRP RTB, USAID, co-funding from Institute contribution, etc.).
Please, summarize complementarities, activities & WP(s) concerned.

RTBfoods at NARL received co-funding **from ABBB to procure tabs for the sensory laboratory**, **freezer and gas cooker for the lab kitchen.**

Summary on Main Conclusions from cross-program coordination meetings (if any). Make sure to mention Date, Duration and Participants.

RTBfoods/ABBB

No cross-programme meetings took place during period 3. A meeting between ABBB and RTBfoods is planned for Mid-March, 2021. However, the ABBB research teams at NARL and IITA work together. The two breeding programmes provide all the matooke genotypes used in RTBFoods experiments. The RTBFoods team also carries out sensory tests for acceptance of the ABBB generated hybrids.

11 NARL PUBLICATIONS

List of publications (attached with a DOI) published in RTBfoods framework (e.g. Journal Articles, Conference Communications, Manuals, Leaflets, Posters, etc.None

As part of RTBfoods mini scientific webinars, Kephas Nowakunda presented a **webinar on Matooke quality characteristics** learned from WP1 surveys and traits to be analyzed at laboratory level within WP2.

Focus on the institute contribution to the IJFST special issue: list of papers with staff participation in RTBfoods IJFST special issue: ***Consumers Have Their Say: Assessing Preferred Quality Traits of Roots, Tubers And Cooking Bananas, And Implications For Breeding.***

List of staff involved: *Kenneth Akankwasa, Robooni Tumuhimbise, Moreen Asasira, Elizabeth Khakasa, Innocent Mpirirwe, Kephas Nowakunda*

Kenneth Akankwasa, Pricilla Marimo, Robooni Tumuhimbise, Moreen Asasira, Elizabeth Khakasa, Innocent Mpirirwe, Uli Kleih, Lora Forsythe, Geneviève Fliedel, Dominique Dufour, Kephas Nowakunda. (2020). The East African highland cooking bananas 'Matooke' preferences of farmers and traders: Implications for variety development. International Journal of Food Science and Technology. **https://doi.org/10.1111/ijfs.14813**

Any challenges faced in the promotion of NARL work in RTBfoods framework through publication?

None

12 GAPS & CHALLENGES FACED AT NARL

Synthesis on the impact of Covid-19 on the implementation of RTBfoods activities in Period 3? Risks identified & coping strategy proposed in agreement with the focal point for RTBfoods & WP coordinators.

COVID-19 regulations required that no meetings of people exceeding 10 should be held. This **affected the implementation of sensory work**. Since sensory data, biophysical/chemical data and NIRS are recorded on same sample, this **implied that the whole laboratory operation had to be pended.** Delayed COVID also affected and **delayed the completion of WP1 and WP5 field activities**.

Other challenges faced in the implementation of RTBfoods activities in Period 3? Causes, risks identified & mitigation strategy proposed by the focal point for RTBfoods.

None

13 NARL PERSPECTIVE WORK PLAN & INTERNAL ORGANIZATION FOR PERIOD 4

Draft Roadmap with main activities planned at Institute level in Period 4 (all WPs included).

1. **Publishing results from WP1 activities 4 and 5**
2. **Optimise/share optimised SOPs** and methods with partners (including **pectin analysis, starch characterisation, polyphenols**)
3. Continue with bio-phemical analyses (**carotenoids, pectins, amylase/amylopectin's, total starch, pasting properties, water absorption, total polyphenols and dry matter**), **NIRS** and **Sensory** profiling
4. **Perform correlations between sensory and instrumental trait measurements** (including sensory texture & colour with instrumental texture & colour, carotenoids with sensory colour, starch, amylose/amylopectins, pasting properties, pectins with sensory texture)
5. **Participatory evaluation of the 91 genotypes** in the yield trials at four locations. The evaluations will include **farmers and extension workers.**
6. Conduct **inter work package meetings for Matooke** and other product profiles
7. **Submission of lab data** to PMU and WP2 coordinators

NB: There was limited field activities during Period 3 due to COVID -19. Most of the field operations under WP5 will be conducted during Period 4 and 5.

14 APPENDICES

14.1 Annex 1: Matooke lexicom

Type	Attributes	Definition	How to measure?	Scale
Appearance	Yellow	Color of the surface of the sample from light yellow to bright yellow	When you receive the sample, observe the surface and evaluate the intensity of the color and its homogeneity	0: very light yellow 10:bright yellow
	Homogeneity of colour	Uniformity of color of the surface of the sample		0 : heterogeneous 10 : homogeneous
Texture in mouth	Firmness	Mechanical textural attribute relating to the force required to achieve a given deformation, penetration, or breakage of a product.	Put a part of the sample in your mouth, evaluate during the first bite (between molars) how hard the sample is.	0: soft 5 : firm 10: hard
	Moisture	perception of moisture content of a food by the tactile receptors in the mouth and also in relation to the lubricating properties of the product	Put a part of the sample in the mouth, chew and evaluate the quantity of water within the sample.	0: Dry 10: Moist
	Smoothness	geometrical textural attribute relating to lack of presence of particles in a product	Put a part of the sample in mouth, chew it and after 5 chews, evaluate between tongue and palate the number and the size of the particles.	0: lumpy 5 : grainy 10: smooth
Texture by touch	Hardness	Mechanical textural attribute relating to the force required to achieve a given deformation, penetration, or breakage of a product.	Take a part of the sample between fingers and evaluate how hard the sample is	0: soft 5 : firm 10: hard
	Moldability	mechanical textural attribute relating to the degree to which a substance can be deformed before it breaks	try to make a ball (agglomerate) of the sample and evaluate how easy it is to deform or break the sample	0: crumbly 10: moldable
	Stickiness	mechanical textural attribute relating to the force required to remove material that sticks to the mouth	put a part of the sample between thumb and index fingers and using tapping motions, evaluate the amount of product adhering on them	0: non sticky 10: sticky
Taste	Sweetness	basic taste produced by dilute aqueous solutions of natural or artificial substances such as sucrose	Put a part of the sample in the mouth and evaluate the intensity of taste of sugar	0 : no intensity 5 : medium intensity 10 : high intensity

Type	Attributes	Definition	How to measure?	Scale
Impression	Astringency	complex sensation, accompanied by shrinking, drawing or puckering of the skin or mucosal surface in the mouth, produced by substances such as kaki tannins or sloe tannins	Put a part of the sample in the mouth and evaluate the intensity of astringency impression due to the sample	0 : low intensity 5 : medium intensity 10 : high intensity
	Sourness	gustatory complex sensation, generally due to presence of organic acids	Put a part of the sample in the mouth and evaluate the intensity of the sourness	0 : low intensity 5 : medium intensity 10 : high intensity
Aroma	Matooke	Aroma of the local Matooke	Put a part of the product and by retro-olfaction evaluate the presence and the intensity of this specific aromas	0 : no intensity 5 : medium intensity 10 : high intensity
	Pumpkin	Aroma of pumpkin		YES/NO
	Grassy	Aroma of fresh grass		YES/NO

14.2 Annex 2: Descriptive terms used for sensory profiling of Cooked Matooke on a 5-point scale

Descriptor	Definition	How to Measure
Colour	The degree of yellow colour intensity of the *Matooke*	Visually inspect sample surface
Homogeneity in colour	The degree of evenness of colour throughout the entire surface of sample	Visually inspect sample surface
Matooke aroma	The characteristic aroma of a local steamed *Matooke*	Place the warm sample under the nose and inhale
Texture by mouth	Mechanical textural attribute related to force required to achieve a given deformation, penetration, or breakage of a product	It is perceived by compressing the product between the teeth (solids) or between the tongue and palate (semisolids)
Texture by touch	Mechanical textural attribute related to cohesiveness and hardness and to the force necessary to break a product into crumbs or pieces	It is evaluated by suddenly placing the product between the thumb and the index finger
Taste	The sensation of flavour perceived in the mouth and throat on contact with a substance.	It is evaluated by the intensity of the *Matooke* taste or astringency on the tongue

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