Annual Report 2019

Addressing Micronutrient deficiencies in Sub-Saharan Africa through Musa-based food systems

Specific Information

1. Synopsis of Research Activity and Expected Results

Micronutrient deficiencies, especially vitamin A deficiency (VAD) remain a public health problem in Sub-Saharan Africa and in Eastern Africa, the prevalence of VAD significantly exceeds the WHO threshold point of 15%, with countries such as DR Congo (DRC) recording prevalence as high as 64% (IFPRI, 2016).

Among the numerous strategies that have been employed in the fight against VAD, reports indicate that food-based strategies are the most sustainable, especially among rural communities dependent on agriculture for both food and income. This project is defining the strategies and fast-track deployment mechanisms that will increase access to and consumption of high-micronutrient Musa-based foods for micronutrient-deficient populations in Sub-Saharan Africa focusing on Burundi, Eastern DRC, Uganda and Tanzania.

Currently 15 provitamin A rich banana cultivars of different sub-groups (plantain, East African Highland bananas, ABB cooking bananas, AA and AAA dessert bananas, Pacific plantains and AA cooking bananas) with above-average levels of pVACs (total beta-carotene equivalents of between 40-95 t-BC µg /gdw, giving a retinal activity equivalent (RAE) of more than 333 µg/100gdw) have undergome agronomic evaluation alongside local cultivars of the same sub-group for between 3-6 cycles. Following this some cultivars Apantu-AAB African plantain from Ghana, Bira-AAB Pacific plantain from Papua New Guinea, Pelipita-ABB plantain from the Phillipines, Lahi- AAB Pacifc plantain from Hawaii, Lai-AAA Desert from Thailand, Pisang papan-AAA Dessert from Indonesia and Muracho-AAB plantain from the Philipines, have demonstrated potential to perform well within Eastern Africa. All the 15 cultivars have also undergone sensory evaluation alongside local cultivars of similar sub-group. They have been evaluated following boiling, roasting, frying, steaming and ripe (dessert) and more than 500 farmer representatives have been involved in these evaluations. Findings indicate that 4 of the 15 tested cultivars (Apantu, Bira, Lai, pelipita, To'o,) are well accepted and their preference is not statistically different from that of local cultivars with acceptability scores ranging from good to very good (Ekesa et al, 2017a).

Following on the agronomic and sensory evaluation, In Eastern DRC and Burundi, farmers were involved in selection of their preferred cultivars and the selected varieties included Apantu, Bira, Pelipita, Lahi, Lai and To'o. Therefore since 2016 effort has been put in place to accelerate macropropagation activities to ensure enough planting material of the preferred banana, so far more than 17,000 high pVACs banana plantlets have been distributed directly to farmers by the project team and partners and farmer-to-farmer sharing of the banana planting material has also been reported. Through 497 community members have so far been trained as community own resource persons using TOT approach, more than 12,900 farmer households have been reached directly with information on sustainable utilization of the vitamin A bananas (VAB) in their farming and food system.

Through involvement of community members, nutritious recipes based on the provitamin A rich bananas have been developed, tasted using mother-child pairs and through collaboration with CIP-Nairobi, samples of the developed recipes, were tested to establish their full nutrition composition value. Findings indicated that the content of iron ranged between 4mg-5mg/100gep while that of provitamin A carotenoids ranged from 5µg to 69µg RAE/100gep. Therefore, consumption of just 200g of the dishes would contribute to more than 50% of the estimated average requirements for iron and between 4% and 65% of the vitamin A requirements for under-fives.

In 2019 the focus has been on continued agronomic evaluation, promotion of the developed recipes, training of community members on community level micropropagation to enable them continue to multiply and share the planting materials and institutionalizing of the vitamin A rich banana cultivars to have them as part

of the national germplasm collection for continued and sustainable conservation and future use in research and development. Currently, in NARO-Uganda, TARI-Tanzania and ISABU-Burundi, the vitamin A tich bananas are already being integrated into the national banana germplasm collections. In DRC the process will happen early 2020.

III. Schedule of Deliverables/Payments and Tasks

1. Schedule of Payments

1.1 Schedule of Payments	**Completion Date**	**Amount (USD)**
- Upon acceptance of signed contract	Not Applicable (N/A)	
- Upon receipt of Progress Report (including financial report)	30 June 2019	
- Upon receipt of Final Report (including financial report)	31 December, 2019	
	TOTAL:	

1.2 Schedule of Tasks

Tasks	**Estimated Completion Date**	**Amount (USD)**
Task 1: G x E Testing (Agronomic evaluation, institutionalizing trials)	31 December 2019	**1,510**
Task 2: Capacity building & awareness creation	31 December 2019	**31,610**
Task 3: Multiplication & Distribution of *Musa* planting material	31 December 2019	**7,410**
	TOTAL:	**90,530**

2. Scope of Activities

Goal: To improve the nutrition status of micronutrient-deficient populations in Sub-Saharan Africa, with particular focus on vitamin A status.

Purpose: To enhance the availability of and access to banana-based foods that are rich in pro-vitamin A carotenoids (pVACs) and to promote production methodologies that are accessible and attractive to small-scale farmers and their communities.

To achieve these goals, the following activities will be carried out in 2019:

2.1. Task 1: G x E Testing: Agronomic evaluation and institutionalizing of high-pVAC fast-track *Musa* cultivars through NARs

(= H+ IP / BMGF Activity 8 – Release Biofortified Crops in Target Countries; 8.1 – Fast-Track Varieties Identified)

Task description and main milestones	Participating Institutions
Status An assessment of the agronomic performance, consumer acceptance, potential impact and feasibility of fast-tracking pVAC-rich cultivars of three different subgroups (plantain, EAHB, ABB cooking banana) began in 2010 following establishment of trials in DRC (South Kivu and North Kivu) and Burundi. The approach was based on the results of large-scale screening activities undertaken from 2005-2008 that showed there is a high degree of genetic variability in the fruit pVACs content of *Musa* cultivars, which could be used in breeding programmes (Garming and Ekesa, 2008). However, *Musa* breeding is difficult and time-consuming, and the direct introduction or 'fast-tracking' of existing pVAC-rich cultivars can offer substantial savings in terms of cost and time. Results of an ex-ante impact assessment (Garming and Ekesa, 2008) indicate that fast-tracking can lead to a 9.6-17.1% reduction in the burden of vitamin A deficiency (VAD)-related illness in three African countries, Ghana, Rwanda and Uganda, and is more cost effective than other health-nutrition interventions. In 2009, 11 cultivars of different subgroups with higher-than-average fruit pVAC levels were selected for fast-tracking, and their information on agro-climatic requirements, production characteristics, pest and disease tolerance and yields was compiled. In 2010, these cultivars were ordered from Bioversity's International Transit Centre (ITC) for *Musa* germplasm, in Leuven (Belgium) and sent to Phytolabu in Burundi for further multiplication up to the required number of plantlets for evaluation in several sites in North and South Kivu in DRC and in Burundi. The eight sites are located in different agro-ecological zones (different altitudes, slope gradient etc.) with contrasting soils (fertility) and rainfall, and all have active field organizations. Field planting was completed early in 2011 at two sites in Burundi, and at three sites each in North and South Kivu (DRC). The trials are evaluated for agronomic performance every six months and the first mature fruit bunches were harvested in June 2012. Agronomic evaluations show that 5 of the 11 cultivars (Apantu, Lahi, Lai, Bira and Pelipita) displayed good agronomic performance over all the sites, with bunches above 10 kg. In terms of disease tolerance/resistance, the cultivar Apantu (plantain) has persistent male bracts and flowers, which make it an ideal cultivar to prevent insect vector transmission of Banana Xanthomonas Wilt-BXW (more details can be found in the Bioversity International HarvestPlus Annual Report of 2012 and 2013). Sensory and organoleptic tests were also conducted in 2012 and 2013 and results showed that four of the cultivars ('Apantu', 'Lahi', 'Bira' and 'To'o') are organoleptically acceptable. Generally, the overall acceptability scores for the cultivars ranged from 3 to 4 (neither good nor bad to good) on a 1-5 Likert scale. No statistically significant differences were observed between the mean overall acceptance scores of the local cultivars and those for the cultivars on trial: Apantu and Lahi in Burundi and North Kivu; Bira	Bioversity, Agricultural Research Institute-MARUKU (Tanzania), National Agricultural Research Institute NARO (Uganda). INERA-South Kivu DRC, ISABU-Burundi, KALRO-Kenya.

in South Kivu; and the dessert To'o in Burundi. These all had mean scores of 4 (good) (more details can be found in the Bioversity International HarvestPlus Annual Report 2013).

In 2013, samples of the banana cultivars under agronomic evaluation were collected when the fruit was unripe and ripe, and taken to Katholieke Universiteit Leuven for analysis. Findings indicated that the mean total pVACs ranged from 32.42- 198.09 nmol/gfw (1740.16 - 10632.79 µg/100 gfw) with Bungaoisan having the lowest value and Bira recording the highest. All cultivars showed a significant increase in their total carotenoid content from stage 1 to stage 5 of ripening. Daily consumption of 100 g of ripe Lahi, Apantu, Bira, To'o, Sepi and Hung'tu fruit by a child aged 1-5 years would meet >100 % of their Daily Recommended Intake (DRI) of 400 µg Retinol Activity Equivalent (RAE), while consumption of 100 g of Lahi, Apantu, Bira and Sepi by an adult woman would meet >90% of their DRI of 700 µg RAE (more details can be in a published article at https://www.sciencedirect.com/science/journal/08891575/43). In 2014, the same cultivars were heat processed using local methods (boiling, steaming, frying and roasting), the samples were freeze-dried and, together with unprocessed reference samples, sent to the University of Natural Resources and Life Sciences – BOKU Austria for analysis of pVAC retention following processing. Where higher levels were observed from the fried samples, as compared to other processing methods, lowest levels were observed in boiled samples and this could be due to loss in water and longer boiling times and temperatures.

In 2015, 2016, 2017 and 2018, agronomic evaluation of the cultivars continued for the 3rd 4th cycles in Burundi and South Kivu DRC understandardise trials and these trials included an additional 3 vitamin A rich banana cultivars (Muracho, Tudlo Tumbaga, and Pisang Papan) following obtaining them from ITC and carrying out tissue culture multiplication as per standards. The continued agronomic evaluation especially in 2017 and 2018 put in more emphasis on susceptibility to disease and yield across agroecological zones. Agronomic evaluations between 2015 and 2018 confirm results from 2012 and 2013, showing that in Burundi and DRC, 5 of the 11 cultivars; Apantu, Bira, Lahi, Lai and Pelipita continue to display good agronomic performance over all the sites and yielded relatively the heaviest bunches above 12 kg. Although To'o does not produce a big bunch (3-6 kg), it has high ability of suckering and its cycle is shorter. Disease tolerance/ resistance confirms the preliminary findings indicate that the cultivar Apantu (plantain) has maintained its persistent male bracts and flowers, making it an ideal cultivar to prevent insect vector transmission of BXW although it has very low suckering ability. More data is still being collected to evaluate resistance to disease and farmers are being informed on adhering to the known procedures for preventing disease occurrence and spread (more details can be found in the Bioversity International HarvestPlus Annual Report of 2018).

In 2017, In Tanzania and Uganda the standard trials were established and agronomic evaluation of 9 cultivars including the additional three vitamin A rich bananas (Muracho, Tudlo Tumbaga, Pisang papan). Current findings show that some of the cultivars with heaview bunches >14kg include Lahi, Apantu, Pisand papan and Muracho. Toó remains as one with the smallest

bunch. Pelipita, Bira and Toó have high suckering level whilw Apantu has lowest suckerine ability.

In 2018, sensory evaluation took place at all the sites where in Brundi and Tanzania it only involved the 3 additional cultivars (Muracho, Tudlo Tumbaga, Pisang papan) alongside local varieties. While in Uganda and Tanzania 5 and 6 vitamin A rich banana cultivars were evaluated respectively alongside at least 3 local varieties of similar genomic group. The data for 2018 sensory evaluation is still being compiled.

Based on the above status and the need to ensure that these bananas are accessible to more farmers within east Africa, the 2019 milestones have been defined as follows:

Milestones 2019

- Continued assessment of agronomic performance of the preferred cultivars to assess performance in subsequent cycles
- Institutionalization of the VAB trials to ensure they are included in NARs (TARI, NARO, INERA. ISABU) banana germplasm trials for conservation and continued evaluation
- Finalizing analysis and reporting on sensory evaluation work carried out in 2018
- Introduction of at least 6 vitamin A rich banana cultivars (with observed higher agronomic and food characteristics) into the germplasm trials in Kenya through KALRO-Kisii

Description of Deliverables

1. Agronomic data collected (at 6 months after planting, at flowering and at harvest) and reports submitted.

   Information for the following agronomic variables will be collected: height of pseudostem (cm), girth of pseudostem at base (cm), girth of pseudostem at 100 cm, number of functional leaves, number of dead leaves, number of suckers, and any additional observations.

   Information for the following variables will be collected to assess pests and diseases:

   - Sigatoka - Youngest leaf with >10 necrotic spots;
   - Fusarium - Yellowing of foliage, splitting of pseudostem base, petiole collapse;
   - Banana *Xanthomonas* wilt (BXW) - Yellowing of leaves, drying rot and blackening of male bud bracts and rachis;
   - Banana bunchy top virus (BBTV) - Rosetting, presence of black aphid;
   - Nematodes - Plant toppling, Functional roots, Dead roots, Root necrosis index (%);
   - Weevils - Plant snapping, UXO, UXI, LXO, LXI;
   - Additional observations

   The following bunch characteristics will be recorded: weight of bunch (kg), number of hands in bunch, total number of fruits, number of fruits in lower row of second lowest hand, fruits total fresh weight, additional observations.

   The following fruit characteristics will be measured: fresh weight of fruit (g), fruit length (cm), fruit circumference (cm), fresh peel weight (g), peel thickness (mm), pulp firmness, total soluble

solids, pH, total titrable acidity, starch content, fresh weight of pulp (g), lyophilized dry weight of pulp (g), pulp color, total carotenoids, t-AC, t-BC, c-C, lutein, additional observations.

With the 15 replicates per cultivar at each trial the results will be compared across agroecological zones to assess differences and similarities.

2. Through collaboration with the NARS and to ensure continuity of the work and sustainability, the resources at the NARS (NARO-Uganda, TARI-Tanzania, INERA-DRC, ISABU-Burundi) will be reviewed and measures put in place to institutionalize the trials we have in these countries for conservation and continued evaluation.
3. Through meetings with KALRO Kisii, the feasible vitamin A banana cultivars will be discussed and processes of bringing them to Kenya agreed on (this will be facilitated by the Bioversity team at the International transit center in Belgium). KALRO =Kenya will then be responsible for multiplying the materials and ensuring the materials is in their banana germplasm for conservation and continued evaluation.

Annual Report:
Task 1: G x E Testing: Agronomic evaluation and institutionalizing of high-pVAC fast-track Musa cultivars through NARs

i) Status (Complete / In development / Incomplete)

In Development

ii) Outputs

1. Agronomic evaluation of vitamin A banana (VAB) cultivars

Agronomic evaluation of the VAB continued in 2019 in Burundi, South Kivu-DRC, Tanzania and Uganda. The nine VAB cultivars under evaluation are Apantu, Bira, Lahi, Pelipita, Muracho, Lai, Pisang Papan, Tudlo Tumbaga, and To'o and they are assessed alongside reference local cultivars specific to the sites.

The standard agronomic trials in Burundi were set up in January 2016 with the reference local cultivars Igisahira, Umuzuzu, and Kamaramasenge. Burundi has 2 sites, in Gitega at an altitude of 1504m and in Cibitoke at 925m. The standard agronomic trials in South Kivu, DRC were set up in March 2016 with the reference local cultivars Barhabesha, Musheba, and Gros Michel. South Kivu has 2 sites, in Inera at an altitude of 1707m and in Burhale at 1647m.

Tanzania has 2 agronomic trial sites, in Maruku at an altitude of 1313m and Misenyi at 1220m with the reference local cultivars Nyoya, Nshakara and Nshasha. The trial in Maruku was set up in November 2016 while the ttrial in Missenyi was set up in October 2017. The standard agronomic trials in Uganda were set up in November 2016 with the reference local cultivars Mbwazirume, Gonja, and Sukali Ndizi. Uganda has 1 site in Mukono at an altitude of 1151m.

a) At flowering

At flowering, data on plant height, number of suckers removed, plant girth at base level and at 1m level, number of functional leaves, dead leaves and date of flowering was collected. Significant results are described below, while all the averages are presented in the appendix.

Uganda had the tallest VAB cultivars with Pisang Papan and Bira >400cm, followed by Cibitoke and Inera (figure 1). Maruku and Gitega had the shortest cultivars <330cm. The tallest VAB across all sites were Muracho (307-386cm), Lai (289-383cm), Pisang Papan (265-403cm), Pelipita (281-369cm), Bira (270-512cm), and Lai (289-383cm). To'o was the shortest cultivar in all sites ≤280 cm.

Missenyi and Inera had cultivars with the highest plant girth at 1m level. The plant girth in these sites for all VAB except To'o was >50cm. On the other hand, Gitega and Burhale had the smallest plant girth with all cultivars with all cultivars <55cm. To'o had the smallest girth across all sites.

Across all VAB cultivars and sites, the average number of functional leaves ranged from 7 to 13 leaves, where the minimum of 7 functional leaves was for Apantu in Maruku, Inera and Burhale. The maximum number of functional leaves was 12 leaves for Lai in Uganda and 13 leaves for Muracho in Inera. The number of dead leaves ranged from 1 to 5 leaves across VAB cultivars and sites with 1 dead leaf for Muracho in Gitega and Cibitoke and Apantu and Lai in Uganda to 4 dead leaves for Pisang Papan in Burhale and 5 leaves for Bira and To'o in Inera. Growth at flowering varied across sites and cultivars and is a reflection of the differences in agroecological zone, climate, rainfall and soils in the different sites and the different cultivars.

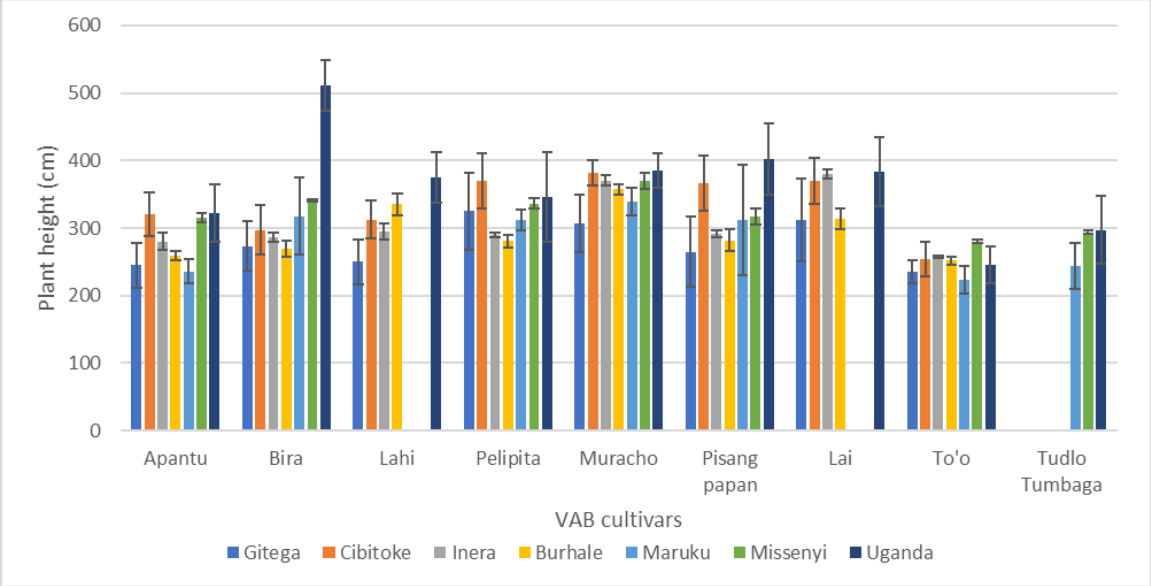

Figure 1 Average plant height (cm) of VAB in different sites

The plant height and plant girth at 1m level at flowering of VAB and local cultivars, and across cycles is summarized for each site below (table 1). Data for other attributes at flowering is presented in the appendix.

In Burundi, plant height and plant girth at 1m level was higher in Cibitoke compared to Gitega. In Gitega, plant height ranged from 235cm for To'o to 325cm for Pelipita while in Cibitoke, plant height ranged from 254cm for To'o to 381 for Muracho (table 1). All cultivars had a similar trend in plant height in both sites. Pelipita, Pisang Papan, and local cultivar Igisahira showed an increase in height after the 1st cycle while the height of Muracho, To'o, Kamaramasenge, Umuzuzu, remained consistent across cycles. In Cibiotke, plant girth ranged from To'o at 35cm to Pisang Papan at 61cm and Muracho at 64cm, while in Gitega

plant girth ranged from To'o at 27cm to Muracho at 50cm and Lai at 55cm. Average data for Burundi sites at flowering is presented in appendix 1.

In South Kivu, plant height and plant girth at 1m level were generally higher in Inera compared to Burhale. Plant height was higher in Inera except for Lahi and local cultivar Gros Michel. In Inera, Muracho and Lai were the tallest cultivars >370cm while in Burhale, Muracho and Lahi were the tallest at 357 and 335cm respectively. To'o was the shortest cultivar in both sites at 252-257cm. A similar trend was observed between plant height of different cycles in Inera and Burhale except for Lahi, Pelipita and Pisang Papan. Lai and local Barhebesha had similar plant height across cycles while Bira and local cultivar Musheba showed a decrease in plant height after 1st cycle that levelled off. Apantu, To'o and local cultivar Gros Michel showed an increase in plant height followed by a reduction in 3rd or 4th cycle, while Lahi and Muracho had a decrease in plant height with each subsequent cycle. In Inera, plant girth ranged from To'o at 37cm to Gros Michel at 66cm. Inera had 6 cultivars with plant girth >60cm. Burhale had plant girth ranging from To'o at 35cm to Lai at 55cm and Gros Michel at 53cm. Average data for South Kivu sites at flowering is presented in appendix 2.

In Tanzania, plant height and plant girth at 1m level were higher in Missenyi compared to Maruku. In both sites, To'o was the shortest cultivar at 280cm in Missenyi and 223cm in Maruku, while Muracho was the tallest cultivar at 370cm in Missenyi and 339cm in Maruku. A similar trend was observed between plant height of different cycles in Maruku and Missenyi where an increase plant height was observed with each cycle in all cultivars except Muracho, Pisang Papan and local cultiva Nshasha in Missenyi. In Missenyi, plant girth ranged from To'o at 49cm to Bira at 65cm and local cultivar Nshakara at 62cm. Maruku had plant girth ranging from To'o at 43cm to Pisang Papan and Muracho both at 63cm. Average data for Tanzania sites at flowering is presented in appendix 3.

In Uganda, the plant height of all cultivars ranged from 246cm for To'o to 512cm for Bira. The plant height of local cultivars ranged from 280-347cm. With subsequent cycles, the plant height of all cultivars increased except for Bira and To'o that showed a decrease in height after the 2nd cycle. Plant girth at 1m level ranged from To'o at 38cm to Muracho and Lai at 66cm. Average data for Uganda at flowering is presented in appendix 4.

b) At harvest

At harvest, data on bunch weight, number of hands, total number of fruits, number of fruits and weight of a hand, length and girth of a fruit, and date of harvest was collected. Significant results are described below, while all the averages are presented in the appendix.

The heaviest bunches were in Missenyi-Tanzania with 4 VAB cultivars >20kg. All sites except Gitega had VAB bunches >10kg apart from To'o (figure 2). To'o had the small bunches across all sites. Muracho (7-24kg), Apantu (6-20kg) and Pelipita (5-20kg) had the heaviest bunches across all sites. Other cultivars had bunch weights as follows Pisang Papan (5-24kg), Lahi (2-19kg), Lai (5-16kg), and Bira (5-14kg). A VAB was the heaviest bunch in 3 sites, Cibitoke, Missenyi and Uganda.

Pisang Papan and Lahi had the highest number of hands on a bunch across sites. Pisang Papan had an average of 11 hands in Cibitoke, Maruku and Missenyi, while Lahi had 8-9 hands in Uganda, Cibitoke, Inera and Burhale. To'o had the fewest number of hands and fewest number of fruits on a bunch across all sites. The number of hands for To'o ranged from 2 in Gitega to 6 in Maruku and the number of fruits on a bunch ranged from 15 fruits in

Gitega to 48 in Missenyi.

To'o and Tudlo Tumbaga had the shortest time period between flowering and harvest with To'o taking a minimum of 59 days in Uganda and a maximum of 101 days in Burhale (101 days was the shortest maturation period in Burhale across cultivars). Tudlo Tumbaga took 66 days in Uganda and 98 days in Maruku. On the other hand, Muracho and Lai had the longest time period between flowering and harvest. Muracho took a minimum of 136 days in Inera between flowering and harvest to a maximum of 177 days in Maruku. Lai took a minimum of 76 days in Uganda between flowering and harvest to a maximum of 165 days in Inera. The performance of the different cultivars varied across the sites and was a function of the agroecological zone, climate, soils, and banana pest and disease pressure in the sites.

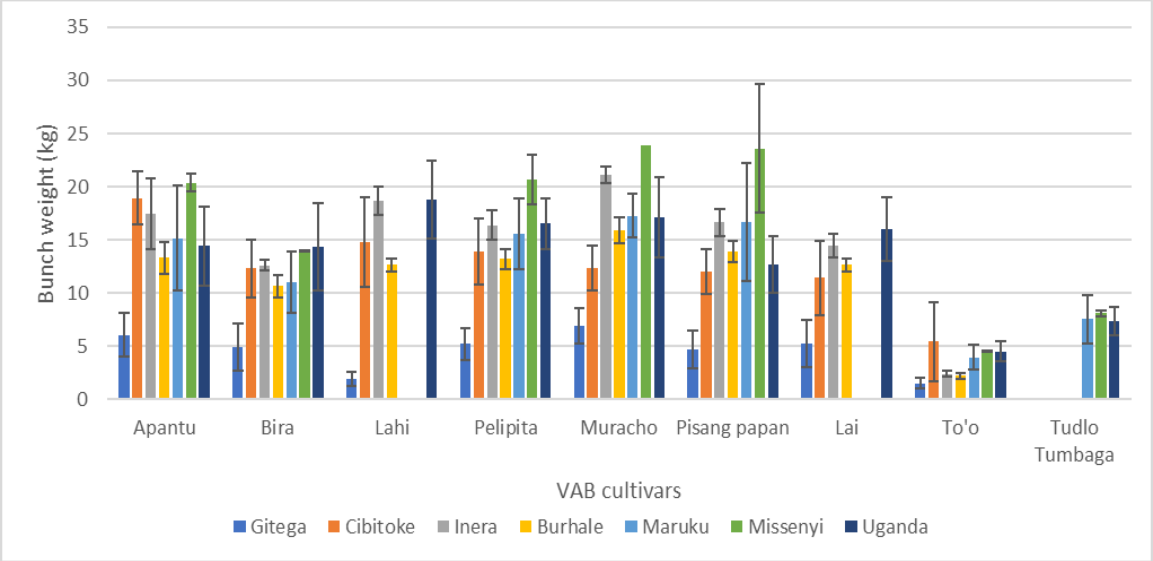

Figure 2 Average bunch weights of VAB cultivars in different sites

The bunch weights and cycle lengths of VAB and local cultivars, and across cycles are summarized for each site below (table 1). Data for other attributes at harvest is presented in the appendix.

In Burundi, Cibitoke had heavier bunches compared to Gitega for all cultivars. In Cibitoke, To'o and local Igisahira had the smallest bunches <10kg, while Lahi and Apantu had the heaviest bunches ≥15kg. In Gitega, To'o and Lahi had the smallest bunches <4kg, while Apantu, Muracho, and local cultivars Igisahira and Umuzuzu had bunches of 6-7kg. Cultivars in Cibitoke are growing at a faster rate compared to Gitega. In Cibitoke, 5 cultivars, Bira, Lahi, Pelipita, Pisang Papan and To'o have plants that are already in the 4th cycle. To'o, Bira and Pisang Papan had the shortest time between flowering and harvest <80 days while Pelipia and Muracho had the longest time between flowering and harvest >130 days. In Gitega, Muracho is still in the 1st cycle, while Apantu and Lai are in the 2nd cycle. Other cultivars are in the 3rd or 4th cycles. To'o and Lahi had the shortest time between flowering and harvest <70 days, while Lai, Muracho and local cultivar Kamaramasenge had the longest time between flowering and harvest of 140-164 days. In Cibitoke, 3 trends of bunch weight were observed across cycles. For Apantu, Bira, To'o, Lahi, Lai and local cultivar Kamaramasenge, bunch weight reduced after the 1st cycle. Muracho, Pisang Papan, and local cultivar Umuzuzu

had similar bunch weight across cycles, while for Igisahira bunch weight increased from 1st cycle and then reduced after the 2nd cycle. In Gitega, Apantu, Pisang Papan, Lai, and local cultivars Igisahira and Kamaramasenge showed an increase in bunch weight after the 1st cycle. The bunch weight of Umuzuzu on the other hand reduced while that of Pelipita remained the same. Average data for Burundi sites at harvest is presented in appendix 1.

In South Kivu, Inera had heavier bunches compared to Burhale. The local cultivars Gros Michel, Barhebesha, and Musheba, and Muracho had the heaviest bunches >20kg in Inera and >15kg in Burhale. To'o had the smallest bunches <5kg in both sites. Growth of cultivars was similar in the two sites where all cultivars except Muracho are in the 4th cycle. Muracho in Burhale is still in the 3rd cycle. In both sites To'o and Bira had the shortest time between flowering and harvest of <120 days while Pelipita and Lai had the longest time between flowering and harvest >155 days, as well as Gros Michel in Inera. Across cycles, a similar trend was observed between bunch weight of different cycles in Inera and Burhale except for Lahi and Pelipita. Aside from Bira and To'o that had similar bunch weights across cycles, all cultivars showed an increase in bunch weight until the 3rd cycle and a decrease in the 4th cycle. Average data for South Kivu sites at harvest is presented in appendix 2.

In Tanzania, bunch weights were higher in Missenyi compared to Maruku. In Missenyi, bunch weights ranged from 4kg for To'o to 17-18kg for Pisang Papan, Muracho and local cultivar Nshakara. In Maruku, bunch weights ranged from 5kg for To'o to >20kg for Pelipita, Pisang Papan, Muracho and local cultivar Nshakara. To'o had the shortest time between flowering and harvest in both sites at 81 days in Maruku and 69 days in Missenyi. Cultivars with the longest time between flowering and harvest in Maruku were Muracho and local cultivar Nshakara at >170 days while in Missenyi it was Muracho at 145 days. The trial in Maruku was planted before that in Missenyi and a result, the cultivars in Maruku are in their 3rd cycle while those in Missenyi are in the 2nd cycle except Muracho that is still in the 1st cycle. Between the 2 sites, cultivars showed some differences across cycles where by in Maruku, all cultivars showed an increase in bunch weight with each subsequent cycle except Apantu, Pelipita and local cultivar Nshasha that showed a decrease in bunch weight after the 2nd cycle and To'o whoe bunch weight remained the same across cycles. In Missenyi, Apantu, Pelipita, Pisang Papan and local cultivar Nshasha showed an increase in bunch weight while, Bira, To'o, Tudlo Tumbaga and local cultivar Nyoyo had similar bunch weights in the 1st and 2nd cycle. Average data for Tanzania sites at harvest is presented in appendix 3.

In Uganda, Lahi, Muracho, Pelipita and local cultivar Gonja had the heaviest bunches of 17-19kg while To'o had the smallest bunches of 5kg. All cultivars are in the 3rd or 4th cycle except Muracho, Apantu, Lahi, Lai, Gonja and Pelipita that are still in the 2nd cycle. No cultivar had completed the 3rd cycle at the time of reporting. To'o and Tudlo Tumbaga had the shortest time between flowering and harvest <70 days while Pelipita and local cultivar Gonja had the longest time between flowering and harvest >160 days. The bunch weight of Pisang Papan, and local Mbwazirume increased each cycle, while that of Bira and Lahi increased after the 1st cycle and reduced at the 3rd cycle. Bunch weights for Apantu and Muracho reduced after 1st cycle while for To,o, Tudlo Tumbaga, and local cultivars Gonja, Sukali Ndizi bunch weights did not differ across cycles. Average data for Uganda at harvest is presented in appendix 4.

Table 1 VAB growth and harvest attributes in different sites

	Site	Apantu	Bira	Lahi [a]	Pelipita	Muracho	Pisang papan	Lai [a]	To'o	Tudlo Tumbaga [b]
Number of cycles	Gitega	2	3	4	4	1	4	2	4	
	Cibitoke	3	4	2	4	3	4	3	4	
	Inera	4	4	4	4	4	4	4	4	
	Burhale	4	4	4	4	3	4	4	4	
	Maruku	3	3		3	3	3		3	3
	Missenyi	2	2		2	2	1		2	2
	Uganda	2	3	2	2	2	3	2	3	3
Average plant height	Gitega	245.3	273.2	250.3	325.3	306.5	264.8	311.5	234.7	
	Cibitoke	320.1	297.3	312.7	369.3	381.4	366.3	370	254.2	
	Inera	280.1	285.8	294.9	289.4	370.6	291.9	379.7	257.2	
	Burhale	259.0	269.8	335.1	280.9	357.4	282.1	313.9	252.1	
	Maruku	236.0	317.3		311.8	339.1	311.9		222.7	243.9
	Missenyi	315.0	340.5		336.3	370.4	317.0		280.0	294.0
	Uganda	322.1	511.5	375.1	346.3	385.5	402.5	383.2	245.5	296.9
Total number of bunches	Gitega	12	26	23	40	5	29	8	18	
	Cibitoke	15	30	12	36	20	34	12	21	
	Inera	40	43	35	38	12	47	28	49	
	Burhale	35	41	34	38	9	42	31	44	
	Maruku	40	45		45	43	45		45	42
	Missenyi	27	28		29	30	30		30	27
	Uganda	14.0	28.0	23.0	27.0	15.0	8.0	37.0	36.0	33.0
Average bunch weight (kg)	Gitega	6.02	4.9	1.9	5.2	6.9	4.7	5.2	1.5	
	Cibitoke	18.9	12.3	14.8	13.9	12.3	12	11.4	5.4	
	Inera	17.4	12.6	18.7	16.4	21.1	16.6	14.5	2.3	
	Burhale	13.3	10.6	12.7	13.2	15.9	13.9	12.6	2.2	
	Maruku	15.1	11.0		15.6	17.2	16.6		3.9	7.5
	Missenyi	20.4	13.9		20.7	23.9	23.6		4.5	8.1
	Uganda	14.4	14.4	18.8	16.5	17.1	12.7	16.0	4.5	7.4
Average time from flowering to harvest (days)	Gitega	117	71.7	66.8	137.1	163.2	86.8	144.3	66.9	
	Cibitoke	88.8	75.9	86.9	132.6	142.7	76.2	109.2	64.2	
	Inera	135.5	117.9	141.4	157.1	135.7	126.5	164.8	100.8	
	Burhale	148.5	113.6	143.7	156.5	152.2	134.2	157.6	101.3	
	Maruku	113.3	90.0		143.7	177.3	89.8		80.5	96.7
	Missenyi	114.3	87.0		108.4	145.3	78.3		69.3	78.1
	Uganda	135.00	70.56	119.65	163.85	139.73	136.50	75.76	58.92	65.70

[a] Cultivars were replanted in Maruku and Missenyi after materials in the mother garden were destroyed by storm prior to trial establishment; [b] Data not available for Burundi and South Kivu due to loss of planting material during multiplication and transport

c) Pests and diseases

To assess pests and diseases, data on root necrosis, sigatoka, fusarium, weevils, number of functional and dead roots, and any other disease was collected. Significant results are described below, while all the averages are presented in the appendix.

Root necrosis from nematode infestation was observed in all sites and all VAB. Inera had the highest incidence >20% followed by Burhale with 8-12% and Maruku with 5% to 20%. Across the 3 sites with the highest incidence, Pelipita, Pisang Papan and Bira were most affected. All other sites had <7% root necrosis in the VAB (figure 3).

Weevils were observed in Uganda, Tanzania and in Gitega. Gitega had only 2 cultivars with <0.5% infestation while infestation in Uganda ranged from 5% in Muracho to >10% in Apantu, Bira and Lahi. In Tanzania, weevils were noted in all cultivars and infestation in Maruku from 0.4% in Tudlo Tumbaga to 10% in Apantu while in Missenyi, infestation ranged from 0.6% in Tudlo Tumbaga to 5% in local cultivar Nshakara.

Sigatoka was noted in all VAB in all sites except Gitega. Cibitoke had the highest incidence because the leaf position with >10 necrotic spots was <4. Lahi and Pelipita had the lowest leaf position of 1. All other sites had leaf positions of all cultivars ranging from 4-7. Fusarium was noted only in Uganda in only 3 cultivars, Apantu, Lahi and Lai.

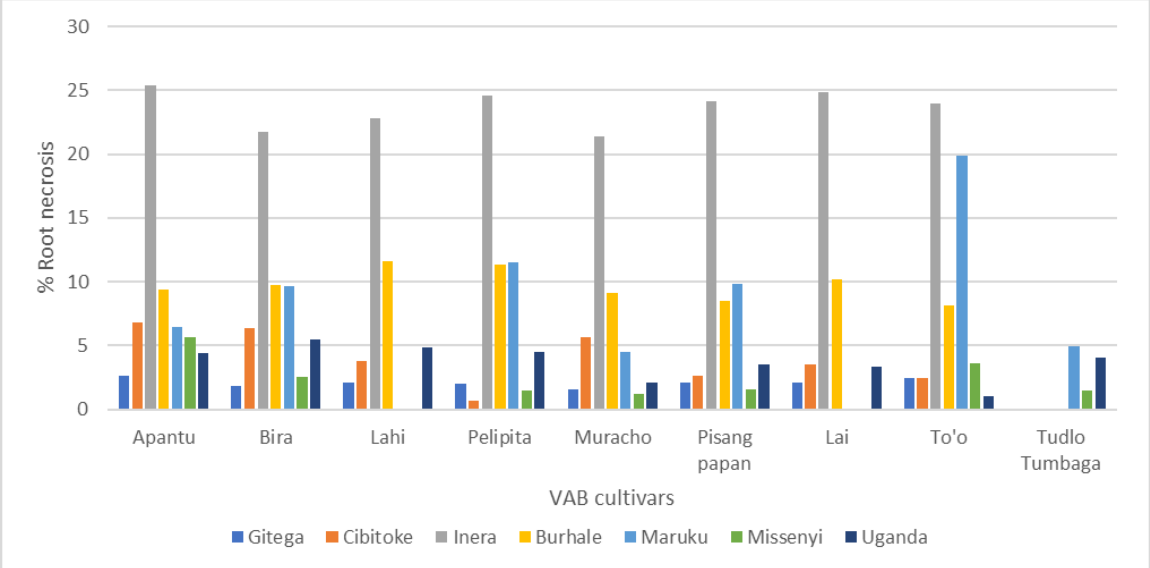

Figure 3. Average root necrosis incidence in VAB cultivars in different sites

Pest and disease incidence of VAB and local cultivars, and across cycles is summarized for each site below.

In Burundi, weevils were observed in 5 cultivars in Gitega and in 1 cultivar in Cibitoke all at <1% infestation. Sigatoka was noted only in Cibitoke in all cultivars with the position of leaves with >10 necrotic spots ranging from 0.4 in Lahi to 5-6 in local cultivars Kamaramasenge and Umuzuzu. Root necrosis was higher Cibitoke compared to Gitega with 2-3% root necrosis in Gitega. While in Cibitoke root necrosis ranged from 1% in Pelipita to >10% in local cultivars Umuzuzu and Kamaramasenge. In Gitega, root necrosis was similar across cycles while in Cibitoke, the percentage root necrosis increased from the 1st to 3rd

cycle. Average pest and disease data for Burundi sites is presented in appendix 1

In South Kivu, only root necrosis and sigatoka were observed in both sites. A higher percentage of root necrosis from nematode infestation was observed in Inera compared to Burhale. In Inera, root necrosis ranged from 21% in Muracho to 27% in local cultivar Gros Michel. An increase in root necrosis with each cycle was noted in Inera in all cultivars except Apantu, Lai, To'o and local cultivar Gros Michel. In Burhale root necrosis ranged from 8% in To'o to 12% in local cultivar Barhebesha. In Burhale, all cultivars except Bira, Muracho, To'o and local cultivar Musheba showed a decrease in root necrosis after the 1st cycle and an increase in the 3rd and 4th cycle. The prevalence of sigatoka was similar in both sites where the position of youngest leaf with >10 necrotic spot ranged from 5 to 7. Average pest and disease data for South Kivu sites is presented in appendix 2.

In Tanzania, root necrosis, sigatoka and weevils were observed in all cultivars in both sites. Root necrosis from nematodes was lower in Missenyi compared to Maruku. In Missenyi, root necrosis incidence ranged from <2% in Pisang Papan, Pelipita, Tudlo Tumbaga and Muracho to 6% in Apantu. While in Maruku root necrosis incidence ranged from 5% in Muracho, Tudlo Tumbaga and local cultivar Nshakara to 12% and 20% in Pelipita and To'o respectively. Across cycles root necrosis in Missenyi reduced in all cultivars except Apantu and To'o, while in Maruku, root necrosis increased in Apantu, Pelipita, and the 3 local cultivars and decreased in Bira, Pisang Papan, To'o and Tudlo Tumbaga. The prevalence of sigatoka was similar in both sites where the position of youngest leaf with >10 necrotic spot ranged from 5 to 7. Weevil infestation begun in the 2nd cycle for all cultivars and Maruku had higher infestation rates than Missenyi. Across sites and cultivars, weevil infestation was ≤10%. In cycles 2 and 3, all cultivars in Maruku had weevils and infestation ranged from 0.4% in Tudlo Tumbaga to 10% in Apantu. While in Missenyi, infestation for the 2nd cycle ranged from 0.6% in Tudlo Tumbaga to 5% in local cultivar Nshakara. Average pest and disease data for Tanzania sites is presented in appendix 3.

In Uganda, root necrosis, weevils, and fusarium were observed. Fusarium was noted in 4 cultivars, Lai, Apantu, Lahi and local cultivar Mbwazirume at ≤0.5. Weevils were observed in all cultivars with Apantu, Bira, Lahi and local cultivars Gonja and Mbwazirume having >10% infestation. Muracho and Tudlo Tumbaga had the lowest infestation of 5%. Weevil infestation across cycles remained the same in Pelipita, Muracho and local Gonja, while it increased in Bira, Pisang Papan, and To'o. in Lahi and local Sukali Ndizi, weevil incidence reduced from 1st to 2nd cycle while in Apantu and local Mbwazirume, the incidence increased after 1st cycle and reduced in the 3rd cycle. Sigatoka was noted in all cultivars. The position of leaves with >10 necrotic spots ranged from 3 in local cultivar Mbwazirume to 5 in To'o, Lahi, and Tudlo Tumbaga. Across cycles, sigatoka incidence did not differ in Pelipita, Lahi, and To'o. In pantu, Bira, Tudlo Tumbaga and local Gonja, the incidence reduced after 1st cycle and increased in the 3rd cycle. While in Muraco, Lai, and local cultivars Mbwazirume and Sukali Ndizi, the incidence increased after 1st cycle and reduced in the 3rd cycle. Root necrosis from nematodes ranged from 1% in To,o and local Mbwazirume to 5% in Bira, Lahi and Pelipita. Across cycles, the percentage of root necrosis in all cultivars except Muracho, Tudlo Tumbaga and local Mbwazirume increased after the 1st cycle and reduced in the 3rd cycle. In Muracho, Tudlo Tumbaga and local Mbwazirume, root necrosis reduced after the 1st cyle and increased in the 3rd cycle. The prevalence of sigatoka and weevils did not differ across cycles. Average pest and disease data for Uganda is presented in appendix 4

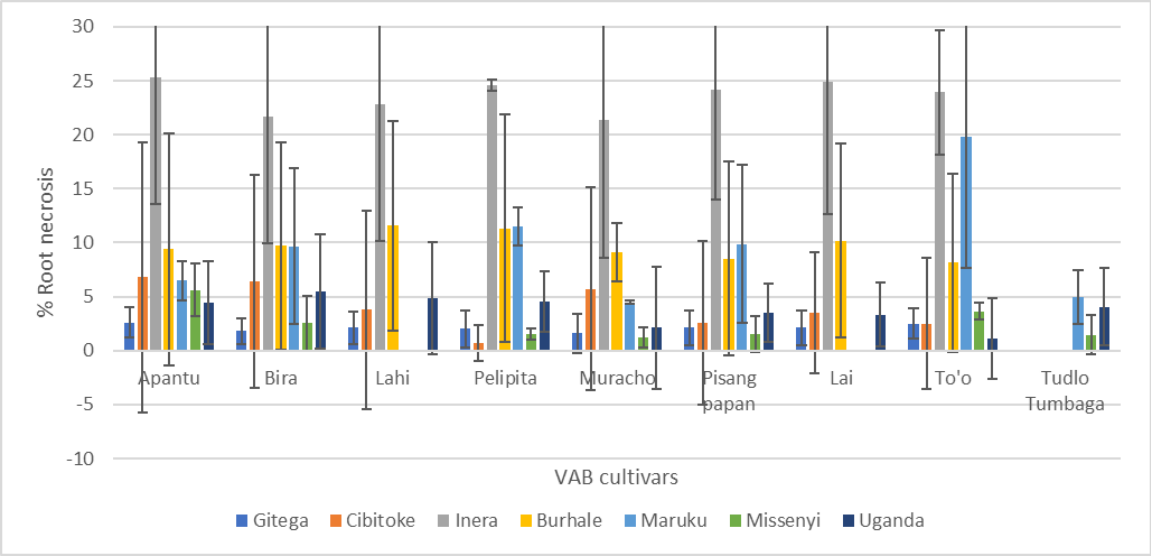

Figure 4 Average root necrosis (%) of VAB in different sites

Based on the results of plant height and bunch size, Pisang papan, Muracho and Pelipita have good performance across the different sites. Cultivars in Missenyi, Tanzania were among those with the tallest plants, heaviest bunches and least pest and disease incidence.

In Burundi, while Cibitoke showed better growth and harvest results, Gitega had the least pest and disease incidence. This has previously been observed and is attributed to the difference in agroecological zones. A similar observation was made in South Kivu with Inera having better growth and harvest results, while Burhale had the least pest and disease incidence. In Tanzania with Missenyi had better growth and harvest results, and also had the least pest and disease incidence.

Consequently, it was noted that the growth and harvest of VAB is comparable to that of the local cultivars. The growth and performance of specific cultivars varied with the specific site due to differences in agroecological zone, climate, soils, and banana pest and disease pressure in the area. Rainfall and soil fertility particularly nitrogen and potassium levels influence the performance of bananas, that is the growth and bunch characteristics while the temperature influences the maturation, the time from flowering to harvest. For example, in Tanzania, Missenyi site receives less rainfall than Maruku but has higher soil fertility and less pest and disease pressure, thus resulting in heavier bunches in Missenyi compared to Maruku which receives higher rainfall. Therefore, the above-mentioned parameters inter-relatedly affect cultivar performance. The pest and disease incidences noted were comparable to the local cultivars and emphasizes the need for building community capacity on appropriate banana agronomic practices among farmers that will produce the VAB, and sensitization on the importance of the VAB and how they differ with other new banana cultivars that are largely hybrids.


Pictures 1 & 2. Agronomic trials in South Kivu (L) and Uganda (R)

2. Institutionalization of the VAB trials to ensure they are included in NARs (TARI, NARO, INERA. ISABU) banana germplasm trials for conservation and continued evaluation

Based on the fact that official finance support from the donor to support fast tracking of these VAB cultivars will end by 31st December 2019, to ensure that the materials remain accessible to the farmers, can be used later for continued research for development work and that they are conserved, the team is working towards ensuring that the better performing varieties are integrated into the national germplasm collections.

In Burundi, a total of 80 plantlets of 8 VAB cultivars Apantu, Bira, Lahi, Lai, Muracho, Pelipita, Pisang Papan and To'o were planted in the ISABU (Institut des Sciences Agronomiques du Burundi) banana germplasm at Mahwa station in November. The VAB will be managed by ISABU. In addition, discussions on the release of the VAB in Burundi were started between Bioversity International, ISABU, and ONCC (Office Nationale de Certification et de Controle des semences), the national office in charge of certification and control of seeds. The 3 institutions set up a collaboration and identified activities required to officially release the VAB. Activities include continued assessment of the VAB in different agroecological zones for yield, pests, diseases and farmer acceptability. Discussions on funds and implementation of activities are ongoing.

In South Kivu, the process of officially releasing and inclusion of the VAB in the INERA germplasm was initiated. However, due to the costs involved, progress could not be made. Discussions are underway with CIAT that has experience with release of beans and maize in the country to move the conservation and continued evaluation of VAB in South Kivu forward. Having one of the trials and mother garden are at INERA (Institut National des Etudes et Recherches Agronomique) will ensure the materials are protected in the meantime.

In Tanzania, VAB suckers are undergoing planting by TARI in Biirabo ward in Muleba District. These materials will be part of the TARI-Maruku germplasm and will be managed by the institute.

In Uganda, discussions were held with NARO where 5 of the 9 VAB were selected for multiplication and addition to NARO's multi-location banana trials. The selection was based on their pVAC and potential acceptability as they will be promoted mainly for their pVAC content. The cultivars are Bira, Apantu, Muracho, Lahi, and Pisang Papan. In addition, bunches of these cultivars were taken to the NARO Food Biosciences Research Centre lab for food processing and

preparation evaluation.

Picture 3. Planting of VAB in the ISABU banana collection in Burundi

3. Sensory/organoleptic evaluation carried out to establish level of acceptability and to predict adoption level of the vitamin A rich bananas within target communities

Below is a summary of results from sensory evaluations carried out in 2018 in Tanzania and Uganda. Data entry and analysis was not complete by the time of preparation of the 2018 annual report.

a) Tanzania

Sensory evaluation of vitamin A rich cultivars was carried out in Bukoba and Misenyi districts in Tanzania in June 2018. 126 participants, 81 men and 45 women took part in the exercise where vitamin A-rich cultivars Apantu (AAB), Bira (AAB), Pelipita (ABB), Muracho (AAB), Pisang Papan (AAA), and Tudlo Tumbaga (AA), assessed were alongside local cultivars Nshakara (AAA), Gonja (AAB) and Kamaramasenge (AAB). The cooking methods were selected based on those commonly used in the community. The cooking cultivars were evaluated when fried, boiled and roasted without peel. The dessert cultivars were served raw after ripening. The respondents assessed the pulp appearance, aroma, texture in hand, texture in the mouth, taste and general acceptability of all the cultivars using a 5-point hedonic scale of 1 = very bad, 2 = bad, 3 = fair, 4 = good, and 5 = very good.

After boiling, Gonja a local cultivar was the most preferred with 90% of respondents scoring the general acceptability as good and very good. This was followed by Bira, a VAB with 61% scoring the general acceptability as good and very good. The order of preference of boiled cultivars based on all attributes assessed was Gonja, Bira, Apantu, Nshakara, Pelipita and Muracho (figure 5).

When roasted, Apantu a VAB was the most preferred cultivar followed by local cultivar Gonja and VAB Bira (figure 5). The general acceptability of Apantu, Gonja and Bira were scored by 79%, 71% and 66% of respondents as good and very good respectively. Based on all the attributes assessed, the order of preference of roasted cultivars was Apantu, Bira, Gonja, Nshakara, Muracho and Pelipita.

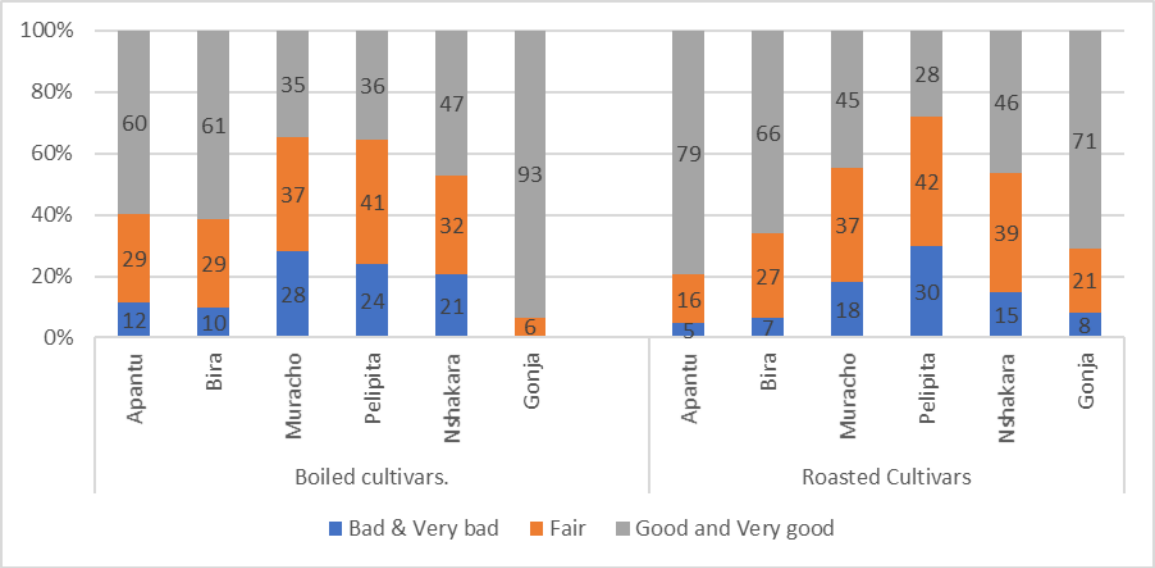

Figure 5 General acceptability scores for cultivars boiled and roasted in Tanzania

When pan fried, VAB Bira and Apantu were the most preferred cultivars with 83% and 88% respectively scoring the general acceptability as good or very good (figure 6). They were followed by Gonja a local cultivar whose general acceptability was scored as good or very good by 66%. The order of preference of pan-fried cultivars based on all attributes assessed was Bira, Apantu, Gonja, Nshakara, Muracho and Pelipita.

For the dessert cultivars, the local cultivar Ndizi was the most preferred followed by Pisang Papan and Tudlo Tumbaga (figure 6). The general acceptability of Ndizi, Pisang Papan and Tudlo Tumbaga was scored as good and very good by 97%, 65% and 20% respectively.

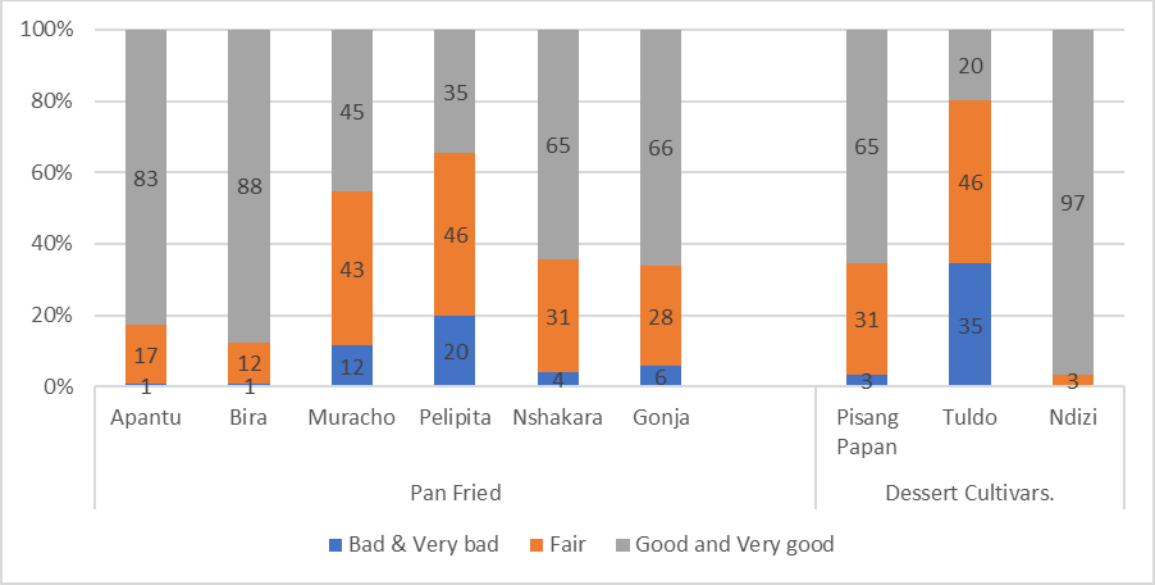

Figure 6 General acceptability scores for pan fried cultivars and dessert cultivars in Tanzania

Apantu and Bira compared well with the local cultivars having been scored >70% when boiled, roasted and pan fried making them acceptable. Though Pelipita and Muracho did not perform

better than Gonja a local cultivar, their ratings were acceptable since 65% of the respondents scored good and very good. The order of sensory preference of the VAB was Bira, Apantu, Muracho and Pelipita.

Results from the sensory evaluation above and the agronomic evaluation both show that the VAB compare well with the local cultivars. Bira, Apantu, and Pelipita are among the cultivars with the heaviset bunches and highest sensory preference. This reflects the potential for adoption of the VAB in the Bukoba and Misenyi farming systems and diets.

b) Uganda

Sensory evaluation of vitamin A rich cultivars in Uganda was carried out in November 2018 in kiboga district with 100 community members, 57 women and 43 men. Participants evaluated 5 vitamin A rich cultivars Apantu (AAB), Bira (AAB), Lahi (AAB), Pelipita (ABB), and Muracho (AAB) together with 2 local cultivars Mbwazirume (AAA) and Gonja (AAB). All cultivars were boiled without peel, steamed with and without peel, roasted with and without peel, and pan fried. The cooking methods were selected based on those commonly used in the community. The respondents assessed the pulp appearance, aroma, texture in hand, texture in the mouth, taste and general acceptability of all the cultivars using a 5-point hedonic scale of 1 = very bad, 2 = bad, 3 = fair, 4 = good, and 5 = very good.

When boiled, Mbwazirume a local cultivar was the most preferred followed by VAB Bira. The general acceptability of both cultivars was rated as good and very good by > 90% of the respondents (figure 7). The order of preference of cultivars boiled without peels based on all attributes assessed was Mbwazirume, Bira, Lahi, Gonja, Apantu, Pelipita and Muracho. When panfried, Mbwazirume a local cultivar and Bira were the most preferred cultivars with 77% and 78% rating their general acceptability as very good respectively (figure 7). The order of preference of cultivars pan fried based on all attributes assessed was Mbwazirume, Bira, Lahi, Gonja, Pelipita, Apantu and Muracho.

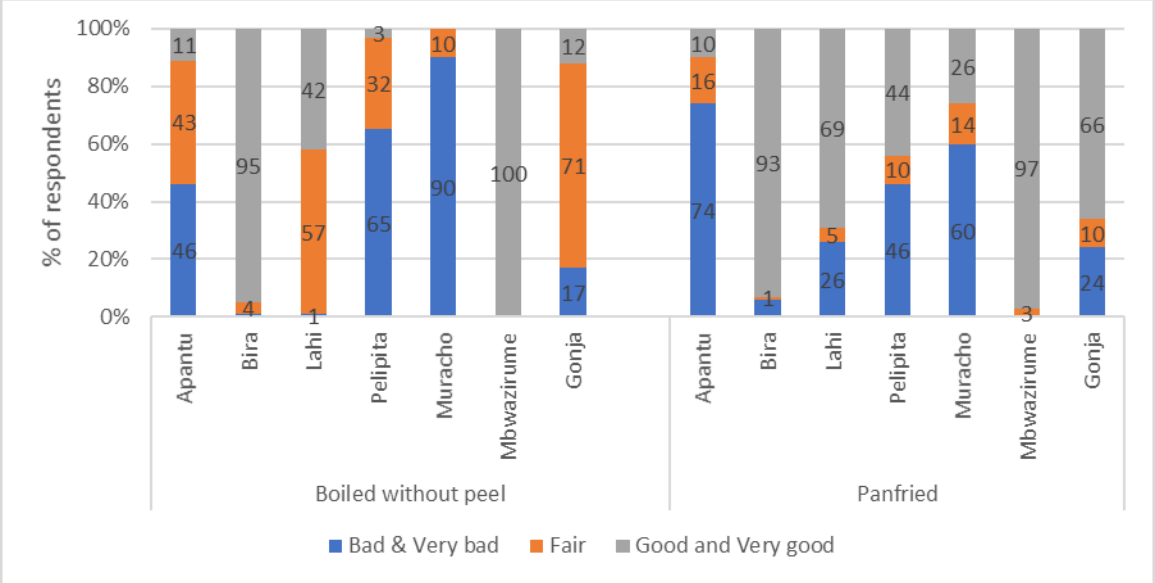

Figure 7 General acceptability scores for boiled and panfried cultivars in Uganda

After roasting with the peels, Mbwazirume a local cultivar and VAB Bira and Lahi had a general acceptability rating of fair, good and very good by > 90% of respondents (figure 8). the order of

preference of cultivars roasted with peel based on all attributes assessed was Mbwazirume, Lahi, Bira, Apantu, Gonja, Pelipita and Muracho. When roasted without peels, VAB Bira and Lahi were most preferred cultivars with 75% and 54% of respondents scoring the general acceptability as good and very good. The order of preference of cultivars roasted without peel based on all attributes assessed was Bira, Lahi, Mbwazirume, Apantu, Muracho, Gonja and Pelipita.

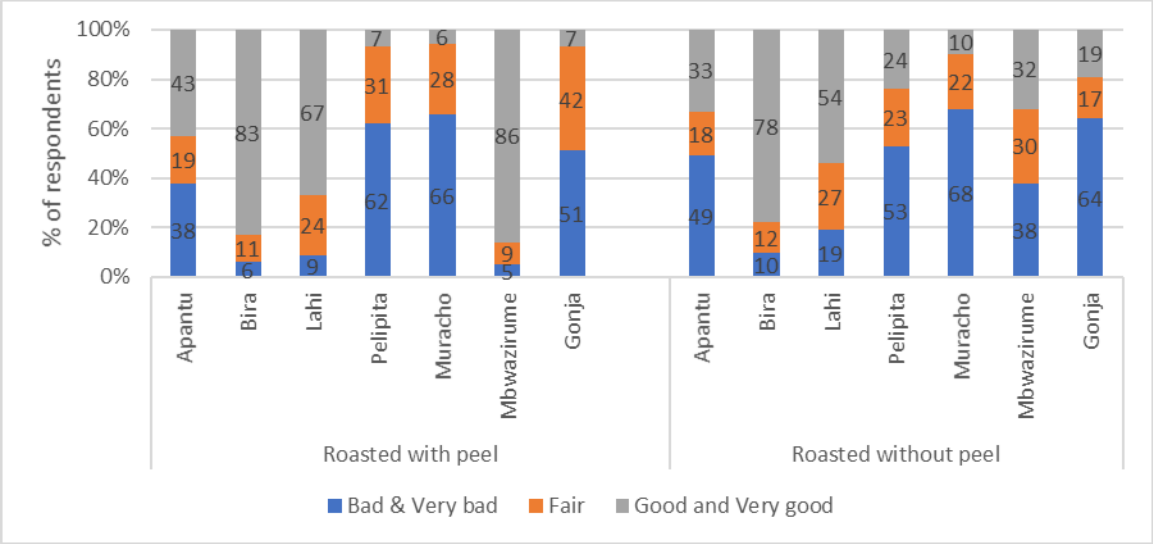

Figure 8 General acceptability scores for cultivars roasted with and without peel in Uganda

When steamed with peels, VAB cultivars Bira, Lahi and local cultivar Mbwazirume were the most preferred cultivars with >60% scoring the general acceptability between good and very good (figure 9). After steaming without peels, Bira, Lahi and local cultivar Mbwazirume were the most preferred cultivars with 90%, 67% and 60% scoring the general acceptability between good and very good. The order of preference for cultivars steamed with and without peel based on all attributes assessed was Bira, Mbwazirume, Lahi, Gonja, Apantu, Pelipita, and Muracho.

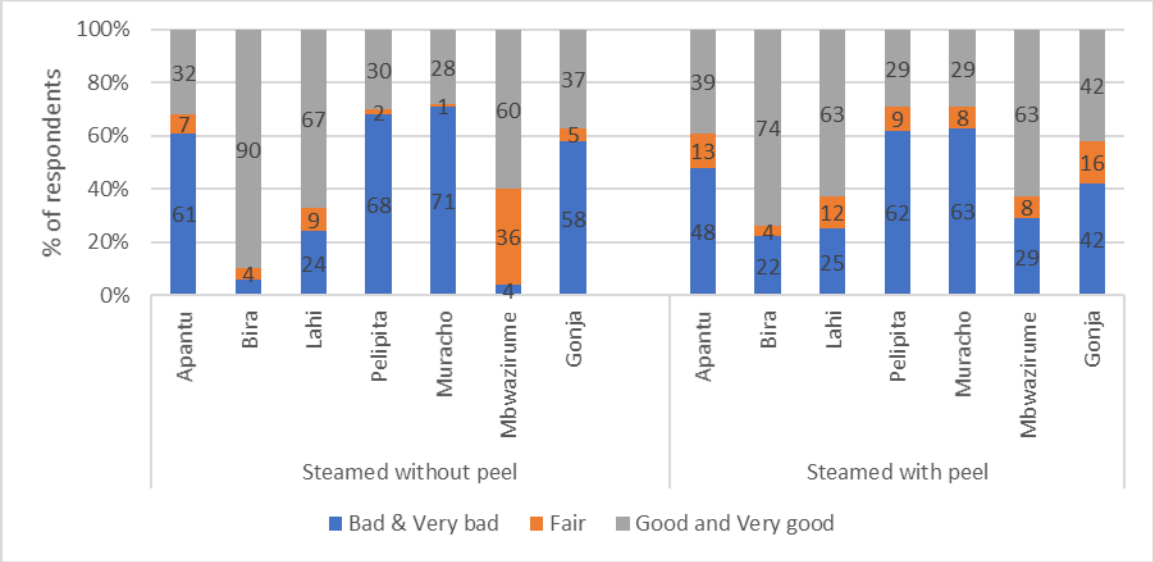

Figure 9 General acceptability scores for cultivars steamed with and without peel in Uganda

The results from this evaluation showed that across all cooking methods, Bira and Lahi were the most preferred VAB with >70% of respondents scoring fair, good or very good when boiled, roasted with peel and pan fried. Based on sensory attributes, these two cultivars compared well against the local cultivars and have a high potential for adoption. The order of sensory preference of the VAB was Bira, Lahi, Apantu, Pelipita and lastly Muracho.

Considering both sensory evaluation and agronomic evaluation, Bira and Lahi the best performing cultivars from the sensory evaluation in Uganda are also among the VAB with the heaviest bunches that compare well with the local cultivars. Bira also has the advantage of a short cycle taking 2 months from flowering to harvest, and good suckerbility with 5 suckers removed at flowering. These attributes will contribute to regular food availability in a household. Lahi has shown low infestation by nematodes and weevils. Though Bira is among the cultivars affected by weevils, their infestation by nematode and sigatoka is low. In addition, with good agronomic practices, the rate of infestation and effects of weevils can be reduced. Based on these results, both Bira and Lahi have a good potential for adoption in Uganda.

Overall, the VAB cultivars, particularly Apantu and Bira in Tanzania and Bira and Lahi in Uganda were acceptable. Sensory acceptability of the VAB appeared to be higher in Tanzania compared to Uganda. Previous sensory evaluation results in Burundi and South Kivu found Apantu and Bira as the most preferred cultivars followed by Lahi and Pelipita when prepared using under different cooking methods. These results are in tandem with those presented above for Tanzania and Uganda, which also reflect Apantu, Bira and Lahi as the most preferred cultivars. These results can guide the selection of cultivars for multiplication and distribution to farmers in Uganda and Tanzania.

4. Introduction of at least 6 vitamin A rich banana cultivars (with observed higher agronomic and food characteristics) into the germplasm trials in Kenya through KALRO-Kisii

Due to the fact that the project would officially close by end of 2019, it was deemed not feasible to initiate the work in KALRO Kenya through this project and the budget for this was devoted towards enhanced micropropagation in Burundi, and DRC to ensure more farmers acess the amterials. Alternative funding will be sourt to scale this initiative into Kenya.

iii) Outcomes / Significance

The agronomic results show the potential of adoption of the VAB and their inclusion in the farming systems because their performance and preference are comparable to the local cultivars in the different sites.

As the project comes to a close, it is imperative that the planting material is conserved and made available for continued evaluation, multiplication and distribution. The NARs provide a vital framework for sustainability and continued availability of the materials while the community members and their adoption levels enhance the chances for scaling and continued utilization.

iv) Lessons Learned

The national partners have been part of the project and this enabled the discussions on the institutionalization of the VAB trials to ensure they are included in NARs banana germplasm trials. Through the existing partnership with the NARs we realize this makes it easier to link with the institutions directly responsible for the official release of the banana cultivars..

v) Publications (published / forthcoming / accepted)

Manuscript based on the sensory evaluation of the provitamin A-rich bananas in Tanzania and Uganda is under development

Manuscript title 'Agronomic performance of selected exotic plantains, dessert and cooking bananas (*Musa* spp.) with high provitamin A content across different agro-ecological zones in Burundi and in eastern Democratic Republic of Congo' Still being reviewed by the team before journal selection.

2.2. Task 2: Capacity building, awareness creation and promotion

(= H+ IP / BMGF Activity 9 – Dissemination, Promotion & Consumer Acceptance; 9.4 – Training and Extension)

Task description and main milestones	**Participating Institutions**
Status: To date, the project has produced technical reports, briefs, posters, factsheets, PowerPoint oral presentations and scientific publications with findings on: • Agronomic characteristics and performance of the eight cultivars (five tested and selected and three additional awaiting testing) under fast-tracking in Eastern Africa as compared to the existing local cultivars • The acceptability and potential adoption levels of the cultivars on fast-tracking following sensory/organoleptic tests a publication available at http://www.pubhort.org/fruits/72/5/1/index.htm • pVACs in Vitamin A rich banana cultivars when fruit is raw (unripe, ripe) and following local processing https://www.sciencedirect.com/science/journal/08891575/43 • Appropriate production, processing/cooking, dietary combination techniques to ensure high yields and nutrient retention and availability A community-level training manual on appropriate production techniques, consumption practices targeting banana-based farming and food systems has been developed, and is already published (Ekesa et al, 2017b). It is available in hard copies and online at http://www.ishs.org/scripta-horticulturae At present more than 485 community trainers of trainers (TOTs) have been trained on good production practices, basic concepts in food and nutrition security and appropriate dietary practices. By December 2018, 11,998 farmer households have been reached directly by the TOTs with key messages on production, nutrition and food security through community-based information sharing platforms. In additional factsheets highlighting kep indicators for the vitamin A rich bananas have been developed and are being finalized and Recipe cards are at the initial stage of development In 2019, project results will continue to be disseminated through participation in international conferences, for example the 4th Federation of African Nutrition Societies (FANUS) Conference. 12-15th August 2019, and the Tropentag conference that takes place annually in Germany. Capacity building and awareness creation on the sustainable utilization of high pVACs banana in diets will continue accompanied by techniques and skills on community level	Bioversity, ISABU-Burundi, INERA-South Kivu DRC, NARO-Uganda, ARDI-Maruku (Tanzania)

macropropagation sthat will be accorded to lead farmers that are already beneficiaries of the project. The fact sheets will be completed, and the recipe cards developed and finalized. These materials will be translated in appropriate languages and made available to different stakeholders through multiple channels, some of which will include, community meeting, distribution through local partners, online materials and recipe cards. In addition since 2019 might be the final year to receive funding for this work from Harvestplus the team will document the evolution of this work upto the current status.

Considering the above information, the milestones for 2019 will be as follows:

Milestones 2019:

- Stakeholder sensitization, and transfer and sharing of knowledge/information on the potential contribution of *Musa* fruit and *Musa* products to Vitamin A needs of vulnerable population groups among smallholder farmers and the importance of vitamin A to health will be continued. This will be done through various channels and with different categories of people:
    - International/national scientific community through conferences, workshops, peer-reviewed publications and online briefs
    - Continued updating of Musapedia page on vitamin A (http://www.promusa.org/tiki-index.php?page=Vitamin+A+in+banana) with relevant results from the project
    - National and local partners in Eastern DRC (South Kivu, North Kivu), Burundi, Rwanda, Tanzania and Uganda through stakeholder forums, annual technical reports and leaflets/posters
    - Target community members through community gatherings, focus group discussions, community-tailored posters/leaflets, through trainers of trainers (TOTs).
- Community change agents and lead farmers equipped with information on macropropagation and able to lead the establishment and management of community level macropropagation units.
- Community promotion of the Vitamin A banana-based recipes, following their laboratory nutrition analysis, through development and distribution of community-friendly recipe cards directly and through local partners.
- The evolution of the work on Vitamin A banana for addressing VAD will be documented and the information available to all stakeholders

Description of Deliverables

1. Research findings disseminated as reports, peer-reviewed publications, leaflets, factsheets, recipe cards and verbal communication and community level.
    - Mid-Term and Annual Technical Reports
    - At least one manuscript on sensory evaluation of the VAB alongside local varieties in Rwanda, Tnazania and Uganda developed and submitted for publication in a peer-reviewed journal

- Key findings from the research work presented in at least one international conference/workshop
- Musapedia updated and pages on the importance of the *Musa* cultivars to nutrition created

2. At least four recipe cards and six factsheets developed and made available online in English, French and preferred local language. Hard copies of factsheets and recipe cards available in the preferred local language. These materials will be multiplied into enough copies for distribution to the target population, at least 2,000 copies of factsheets/brochures per region and 5000 recipe cards by 31 December 2019.
3. At least 60 lead farmers in the operating sites trained on macropropagation (setting up, multiplication and distribution techniques) at community level
4. A document detailing the evolution of the work on the vitamin A banana in Eastern Africa available online and in hard copies to all key stakeholders

Annual Report:
Task 2: Capacity building, awareness creation and promotion
Please Report:

i) Status (Complete / In development / Incomplete)

In Development

ii) Outputs

1. Dissemination of research findings

– After the creation of the pages on 'important Musa cultivars to nutrition' in Promusa, these pages are continuously updated see http://www.promusa.org/Vitamin+A+in+banana

– Manuscript based on the sensory evaluation of the provitamin A-rich bananas in Tanzania and Uganda is under development

2. Factsheets, recipe cards, policy briefs and Posters

Factsheets sharing information on vitamin A rich banana characteristics and agronomic performance were finalized and are available in English and french. The target audience for the factsheets is research and partner institutions in the countries of implementation and online platforms such as the promusa website. The factsheets for Apantu, Bira, Lahi, Pelipita, Lai, and To'o are attached. They are in the formatting process for the promusa website. Hard and soft copies are being shared directly with partners in Burundi, South Kivu, Tanzania and Uganda in December 2019.

Recipe cards that share the preparation methods and nutrient content of vitamin A rich banana recipes developed through a participatory process in South Kivu were also finalized in English and french. Recipes for (i) cifukama with vegetables a banana dish with beans, (ii) futari, a banana dish with sardines and soy flour, (iii) banana-soy porridge, (iv) sorghum porridge enriched with banana and soy flour, and (v) maize porridge enriched with banana and soy flour were developed for the communities in the project sites, institutions in the countries of implementation, and online platforms. The recipe cards (attached) are in the formatting process for the promusa website, while hard and soft copies are being shared directly with partners and communities in Burundi and South Kivu in December 2019.

3. Training of trainers (ToTs) and trainings at community level (under 2018 NCE)

a) Uganda

42 TOTs were trained in Kiboga district in December 2018 in a 2-day training of trainers workshop. The TOTs formed 13 groups each representing a village and set out to train community members on banana production, food security, nutrition and food safety and hygiene in 3 separate sessions. In April 2019, a follow up meeting was held to discuss the community training exercise.

The TOTs reached and trained a total of 725 community members from 13 villages (table 1). 289 of the participants were male and 436 were female. The training was well received by the community. Both the TOTs and community members reported learning new information and requested for further training. The TOTs were also motivated to adopt the recommended practices so that they become role models. Certificates of completion of the training of trainers' workshop were also handed out to the TOTs at the end of the meeting.


Pictures 4 & 5. Meeting with community trainers to review training and awareness creation carried out at community level. Uganda

b) Tanzania

In December 2018, 29 ToTs from Bukoba and Missenyi districts were trained on banana production, food security, nutrition and food safety and hygiene. Following this workshop, the ToTs trained their fellow community members from 5 wards: Kanyengereko, Izimbya, Nsuga, Kasambya and Maruku. Results from 3 of the wards showed that 235 farmers were trained. Of these, 128 were men and 107 were women (table 1).

The data from the community training exercise in Uganda and Tanzania brings the total of farmers reached using the TOT approach in the different sites to 12,958 farmers (table 2). Majority of the farmers trained on community macro-propagation (an exercise described below) were already community trainers under the project. With the 12 new farmers that were trained in this exercise, the total number of community trainers under the project comes to 497. (table 2).

Table 2 Number of community trainers trained, and farmers reached with information

	Community trainers trained	Farmers reached with formation by community trainers		
	2014-2019	2014-2018	2019	Total
Burundi	63	2,642	-	2,642
South Kivu	176	7,141	-	7,141
North Kivu	100	999	-	999
Uganda	98	896	725	1,621
Rwanda	31	320	-	320
Tanzania	29	-	235	235

Total	497	11,998	960	12,958

4. Community level training on macro-propagation

To ensure continued access to, increase the availability and scale production and utilization of VAB l within the community during and after the project implementation period, selected lead farmers were trained on community level macro-propagation. The purpose of this training was to equip lead farmers with information and skills on macro-propagation and lead to the establishment and management of community level macro-propagation units. Macro-propagation is also an opportunity for income generation for farmers following enhances demand and uptake of the VABs.

During 2-day workshops, farmers where trained on the purpose of macro-propagation, building the chamber, selecting and preparing and planting corms, managing the chambers, hardening and nurseries. In Burundi, a total of 20 farmers were trained, 10 from Cibitoke and 10 from Gitega (table 3). Each site selected a committee and prepared action plans. Anticipated challenges that participants discussed included getting market for the plantlets and continued access to water.

In South Kivu, a total of 42 farmers were trained, 22 from Inera and 20 from Burhale. In each site, 4 groups were formed where each group started preparations for setting up their macro-propagation units.

In Tanzania, the training of farmers on community macro-propagation was ongoing at the time of reporting.

Table 3 Farmers trained on community macro-propagation

Site		Men	Women	Total
Burundi	Citbitoke	7	3	10
	Gitega	6	4	10
	Total	13	7	20
South Kivu	Inera	17	5	22
	Burhale	13	7	20
	Total	30	12	42
Total		43	19	62

Picture 6-9. Participants in Burundi learning different aspects in community macro-propagation

Picture 10-13. Participants in South Kivu learning different aspects in community macro-propagation

5. Chronology of the evolution of the work on vitamin A rich bananas in East Africa

   A document detailing the chronology of the evolution of the work on vitamin A rich bananas in Eastern Africa has been developed and it is attached to this report.

iii) Outcomes / Significance

The capacity building of communities in the different project sites has enhanced the awareness and promotion of VAB. Individuals in these communities are now equipped with knowledge and skills in banana production, nutrition, and macro-propagation and this will ensure that VAB are maintained, multiplied, shared, and consumed.

iv) Lessons Learned

As ToTs share information on banana management and VAB, awareness and demand for VAB planting material increases. Training in macro-propagation will ensure that communities have

continued access to VAB planting materials when needed.

v) Publications (published / forthcoming / accepted)

A chronology of the evolution of the work on vitamin A rich bananas in East Africa was developed avenues of having it published are still being sought.

Recipe cards for five recipes that utilize VAB were developed through a participatory process in South Kivu, measures to have them on the Bioversity website have began the same will also be initiated to have them on the Harvestplus website

Factsheets sharing information on vitamin A rich banana characteristics and agronomic performance of Apantu, Bira, Lahi, Pelipita, Lai, and To'o have been developed, measures to have them on the Bioversity website have began the same will also be initiated to have them on the Harvestplus website

A community macro-propagation training manual was developed and is available in English, French and Swahili

2.3. Task 3: Multiplication & Distribution of *Musa* planting material *(= H+ IP / BMGF Activity 9 – Dissemination, Promotion & Consumer Acceptance)*	
Task description and main milestones	**Participating Institutions**

Status The sensory/acceptability evaluations and related laboratory analyses carried out between 2012 upto date have helped to identify the highly nutritious and most preferred *Musa* cultivars among the cultivars under fast-tracking. The most promising of the cultivars tested, Apantu, Bira, Lahi, Pelipita, Lai, and To'o were selected for further multiplication. Multiplication was carried out by Phytolabu Burundi and at least 13, 539 plantlets have been made available directly by Bioversity research team and there has also been reported dissemination at community level. Through the community agents of change (TOTs) trained in 2013, more than 1923 farmer households, including those who received the plantlets, received information on potential contribution of the introduced bananas to the farm produce and their household food basket. Three additional cultivars (Muracho, Tudlo Tumbaga, and Pisang Papan) were ordered from ITC because of their already known high provitamin A content and four more additional already-preferred cultivars (Apantu, Pelipita, Bira and Lai) ordered. These materials are currently in the trials being evaluated and they should be out with the farmers within the next 2 years (if selected). (HarvestPlus Annual Technical Report. See 2015/16/17/18). With the above background, the milestones for 2019 will therefore be as follows: **Milestones 2019:** • Establishment of at least 6 community level macropropagation units that can be managed by the lead farmers in Burundi, South Kivu-DRC, Uganda and Tanzania. • Continued macropropagation at institution and community level and dissemination of the materials to reach more farmers with Vitamin A rich banana planting materials especially in Burundi ad South Kivu DRC	Bioversity, CIALCA-HT (Butembo, Bukavu, Burundi), Institut des Sciences Agronomiques du Burundi (ISABU), Ministry of Health (Eastern DRC, Burundi), Gardens for Health, Agricultural research Institute-Maruku Tanzania, National Agricultural Research Institute-NARO Uganda,
Description of Deliverables	
1. Macropropagation carried out and community farmer-to-farmer sharing monitored to ensure at least 2,000 more plantlets are shared with farmers with each receiving at least two varieties of the vitamin A-rich preferred *Musa* cultivars for incorporation in their farming systems by 31 December 2019 2. At least 6 community level macropropagation units established and under management by lead farmers	

Annual Report:
Task 3: Multiplication & Distribution of Musa planting material

i) Status (Complete / In development / Incomplete)

In Development

ii) Outputs

1. Macropropagation

Macropropagation units were set up in Burundi in August 2019. 258 corms of 8 VAB and 2 local cultivars were planted and at the end of October, 1,453 plantlets had been harvested as shown in table 4 and majority are still undergoing hardening. Bira and local cultivar Umuzuzu had a higher average number of plantlets per corm produced 11.2 and 11.7 respectively while Muracho and local cultivar Kamaramasenge had the lowest average number of plantlets per corm produced 2.0 and 2.7 respectively. Harvesting of corms is still ongoing.

In South Kivu, 115 corms were planted in March 2019 for micropropagation where 1,235 plantlets were obtained and were distributed to farmers (table 4).

Table 4 Plantlets obtained through macro-propagation in Burundi and South Kivu

Site	Cultivar	Corms planted	Number of plantlets harvested*	Average of plantlets per corm
Burundi	Apantu	21	160	8.4
	Bira	32	314	11.2
	Lahi	26	184	9.2
	Muracho	37	68	2
	Pelipita	43	323	7.9
	Lai	31	84	8.4
	Pisang Papan	30	178	6.4
	To'o	30	99	6.6
	Umuzuzu	3	35	11.7
	Kamaramasenge	5	8	2.7
	Total	258	1453	
South Kivu	Apantu	25	230	9.2
	Bira	25	260	10.4
	Muracho	25	235	9.4
	Pelipita	25	290	11.6
	Pisang Papan	25	220	8.8
	Total	125	1235	

*Numbers harvested in Burundi are as per time of reporting. Harvesting is still in progress

2. Distribution of planting material

Plantlets were distributed in South Kivu in April 2019 under the 2018 NCE. Out of the 3,267 plantlets produced, 250 were planted in the Inera multiplication field to generate more suckers while the rest were distributed (table 5). 850 plantlets were given to Kavumu farmers association for multiplication and distribution to its members while 1,232 and 935 were directly distributed to farmers in Inera and Burhale respectively. In Burhale, 50 farmers each received 18 plantlets while in Inera, 60 farmers each received 20 plantlets. In September 2019, 1,235 plantlets were distributed to 60 farmers in Inera (30 farmers) and Burhale (30 farmers). Apantu, Bira, Pelipita, Muracho and Pisang Papan cultivars were distributed with each farmer getting between 3 to 6 plantlets of each cultivar.

Following the macro-propagation conducted in 2019 in Burundi, 181 plantlets were distributed to 45 farmers in November 2019 (table 5). 20 men and 25 women each received 4 plantlets. The cultivars distributed were Apantu, Bira, Pelipita, Lahi, Muracho and Pisang Papan. Additional plantlet distribution will be conducted in December 2019 and in the 1st quarter of 2020.

At the time of reporting, the total of VAB plantlets distributed since 2014 is 17,106 and these have been distributed to 2,138 farmers. When the local cultivars are included, the total number of planting materials distributed since 2014 to is 24,323.

Table 5 Plantlets distributed in Burundi and DRC

Site	Burundi		South Kivu		North Kivu	Total
Period	2014-2018	2019	2014-2018	2019	2014-2017	2014-2019
Number of farmers	715	45	985	170	223	2,138
Vitamin A rich Cultivars						
Apantu	902	15	612	701	215	2,445
Pelipita	924	72	1,705	958	347	4,006
Bira	1,645	39	2,288	771	446	5,189
Lahi	22	18	779	-	124	943
Lai	18	-	1,603	-	132	1,753
To'o	200	-	401	-	314	915
Muracho	49	19	391	736	66	1,261
Tudlo Tumbaga	-	-	-	-	-	-
Pisang Papan	-	18	290	220	66	594
Total Vitamin A plantlets	3,760	181	8,069	3,386	1,710	17,106
Local cultivars						
Fhia21	-		1,080	-		1,080
Barhabesha	-		1,617	866		2,483
Gros Michel	-		1,817	-		1,817
Musheba	-		1,662	-		1,662
Igisahira	103		-	-		103
Kamaramasenge	36		-	-		36
Umuzuzu	36		-	-	-	36
Total local cultivar plantlets	175	-	6,176	866	-	7,217
Total number distributed	3,935	181	14,245	4,252	1,710	24,323


Pictures 14 & 15. Plantlet distribution in South Kivu (L) and Burundi (R) in 2019

iii) Outcomes / Significance

As more farmers are trained and receive VAB planting material, awareness and demand increases. This will be addressed as the communities start macro-propagation and share within the community.

iv) Lessons Learned

It is important farmers that receive VAB planting material are aware of the benefit of these

cultivars with regard to their vitamin A content, the health implications and need to incorporate them in their diets. The ToTs in the community and those trained in macro-propagation are equipped and can share this information.

v)Publications (published / forthcoming / accepted)

A manuscript using data collected from the 2018 macropropagation exercise in Burundi and South Kivu is under development

3. Role of Contributing Collaborators (if any)

Bioversity International: In-kind contribution in personnel time from the scientific team, science editing, administration team and finance departments

4. Technical Approach and Methodology *(max. one page, if above $150,000 instead attach detailed proposal)*

This project will adopt both community participatory and experimental approaches.

Agronomic characteristics of the fast-tracked *Musa* cultivars: Through the engagement of qualified agronomists, an observation checklist has been prepared and variables relating to the whole plant, bunch and fruit observed, measured and recorded, these will include: Height of pseudostem (cm), Girth of pseudostem at base (cm), Girth of pseudostem at 100cm, Number of functional leaves, Number of dead leaves, Height of collar (cm), Number of suckers, Weight of bunch (kg), Number of hands in bunch, Total number of fruits, Number of fruits in lower row of second lowest hand, Fresh weight of fruit (g), Fruit length (cm), Fruit circumference (cm), Fresh peel weight (g), Peel thickness (mm), and Pulp firmness.

The following variables will be collected to assess pests and diseases: Sigatoka - Youngest leaf with >10 necrotic spots, *Fusarium* - Yellowing of foliage, splitting of pseudostem base, petiole collapse, BXW - Yellowing of leaves, drying rot and blackening of male bud bracts and rachis, BBTV - Rosetting, presence of black aphid, Nematodes - Plant toppling, Functional roots, Dead roots, Root necrosis index (%), Weevils - Plant snapping UXO, UXI, LXO, LXI.

Through community change agents (TOTs) trained by the project, community-friendly materials will be developed and translated into at least two local languages per region. The materials developed will be disseminated through traditional channels (community gatherings and focus group discussions), posters, brochures and factsheets, and used as supporting information for oral education/information sharing sessions organized and conducted by the TOTs.

Technical reports will be developed and available online for download, while some of the findings will be disseminated through oral and poster presentations at national and international fora; briefs and factsheets available both in hard copies and online, and findings disseminated through peer-reviewed scientific publications.

Work in 2019 will mostly focus on the following: 1. Capacity building of lead farmers at community level to enable them carry out macropropagation to ensure continued access to the VAB planting materials and also reach more farmers with the materials: 2. Ensuring all countries within eastern Africa (including Kenya0 has the vitamin A cultivars within their NARs germplasm so that after evaluation the farmers can have these varieties within those that can be selected for integration within their farming and food systems; 3. Continued awareness creation at community level on the consequences of VAD and the potential role of food based approaches using VAB as entry point in addressing VAD; 3. Development and dissemination of recipe books/cards and factsheets

based on VAB. We will also engage stakeholders such as Ministry of health and other development partners like World Vision to see their potential involvement in scaling the good technologies emerging from this project. The objective is to ensure that the community can be able to sustainably access the planting materials for the vitamin A rich bananas and use them appropriately within their farming and diet systems beyond 2019.

References

Beatrice Ekesa, Deborah Nabuuma, Gina Kennedy, Inge van den Bergh. 2017a. "Evaluation of Sensory Attributes of Provitamin A Carotenoids-Rich Banana Cultivars on Trial for Potential Adoption in Burundi and Eastern Democratic Republic of Congo" Fruits 72(5), 261–272 | ISSN 0248-1294 print, 1625-967X online | https://doi.org/10.17660/th2017/72.5.1 | © ISHS 2017.

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IFPRI (2016). Global Nutrition report 2016: From Promise to Impact; ending malnutrition by 2030, Washington DC. Ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/130354/filename/130565.pdf

5. Labor Cost Analysis – see excel file attached

6. Financial Items – see excel file attached

7. Project Location and Equipment	
7.1 Institution	**Location, Facilities and Equipment**
Bioversity International	Kampala, Uganda,
CIALCA	Burundi, South Kivu, North Kivu, Extension workers and field trials
Katholieke University of Leuven	Leuven, Belgium, laboratory, HPLC machine

FORMATS FOR MID TERM AND FINAL REPORTS (Updated Version)

Both, Technical and Financial reports shall be submitted fully signed by the Principal Investigator or Project Leader and the Finance Officer in charge.

Technical Reports: Mid Term and Annual reports shall specify the progress, any actual or proposed deviations and modifications to the Work Plan, and the results obtained. The reports shall contain sufficient information to enable assessment of the progress and cooperation within the Project.

A suggested format for Mid Term, Annual and Final reports is as follows:

I. Summary of Technical Progress (by task in the Work Plan)
II. Milestones Completed
III. Summary of Personnel Commitments
IV. Major Equipment Acquired
V. Description of Significant Travel
VI. Current Technical Status (on schedule, behind schedule, ahead of Schedule)
VII Delays, Problems, Suggestions
VIII. Financial Reporting

Financial Reports: Mid Term and Annual/Final Financial Reports should be submitted according to the Schedule of Deliverables and Payments table. This should be prepared on standard format Form/Template No. HP-FR#1-09 to be retrieved in Sharepoint from the "HPlus General Information" folder or from this link: http://www.box.net/shared/55yu6431vxm7h6rf550b. You can also request a copy to Sonia Penafiel at s.penafiel@cgiar.org. Financial reports should be prepared individually for each agreement or cost extension amendment's budget.

Financial Reports should be submitted electronically to the Project Coordinator and the Contracts Officers of both IFPRI (Sonia Penafiel) and CIAT (Daniela Acevedo at: d.acevedo@cgiar.org), and Olyn Panlilio at: o.panlilio@cgiar.org. Original signed copies should be sent by post to Contracts Officer, who administers each agreement, i.e.: Contracts numbered under 52XX and 62XX lines should be mailed to Juliana Rivas at CIAT in Cali, Colombia. Contracts numbered under 72xx and 82xx lines should be mailed to Sonia Penafiel at IFPRI in Washington DC. These should also contain an original signed invoice for payment.

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Appendix 1. Average agronomic parameters for different cycles in Burundi

GITEGA Cultivar	cycles	Plant height (cm)	Plant girth - base level	Plant girth - 1m level	Functional leaves	Dead leaves	Root necrosis %	Weevils % infestation	Number of bunches	Bunch weight (kg)	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits	Time flowering to harvest (days)
Apantu	1	231.4	49.6	31.7	8.9	2.7	2.9	0.2	9.0	5.4	7.9	1.0	17.8	12.4	5.2	40.3	120.7
	2	291.7	56.0	38.3	10.0	0.7	1.7	-	3.0	7.8	9.7	1.3	17.7	12.7	6.0	58.7	106.0
	Av	245.3	51.0	33.2	9.2	2.2	2.6	0.1	12.0	6.0	8.3	1.1	17.8	12.5	5.4	45.0	117.0
Bira	1	265.5	59.1	42.5	10.6	2.8	1.4	0.1	16.0	5.0	10.7	1.0	13.7	12.3	5.6	60.1	67.9
	2	283.7	58.8	41.1	9.7	1.0	2.6	0.4	8.0	4.7	10.9	0.8	12.1	11.8	5.6	58.0	76.3
	3	292.0	60.5	42.8	12.5	1.5	2.5	0.1	2.0	5.4	10.5	1.0	13.0	13.0	6.5	68.5	83.0
	Av	273.2	59.1	42.1	10.5	2.1	1.8	0.2	26.0	4.9	10.7	0.9	13.2	12.2	5.7	60.1	71.7
Lahi	1	227.9	45.9	30.1	10.0	2.8	2.0	-	9.0	1.6	7.7	0.5	13.1	8.7	2.6	16.1	74.4
	2	256.0	49.0	30.1	11.3	2.3	2.6	-	7.0	2.0	9.0	0.4	13.4	9.4	3.3	26.6	53.0
	3	264.4	47.2	28.6	10.8	2.0	2.4	-	5.0	2.0	7.2	0.5	11.8	8.5	3.2	24.6	68.0
	4	293.0	50.0	32.5	8.5	3.0	2.0	-	2.0	2.2	9.0	0.6	11.5	8.0	3.5	32.5	77.5
	Av	250.3	47.6	30.0	10.5	2.5	2.1	-	23.0	1.9	8.1	0.5	12.8	8.8	3.0	22.6	66.8
Pelipita	1	277.2	68.0	43.6	10.0	2.1	2.5	-	15.0	4.9	9.2	0.9	12.4	11.5	5.1	47.1	138.6
	2	341.5	65.8	46.1	8.7	2.3	1.9	0.1	12.0	5.5	9.4	1.0	12.3	12.9	5.3	51.0	134.2
	3	346.8	65.1	45.9	8.1	1.8	2.2	0.1	11.0	5.3	9.0	1.0	12.2	13.0	5.0	46.7	133.1
	4	390.5	67.8	49.3	8.8	1.5	1.5	-	2.0	5.2	10.0	1.1	11.8	13.0	5.0	50.0	136.0
	Av	325.3	66.5	45.5	9.0	2.0	2.0	-	40.0	5.2	9.3	0.9	12.3	12.4	5.2	48.3	137.1
Muracho	1	306.5	73.7	50.4	10.3	1.3	1.6	-	5.0	6.9	12.6	1.1	12.4	11.9	6.0	73.4	163.2
Pisang papan	1	227.6	59.5	39.1	9.5	2.7	1.8	-	12.0	3.8	15.0	0.7	10.2	9.2	5.1	70.6	91.8
	2	263.5	61.9	41.9	10.3	1.8	2.3	-	9.0	5.3	15.5	0.9	10.4	9.5	6.0	91.4	79.3
	3	296.2	66.3	45.9	11.0	1.5	3.0	0.1	6.0	6.0	15.5	0.8	11.2	9.5	6.2	91.5	85.2
	4	350.5	67.5	48.3	8.5	3.0	1.5	0.1	2.0	3.1	15.0	0.5	10.0	8.0	5.0	72.0	94.0
	Av	264.8	63.2	42.8	10.0	2.3	2.1	-	34.0	4.7	15.3	0.8	10.5	9.3	5.6	81.4	86.8
Lai	1	278.6	72.1	51.3	9.8	2.7	1.9	-	7.0	4.8	11.6	1.0	12.5	12.0	3.9	46.4	149.9
	2	374.0	84.0	63.5	11.0	2.0	3.0	-	1.0	7.4	10.0	1.5	18.0	15.0	4.0	41.0	105.0
	3	397.5	82.0	62.5	9.5	1.5	2.0	-									
	Av	311.5	75.5	54.9	9.9	2.4	2.1	-	8.0	5.2	11.4	1.1	13.2	12.4	3.9	45.8	144.3
To'o	1	228.9	50.2	28.5	9.5	2.8	2.4	-	7.0	1.6	5.4	0.5	13.9	9.6	2.0	10.9	67.4
	2	234.9	43.9	26.1	9.9	2.1	2.8	-	6.0	1.4	6.4	0.4	12.6	9.0	2.4	16.6	65.0
	3	238.0	42.2	25.1	9.2	1.5	2.5	0.1	3.0	1.2	6.0	0.3	11.6	10.5	2.5	15.0	70.3
	4	256.5	50.0	27.5	10.0	2.0	2.0	-	2.0	1.8	7.5	0.5	14.0	10.0	3.0	23.0	66.5

GITEGA Cultivar	cycles	Plant height (cm)	Plant girth - base level	Plant girth - 1m level	Functional leaves	Dead leaves	Root necrosis %	Weevils % infestation	Number of bunches	Bunch weight (kg)	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits	Time flowering to harvest (days)
	Av	234.7	46.5	27.0	9.6	2.3	2.5	-	18.0	1.5	6.2	0.4	13.1	9.7	2.4	15.2	66.9
Igisahira	1	270.0	94.1	41.2	8.5	3.3	2.3	0.1	17.0	6.4	13.5	1.0	13.2	11.2	6.3	79.1	97.8
	2	317.7	67.7	46.5	8.5	2.1	1.6	0.1	15.0	7.5	14.1	1.2	13.0	11.5	6.7	87.9	103.0
	3	315.9	63.9	43.4	8.5	1.5	2.5	0.1	14.0	6.4	12.9	1.1	13.2	11.7	6.1	75.6	101.3
	4	355.7	69.2	48.3	9.5	1.0	2.0	0.1	4.0	10.8	13.8	1.3	15.5	12.6	6.5	87.0	108.5
	Av	306.2	75.3	44.1	8.6	2.2	2.1	0.1	50.0	7.0	14.0	1.0	13.0	12.0	6.0	81.0	101.0
Kamaramasenge	1	214.2	51.5	30.0	8.6	2.1	2.3	0.1	13.0	3.3	11.2	0.6	9.2	10.3	5.5	55.9	141.5
	2	262.4	53.6	33.9	9.9	0.8	1.5	0.1	12.0	4.0	11.0	0.7	9.5	10.5	5.8	64.8	150.4
	3	259.0	52.9	32.9	9.3	1.1	2.1	0.2	5.0	4.3	11.0	0.6	9.4	10.9	6.6	68.8	149.0
	4	264.3	54.7	34.0	9.0	2.0	3.3	-	2.0	3.9	10.0	0.6	9.5	10.5	6.0	64.0	179.5
	Av	244.4	52.8	32.3	9.2	1.4	2.1	0.1	32.0	3.7	11.0	0.6	9.3	10.5	5.8	61.8	142.8
Umuzuzu	1	256.6	62.9	40.8	9.3	3.0	2.1	0.1	14.0	8.5	10.1	1.3	17.8	12.2	6.3	61.6	114.9
	2	272.8	54.3	37.7	8.4	1.7	2.4	0.2	8.0	6.4	9.1	1.2	17.3	12.5	6.1	56.6	114.1
	3	264.9	51.6	35.3	8.0	1.7	3.0	0.1	8.0	5.1	7.4	3.0	15.7	11.6	5.6	45.5	129.7
	Av	263.3	57.3	38.3	8.7	2.3	2.4	0.1	30.0	7.0	9.1	1.7	17.1	12.1	6.1	56.0	118.3

CIBITOKE Cultivar	cycles	Plant height (cm)	Plant girth - base level	Plant girth - 1m level	Functional leaves	Dead leaves	Root necrosis %	Weevils % infestation	Other diseases	Number of bunches	Bunch weight (kg)	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits	Time flowering to harvest (days)
Apantu	1	290.5	68.357	48	5.3	0.1	1.1	0	BBTV	12	19.8	12.8	3.2	23.4	14	6.9	79.6	112.8
	2	292.5	66.5	46.5	5	0.7	5.7	0	BBTV	2	17.8	12	3	18.5	14	7	85	71
	3	337.5	68.5	45.75	5.5	1.3	3.5	0	0	1	19.3	12	3.3	20	15.5	6.5	86.5	82.5
	4	360	70	49	4	2	5	0	0									
	Av	320.1	68.339	47.3125	5.2	0.5	2.4	0	0	15	18.9	12.3	3.2	20.6	14.5	6.8	83.7	88.8
Bira	1	278.8	62.5	47.5	6.1	0.3	0	0	BBTV	20	12.9	13.8	2.3	15.4	14.3	7.5	100.8	75.3
	2	331	72.5	48.4	5.3	1.2	5.9	0.3	BBTV	7	11.9	12	2.3	15	14	5.5	84	68
	3	305	62.8	39.5	7.3	0.8	2	0	0	2	8.5	13.5	2.3	15.4	14.2	7.2	98.5	74.3
	4	300	60	41	5	0	0	0	0	1	12	12	2.8	16	16	6	81	89
	Av	297.3	65.3	46.5	6	0.6	1.9	0.1	0	30	12.3	13.3	2.2	15.5	14.4	6.9	92.2	75.9
Lahi	1	331.4	84.6	59.1	8.6	0.6	0	0	0	7	17.2	15.6	2.6	13.6	13.5	8.7	120.7	88.6
	2	316.7	70.5	53.5	5.2	0.2	1	0	0	5	11.4	12	2.5	13.8	13.2	7	94	84
	3	290	72	52	8	0	0	0	0									
	Av	312.7	75.7	54.9	7.1	0.4	0.4	0	0	12	14.8	14.1	2.6	13.7	13.4	8	109.6	86.9
Pelipita	1	315.6	67.6	47.8	6.1	0.2	0	0	0	16	14.7	12.5	2.5	14.5	14.5	7.6	103.4	115.6
	2	384.6	80.1	60.8	6.9	0.3	1.9	0	0	6	15	12.5	2.7	16.3	15.2	6.3	91.2	164
	3	392.7	85	62.5	7.3	0.1	1.1	0	0	9	13.1	12.2	2.5	16.3	14.9	6.1	80.2	147.6
	4	384.3	79.1	58	6.6	0.4	2.6	0.1	0	5	11.4	14	2.7	15	14	7.6	104.6	127.3
	Av	369.3	78	57.3	6.6	0.2	1	0	0	36	13.9	12.6	2.6	15.3	14.7	7	95.7	132.6
Muracho	1	378.3	93.7	65.6	7.1	0.6	0	0	0	12	12.5	14.7	2	14.7	12.5	6.2	112	148.7
	2	386.2	85.6	62.1	6.5	0.5	5.1	0	BBTD	7	11.9	13.3	2.4	15.6	14.6	6.3	87.7	131.9
	3	377.8	78.3	63.6	7.7	1.3	7.1	0	BBTD	1	12	14	2.7	16	15	7	99	147
	4	383.3	84	65	6	1.3	0	0	0									
	Av	381.4	85.4	64.1	7	0.8	3.3	0	0	20	12.3	14.2	2.2	15.1	13.4	6.3	102.9	142.7
Pisang papan	1	312.1	73.6	52.3	6.4	0.2	0.4	0	BBTD	13	12.5	21.8	1.9	12.2	11.8	11.7	232.3	88.5
	2	383.8	89.5	65.3	6.5	0.1	3.5	0	0	5	12.3	20.2	1.6	11.6	9.9	10.8	253.6	77.2

CIBITOKE Cultivar	cycles	Plant height (cm)	Plant girth - base level	Plant girth - 1m level	Functional leaves	Dead leaves	Root necrosis %	Weevils % infestation	Other diseases	Number of bunches	Bunch weight (kg)	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits	Time flowering to harvest (days)
	3	376.3	81.6	60.9	8	0	4	0	0	6	11.8	22.7	2.2	13.3	12.2	12	219.3	70.3
	4	393.3	87.5	66.3	7.1	0.8	0.9	0	0	10	11.3	21.2	2.1	12.3	11.8	10.2	196.1	61.8
	Av	366.3	83	61.2	6.8	0.4	1.6	0	0	34	12	21.6	2	12.4	11.6	11.2	222.5	76.2
Lai	1	351.8	82.8	62.4	9.4	0.7	0.5	0	0	11	12.3	14.1	2.2	13.8	14.1	6.7	76.8	117.5
	2	380.9	82.5	63.2	7.1	0.7	2.1	0	BBTD	7	10.4	14.9	2.6	13.1	12.9	5.9	91.3	104.7
	3	383.3	87.7	66	6.7	0.2	2.3	0	0	5	11.1	13	2.4	14.4	13.5	5.2	65	97.4
	Av	370	73	49	8.1	0.6	1.4	0	0	23	11.4	14.1	2.3	13.7	13.6	6.1	78.7	109.2
To'o	1	231.2	53.3	34.8	5.7	0.2	0	0	BBTD	9	7.5	12.8	1.5	14	13.4	6.1	113	62
	2	250	49.9	33.8	6.6	0.4	1	0	0	8	3.3	10.5	0.7	13.4	11.9	4	30.9	73.1
	3	263.3	57.3	38.7	5.7	0.7	8.3	0.3	BBTD	1	5	21	1.5	13	12	5	67	62
	4	272.5	45.8	34.3	6.3	0.5	3	0	0	3	5.8	8	0.8	16.7	13	3.3	29.7	47.7
	Av	254.2	51.6	35.4	6	0.3	1.5	0	0	21	5.4	11.6	1.1	14.1	12.7	4.9	67.6	64.2
Igisahira	1	282.3	62.1	44.1	6.4	0.4	0	0	0	11	10.8	13.8	2.1	13.7	13.5	6.8	83.8	86.8
	2	345	77.3	52.5	6.5	0.7	4.7	0	BBTV	16	12.6	12.7	2.4	14.2	12.8	5.8	93.5	101.4
	3	316.7	71.2	47.6	6.3	0.4	5.6	0	0	8	8.2	14.4	1.9	13.9	12.4	5.5	78.6	82.8
	4	304.3	64.9	47.9	6.1	0.9	4.6	0.1	0	5	7.7	11.6	1.7	13.6	12.8	4.8	56.8	71.6
	Av	312.1	68.9	48	6.4	0.6	3.3	0	0	40	9.8	13.1	2	13.8	12.9	5.7	78.2	85.6
Kamara masenge	1	280.5	70.4	47.3	7.5	0.2	0.2	0	0	20	8.8	12.6	1.7	10.6	11.9	7	58.5	138.4
	2	307.8	65.6	42.2	7.1	0.4	2.9	0	0	14	5.1	12.9	0.9	8.5	10	5.7	57.9	126.1
	3	287.5	58.3	42.2	6.1	0.4	3.9	0	BBTV	10	4.4	12.2	1.3	9.9	10.6	5	55.4	107.3
	4	302.9	61.9	43.4	7.4	2.4	4.7	0	0	2	4	14	0.4	10	8	5	58	113
	Av	294.7	64	43.8	7.1	0.6	2.3	0	0	46	6.5	12.6	1.3	9.8	10.9	6.1	57.6	128
Umuzuzu	1	290.1	68.7	49.3	5.4	0.1	0	0	0	13	16.9	12.8	2.9	19.9	14	6.6	83.7	118.9
	2	346.7	67	47.9	5	1	4.7	0	BBTD	4	17	12.5	3.1	21.1	14.1	7	84.8	96.6
	3	300	49	32	6	2.7	3	0	BBTD									
	Av	312.3	61.6	43.1	5.5	1.3	2.6			17	16.2	12.6	3	20.5	14.1	6.8	84.2	108.4

Appendix 2. Average agronomic parameters for different cycles in South Kivu

INERA Cultivar	Cycle	No. of suckers removed	Height	Girth at base	Girth at 1m	Functional leaves	Dead Leaves	Functional ROOTS	Dead roota	Root necrosis %	Sigatoka	Fusarium	Weevils %	No. of bunches	Time flowering to harvest (days)	Bunch weight	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits
Apantu	1	2.4	270.5	72.9	51.6	8.9	4.2	17.1	3.4	18.8	5.5	0.0	0.0	12.0	138.0	15.4	11.8	1.8	19.6	11.9	7.8	90.3
	2	1.7	297.5	69.7	50.4	6.7	2.1	15.4	3.6	12.2	5.9	0.0	0.0	11.0	162.4	19.9	12.6	2.4	17.8	11.1	8.4	96.7
	3	2.5	282.5	77.9	58.7	6.7	3.1	13.2	4.4	34.5	5.2	0.0	0.0	11.0	111.9	20.5	10.8	2.0	18.2	10.8	6.3	86.5
	4	2.6	269.8	72.6	51.9	6.6	2.1	13.5	5.8	36.0	5.3	0.0	0.0	6.0	129.7	13.9	10.7	1.7	17.8	11.3	6.5	83.2
	Av	2.3	280.1	73.3	53.1	7.2	2.9	14.8	4.3	25.4	5.5	0.0	0.0	40.0	135.5	17.4	11.5	1.9	18.4	11.3	7.2	89.2
Bira	1	2.8	295.7	70.7	57.2	10.1	7.7	14.6	2.2	10.8	5.6	0.0	0.0	10.0	119.7	12.3	12.5	1.5	10.6	10.4	7.2	77.2
	2	4.2	283	74.5	54.2	9.2	3.5	14	2.6	13.1	5.2	0.0	0.0	10.0	113.6	13	11.8	1.6	11.8	10.7	8.4	81.8
	3	4.2	282.2	78.5	58.4	8.9	3.1	12.5	3.4	27.3	5.6	0.0	0.0	8.0	116.8	13	10.1	1.6	9.3	10.1	7.6	78.8
	4	3.3	282.4	75.4	55.3	9.2	3.9	10.3	4.5	35.6	5.1	0.0	0.0	15.0	121.4	12.1	11.3	1.3	9.0	10.0	7.8	89.9
	Av	3.6	285.8	74.8	56.3	9.3	4.5	12.8	3.2	21.7	5.4	0.0	0.0	43.0	117.9	12.6	11.4	1.5	10.2	10.3	7.7	81.9
Lahi	1	3.0	308.2	80.2	62.0	10.4	4.3	15.9	3.4	10.6	4.8	0.0	0.0	9.0	147.9	16.8	12.4	1.9	14.1	12.6	8.9	100.7
	2	2.4	293.4	79.7	59.6	8.1	4.0	15.7	2.6	14.3	5.9	0.0	0.0	7.0	126.3	18.9	12.4	1.9	12.1	11.4	10.1	131.3
	3	2.6	278.3	83.1	62.7	7.4	3.4	17.2	4.3	28.7	5.7	0.0	0.0	12.0	148.8	19.8	11.5	1.9	11.6	11.3	8.9	149.9
	4	3.3	299.8	69.0	55.0	8.1	3.8	15.6	3.8	37.8	2.8	0.0	0.0	7.0	142.6	19.4	10.8	1.8	12.4	12.0	10.2	148.2
	Av	2.8	294.9	78.0	59.8	8.5	3.9	16.1	3.5	22.8	4.8	0.0	0.0	35.0	141.4	18.7	11.8	1.9	12.6	11.8	9.5	132.5
Lai	1	4.4	370.4	82.3	63.4	10.5	5.2	16.0	3.1	18.6	7.3	0.0	0.0	7.0	180.1	15.0	12.9	2.5	17.1	12.1	5.7	73.1
	2	4.4	387.5	77.6	57.1	9.1	3.5	14.3	2.5	17.0	5.8	0.0	0.0	8.0	153.8	15.4	12.4	2.7	13.4	10.6	5.4	71.9
	3	4.0	382.2	85.0	68.0	10.5	2.8	14.2	3.7	20.8	6.3	0.0	0.0	6.0	156.3	12.8	12.0	2.1	14.0	10.3	5.5	67.7
	4	4.3	378.7	85.2	66.8	8.2	3.5	13.6	4.3	43.0	7.6	0.0	0.0	7.0	169.0	14.6	12.3	2.2	15.4	12.1	5.6	72.4
	Av	4.3	379.7	82.5	63.8	9.6	3.7	14.5	3.4	24.9	6.7	0.0	0.0	28.0	164.8	14.5	12.4	2.4	15.0	11.3	5.5	71.3
Muracho	1	5.7	378.7	81.3	62.3	13.7	3.0	19.0	3.0	11.3	7.0	0.0	0.0	3.0	156.0	21.7	13.3	2.6	17.3	13.7	8.3	123.3
	2	5.6	374.0	80.0	63.3	13.0	3.3	21.0	3.3	13.0	7.0	0.0	0.0	3.0	146.7	21.7	13.3	2.4	17.3	13.7	11.0	139.7
	3	6.0	370.0	76.0	60.3	12.3	3.0	18.0	4.3	22.0	6.3	0.0	0.0	3.0	111.0	21.0	13.0	2.4	17.7	13.3	11.7	126.7
	4	6.0	359.7	70.3	55.0	11.7	3.0	17.0	3.3	39.3	6.0	0.0	0.0	3.0	129.0	20.0	12.0	2.4	16.0	13.0	7.0	109.3
	Av	5.8	370.6	76.9	60.3	12.7	3.1	18.8	3.5	21.4	6.6	0.0	0.0	12.0	135.7	21.1	12.9	2.4	17.1	13.4	9.5	124.8
Pisang Papan	1	4.5	284.1	75.3	54.9	10.7	5.4	14.9	2.8	13.2	5.7	0.0	0.0	11.0	129.1	15.1	15.6	1.7	10.8	6.6	8.0	123.2
	2	7.6	294.7	77.7	59.2	10.3	4.0	13.7	3.1	17.7	5.3	0.0	0.0	15.0	125.7	16.1	15.7	1.6	12.7	8.5	9.4	151.6
	3	7.5	294.2	83.8	63.7	9.8	3.2	12.5	4.6	32.1	5.8	0.0	0.0	12.0	138.4	17.5	15.4	1.7	10.0	6.9	7.7	137.6
	4	4.1	294.5	84.8	65.4	9.5	3.6	9.3	4.1	33.7	4.6	0.0	0.0	9.0	113.0	17.8	14.0	1.4	9.4	5.7	10.6	157.1

INERA Cultivar	Cycle	No. of suckers removed	Height	Girth at base	Girth at 1m	Functional leaves	Dead Leaves	Functional ROOTS	Dead roota	Root necrosis %	Sigatoka	Fusarium	Weevils %	No. of bunches	Time flowering to harvest (days)	Bunch weight	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits
	Av	5.9	291.9	80.4	60.8	10.1	4.1	12.6	3.6	24.2	5.3	0.0	0.0	47.0	126.5	16.6	15.2	1.6	10.7	6.9	8.9	142.4
Pelipita	1	5.2	286.9	79.7	59.6	10.7	5.5	14.4	2.1	14.2	5.6	0.0	0.0	10.0	172.7	14.6	10.8	2.1	11.8	13.8	6.6	72.3
	2	6.2	295.4	83.1	62.6	10.1	4.4	13.2	2.8	18.5	5.5	0	0	12.0	168.6	17.1	11.4	2.15	11.9	11.9	7.1	74.9
	3	6.3	289.7	82.3	61.8	9.3	3.4	13.0	3.9	26.8	5.7	0.0	0.0	7.0	135.5	16.0	11.1	2.2	12.7	12.5	6.0	71.6
	4	4.8	285.7	81.1	62.3	8.7	3.6	10.6	4.6	38.7	4.7	0.0	0.0	9.0	151.7	17.9	9.0	1.8	10.7	12.9	7.0	80.4
	Av	5.6	289.4	81.6	61.6	9.7	4.2	12.8	3.3	24.5	5.4	0.0	0.0	38.0	157.1	16.4	10.6	2.1	11.8	12.8	6.7	74.8
To'o	1	4.2	256.5	56.9	36.5	10.5	6.8	16.1	3.4	24.6	7.4	0.0	0.0	11.0	94.4	2.5	10.0	0.7	14.7	7.2	3.7	34.2
	2	6.5	261.6	61.5	41.0	10.3	4.9	10.5	1.6	10.7	5.5	0.0	0.0	13.0	103.8	2.5	11.5	0.5	15.2	9.0	4.0	40.9
	3	6.8	267.5	59.9	39.9	9.6	3.3	13.1	3.5	30.5	6.1	0.0	0.0	15.0	100.2	2.0	12.7	0.4	15.5	7.9	3.2	35.8
	4	3.9	243.1	47.2	29.5	7	3.3	9.1	3.4	29.8	4.8	0.0	0.0	10.0	104.8	2.3	9.9	0.52	13.8	5.9	3.2	33.5
	Av	5.4	257.2	56.4	36.7	9.3	4.6	12.2	3.0	23.9	6.0	0.0	0.0	49.0	100.8	2.3	11.0	0.5	14.8	7.5	3.5	36.1
Barhabesha	1	5.3	296.2	79.9	59.6	10.5	5.3	14.9	1.8	15.0	5.6	0.0	0.0	8.0	123.8	24.3	15.8	2.7	20.6	10.8	8.5	162.6
	2	5.1	306.3	83.8	63.2	9.7	3.6	15.7	3.3	18.3	5.5	0.0	0.0	12.0	159.3	29.0	15.8	2.7	18.8	11.2	9.8	160.2
	3	5.4	307.9	87.7	67.2	9.1	3.3	15.4	3.5	30.0	6.3	0.0	0.0	10.0	140.6	31.0	15.2	2.6	18.6	10.8	9.1	159.2
	4	5.3	299.8	83.3	63.9	8.4	3.1	11.6	5.1	36.6	5.1	0.0	0.0	7.0	123.4	21.1	14.4	2.2	19.3	9.4	8.4	161.7
	Av	5.3	302.5	83.7	63.5	9.4	3.8	14.4	3.4	25.0	5.6	0.0	0.0	37.0	136.8	26.4	15.3	2.5	19.3	10.5	8.9	160.9
Gros Michel	1	4.8	303.9	87.2	63.2	11.4	8.0	17.2	4.1	19.6	7.3	0.0	0.0	10.0	179.6	24.1	14.7	1.9	19.8	13.1	11.5	172.2
	2	4.5	318.6	89.1	68.8	10.5	4.4	13.5	2.7	16.2	5.7	0.0	0.0	11.0	163.8	31.9	15.5	2.7	20.3	10.7	11.1	174.7
	3	4.4	311.9	88.7	68.4	10.0	3.8	13.0	5.7	38.2	6.9	0.0	0.0	9.0	142.8	32.6	14.9	2.3	18.1	11.4	11.0	188.1
	4	4.8	302.6	83.9	63.8	8.8	3.5	13.8	5.4	35.6	5.8	0.0	0.0	9.0	135.9	25.4	13.4	1.9	18.6	12.0	10.6	191.6
	Av	4.6	309.3	87.2	66.1	10.2	4.9	14.4	4.5	27.4	6.4	0.0	0.0	39.0	155.5	28.5	14.6	2.2	19.2	11.8	11.0	181.6
Musheba	1	2.7	298.5	74.2	58.1	9.8	7.3	16.5	2.3	10.6	5.5	0.0	0.0	10.0	119.2	19.3	15.5	2.2	20.9	11.1	7.9	115.9
	2	2.4	291.0	80.0	60.0	9.6	3.4	12.7	1.9	10.7	6.4	0.0	0.0	10.0	126.1	27.6	14.9	3.2	19.3	12.1	7.9	107.0
	3	3.3	290.8	81.6	61.5	7.6	3.2	12.7	3.4	32.8	5.5	0.0	0.0	7.0	139.4	29.9	14	2.84	19.3	11.2	6.2	113.7
	4	3.0	280.0	63.6	50.4	6.7	4.3	10.2	4.7	34.8	4.2	0.0	0.0	10.0	123.7	17.5	13.7	1.9	19.7	11.2	6.7	104.8
	Av	2.9	290.1	74.9	57.5	8.4	4.6	13.0	3.1	22.2	5.4	0.0	0.0	37.0	127.1	23.6	14.5	2.5	19.8	11.4	7.2	110.4

BURHALE Cultivar	Cycle	No. of suckers removed	Height	Girth at base	Girth at 1m	Functional leaves	Dead Leaves	Functional ROOTS	Dead roota	Root necrosis %	Sigatoka	Fusarium	Weevils %	No. of bunches	Time flowering to harvest (days)	Bunch weight	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits
Apantu	1	2.5	252.6	48.1	41.9	7.4	5.5	11.5	2.1	3.6	4.6	0.0	0.0	11	151.9	13.0	9.7	1.8	19.5	12.9	6.8	72.6
	2	1.7	261.4	69.5	49.4	6.5	2.5	15.2	0.5	0.2	5.5	0.0	0.0	13	162.8	15.2	11.8	2.5	15.5	9.5	5.5	71.2
	3	2.4	267.3	49.3	41.3	7.9	3.7	16.3	2.3	9.1	5.1	0.0	0.0	7	156.9	13.6	10.9	2.0	19.0	10.3	6.6	74.9
	4	2.4	254.7	55.0	42.0	6.0	2.1	13.3	5.0	24.5	6.0	0.0	0.0	4	122.5	11.5	10.0	1.6	18.5	10.8	6.0	62.0
	Av	2.3	259.0	55.5	43.6	6.9	3.4	14.1	2.5	9.4	5.3	0.0	0.0	35	148.5	13.3	10.6	2.0	18.1	10.9	6.2	70.2
Bira	1	1.3	259.5	50.6	42.4	6.1	3.7	10.5	1.3	5.1	3.8	0.0	0.0	11	104.8	10.5	9.8	1.4	10.5	11.0	7.0	53.5
	2	4.3	284.3	69.3	52.3	9.4	2.5	18.5	1.2	1.0	4.8	0.0	0.0	12	106.8	11.3	10.3	1.8	10.6	9.3	5.8	56.8
	3	3.5	275.3	63.2	46.2	7.8	2.5	16.3	2.8	9.6	5.7	0.0	0.0	11	114.1	11.6	11.0	1.7	9.2	10.7	6.4	67.8
	4	3.3	260.0	55.0	37.4	5.3	1.6	11.0	4.1	23.1	6.0	0.0	0.0	7	128.7	9.1	10.1	1.4	7.0	9.6	6.0	57.7
	Av	3.1	269.8	59.5	44.6	7.2	2.6	14.1	2.4	9.7	5.1	0.0	0.0	41	113.6	10.6	10.3	1.6	9.3	10.1	6.3	59.0
Lahi	1	2.2	324.5	72.6	57.7	9.1	5.4	9.4	2.5	9.3	6.1	0.0	0.0	10	124.0	12.6	10.8	1.54	14.4	12.4	7.7	78.6
	2	2.5	320.3	65.2	48.7	9.6	2.4	17.7	1.6	2.1	4.4	0.0	0.0	12	154.2	12.3	9.8	1.6	11.9	10.1	8.0	94.9
	3	2.5	353.8	73.0	52.5	8.2	3.5	13.5	2.2	9.7	5.5	0.0	0.0	6	159.2	13.5	9.5	1.6	12.3	13.0	8.7	79.3
	4	2.5	342.0	67.5	48.3	6.2	2.0	10.5	4.3	25.2	5.7	0.0	0.0	6	137.3	12.2	8.7	1.4	10.7	11.8	7.7	70.7
	Av	2.4	335.1	69.6	51.8	8.3	3.3	12.8	2.6	11.6	5.4	0.0	0.0	34	143.7	12.7	9.7	1.5	12.3	11.8	8.0	80.9
Lai	1	2.5	324.9	74.8	49.5	7.0	3.4	11.3	2.6	11.9	5.9	0.0	0.0	11	134.2	12.5	11.2	2.1	13.0	11.2	5.7	60.6
	2	4.6	334.2	82.5	61.8	9.1	1.7	19.3	2.1	1.4	5.6	0.0	0.0	8	157.9	12.4	11.3	2.5	13.6	8.5	4.4	48.3
	3	3.8	353.8	71.0	57.6	8.4	2.8	16.7	2.3	5.5	4.8	0.0	0.0	6	186.2	13.5	13.0	2.3	12.3	11.2	5.3	63.5
	4	3.8	342.0	75.0	52.9	6.4	2.0	12.5	4.7	22.0	5.3	0.0	0.0	6	152.0	12.2	12.3	2.1	10.7	10.0	4.3	54.0
	Av	3.7	338.7	75.9	55.4	7.7	2.5	14.9	2.9	10.2	5.4	0.0	0.0	31	157.6	12.6	11.9	2.2	12.4	10.2	4.9	56.6
Muracho	1	4.0	365.7	66.3	47.0	10.0	2.3	13.3	3.3	6.7	6.3	0.0	0.0	3	174.3	14.7	14.3	2.1	17.0	12.7	7.3	124.0
	2	5.3	355.7	63.3	43.0	10.3	3.0	15.0	4.0	8.7	4.7	0.0	0.0	3	150.7	17.0	13.7	2.1	16.7	13.0	7.7	122.0
	3	4.3	351.0	63.0	42.0	12.0	4.0	16.0	4.0	12.0	5.0	0.0	0.0	3	126.3	16.0	14.0	2.0	16.0	12.7	7.7	115.3
	Av	4.5	357.4	64.2	44.0	10.8	3.1	14.8	3.8	9.1	5.3	0.0	0.0	9	152.2	15.9	14.0	2.1	16.6	12.8	7.6	120.4
Pisang Papan	1	2.7	269.1	54.2	45.9	7.3	4.5	9.3	1.7	3.3	5.5	0.0	0.0	12	127.5	12.9	13.7	1.6	10.1	9.0	7.8	109.4
	2	5.8	270.1	56.7	43.5	8.4	3.9	16.5	0.6	1.1	5.1	0.0	0.0	12	138.4	13.8	12.2	1.6	9.8	7.6	7.4	83.7
	3	5.1	301.1	63.8	50.3	10.5	3.6	15.4	2	8.6	5.3	0	0.0	10	145.2	15.3	12.1	1.65	9.8	9.2	8.6	102.3
	4	5.1	288.1	56.5	45.2	8.5	2.6	10.6	4.3	21.1	5.3	0.0	0.0	8	125.6	13.5	12.0	1.4	9.0	8.8	7.9	93.0
	Av	4.7	282.1	57.8	46.2	8.7	3.7	13.0	2.1	8.5	5.3	0.0	0.0	42	134.2	13.9	12.5	1.6	9.7	8.6	7.9	97.1
Pelipita	1	2.9	277.6	57.7	52.1	7.7	4.6	9.5	1.5	4.4	5.7	0.0	0.0	11	182.2	12.0	11.2	1.9	11.8	6.6	5.6	60.5

BURHALE Cultivar	Cycle	No. of suckers removed	Height	Girth at base	Girth at 1m	Functional leaves	Dead Leaves	Functional ROOTS	Dead roota	Root necrosis %	Sigatoka	Fusarium	Weevils %	No. of bunches	Time flowering to harvest (days)	Bunch weight	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits
	2	6.2	292.5	62.2	44.1	10.8	2.8	15.9	1.5	3.0	5.5	0.0	0.0	13	152.2	13.4	9.9	2.4	12.5	6.2	5.2	58.6
	3	4.8	282.9	65.3	56.0	8.7	3.2	13.9	3.3	11.9	5.9	0.0	0.0	8	146.5	14.3	12.4	2.2	12.8	7.6	5.9	68.1
	4	4.8	270.4	58.8	51.8	6.7	2.3	11.3	5.5	26.0	5.5	0.0	0.0	6	145.2	13.2	11.8	1.8	10.7	7.0	5.7	56.2
	Av	4.7	280.9	61.0	51.0	8.5	3.2	12.6	2.9	11.3	5.7	0.0	0.0	38	156.5	13.2	11.3	2.1	11.9	6.9	5.6	60.8
To'o	1	1.6	248.9	39.3	30.0	6.3	5.0	10.2	1.5	5.3	4.7	0.0	0.0	11	90.4	2.5	7.9	0.6	11.7	6.6	3.5	25.9
	2	6.6	255.0	63.2	40.8	9.1	2.1	15.9	1.2	3.4	5.4	0.0	0.0	13	97.1	2.5	12.6	0.9	15.7	5.8	2.5	24.5
	3	4.6	258.5	50.2	36.5	10.2	2.7	14.9	1.1	3.4	5.4	0.0	0.0	10	111.2	2.0	10.6	0.5	13.7	6.0	3.3	31.9
	4	4.6	245.8	43.9	33.1	8.2	2.9	11.7	4.1	20.4	5.6	0.0	0.0	10	106.7	1.9	10.4	0.4	11.9	5.4	2.7	22.3
	Av	4.4	252.1	49.1	35.1	8.4	3.2	13.2	2.0	8.1	5.3	0.0	0.0	44	101.3	2.2	10.4	0.6	13.2	6.0	3.0	26.2
Barhabesha	1	5.1	286.7	64.6	49.5	8.1	4.4	11	1.7	5.2	4.4	0.0	0.0	10	164.3	16.7	14	2.2	16.6	12.2	7.3	120.1
	2	5.9	280.3	66.2	49.3	8.3	5.2	17.8	1.1	4.4	5.1	0.0	0.0	13	136.1	18.6	14.5	2.2	17.8	11.6	8.0	122.4
	3	5.2	282.8	69.3	52.4	10.1	4.1	11.9	2.6	11.7	4.8	0.0	0.0	9	162.1	15.0	14.6	1.8	15.3	11.8	8.9	150.6
	4	5.1	272.1	62.6	47.7	8.3	3.0	10.4	3.9	26.1	4.9	0.0	0.0	7	136.4	14.0	13.9	1.5	13.9	11.1	8.7	139.4
	Av	5.3	280.5	65.7	49.7	8.7	4.2	12.8	2.3	11.8	4.8	0.0	0.0	39	149.7	16.1	14.2	1.9	15.9	11.7	8.2	133.1
Gros Michel	1	1.8	298.0	70.4	49.0	6.4	4.4	9.8	2.4	6.5	5.0	0.0	0.0	12	145.6	18.6	12.9	2.1	14.3	11.4	8.3	114.0
	2	4.3	306.5	69.5	51.5	9.2	6.2	17.6	0.6	1.2	6.4	0.0	0.0	13	162.1	19.8	15.0	1.9	20.5	10.0	9.8	152.2
	3	4.3	327.4	80.0	59.6	11.6	3.9	15.3	2.9	4.3	5.4	0.0	0.0	7	159.1	21.1	13.0	2.1	19.3	10.9	9.3	131.4
	4	4.3	314.7	72.9	53.6	9.6	3.6	11.3	4.1	23.0	6.0	0.0	0.0	7	136.0	19.4	12.3	1.9	17.1	10.0	8.3	120.9
	Av	3.7	311.7	73.2	53.4	9.2	4.5	13.5	2.5	8.7	5.7	0.0	0.0	39	150.7	19.7	13.3	2.0	17.8	10.6	8.9	129.6
Musheba	1	1.9	289.6	57.3	51.7	6.5	4.7	10.1	2.3	2.8	5.2	0.0	0.0	12	133.3	15.1	12.8	2.4	17.7	12.7	5.9	68.8
	2	2.0	246.1	58.1	44.3	9.5	4.5	17.8	1.0	1.0	5.1	0.0	0.0	11	129.4	16.1	13.7	2.9	20.2	10.6	4.6	66.0
	3	2.5	273.3	57.2	48.5	8.7	4.5	17.3	1.8	8.3	5.5	0.0	0.0	6	152.7	15.8	12.7	2.1	17.3	11.5	6.7	81.5
	4	2.5	261.0	51.5	44.2	6.7	2.5	12.7	4.3	24.8	5.7	0.0	0.0	6	119.7	14.2	11.8	1.8	15.8	10.5	5.8	69.0
	Av	2.2	267.5	56.0	47.2	7.8	4.0	14.5	2.4	9.2	5.4	0.0	0.0	35	133.8	15.3	12.8	2.3	17.8	11.3	5.8	71.3

Appendix 3. Average agronomic parameters for different cycles in Tanzania

MARUKU Cultivar	Cycle	Plant height (cm)	Time flowering to harvest (days)	Plant girth - base level	Plant girth - 1m level	Functional leaves	Dead leaves	No. functional roots	No. dead roots	Root necrosis %	Sigatoka	Weevils %	No. of bunches	Bunch weight (kg)	No. of hands	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	Total No. of fruits
Apantu	1	214.9	113.3	57.4	44.0	7.1	2.7	7.2	2.3	4.4	5.1	0.0	13.0	9.5	5.7	10.2	914.3	17.8	12.4	58.7
	2	246.5	113.3	58.5	49.7	6.8	3.3	5.3	2.7	7.5	5.2	4.5	15.0	18.5	8.0	12.0	1511.0	21.1	14.4	95.5
	3	246.5	113.3	58.5	49.7	6.8	3.3	5.3	2.7	7.5	5.2	24.7	12.0	17.5	12.1	17.9	1490.0	17.9	120.3	101.7
	Av	236.0	113.3	58.1	47.8	6.9	3.1	5.9	2.5	6.5	5.1	9.7	40.0	15.1	8.6	13.4	1305.1	18.9	49.0	85.3
Biira	1	271.2	90.7	72.5	52.8	9.3	3.2	9.2	2.5	17.6	5.8	0.0	15.0	7.9	6.6	10.0	1063.1	10.6	11.5	70.7
	2	299.5	90.7	68.7	54.6	8.5	2.5	7.3	3.1	8.1	6.2	3.5	15.0	11.4	7.2	9.7	933.3	10.4	11.0	71.5
	3	381.3	88.7	84.7	68.2	11.5	2.8	7.4	2.1	3.4	7.7	6.6	15.0	13.6	9.7	12.9	1211.0	12.9	88.7	88.0
	Av	317.3	90.0	75.3	58.6	9.8	2.8	8.0	2.5	9.7	6.6	3.4	45.0	11.0	7.8	10.9	1069.1	11.3	37.1	76.7
Pelipita	1	293.5	143.7	60.9	47.8	8.9	2.2	11.4	2.5	9.4	6.4	0.0	15.0	12.4	6.4	10.3	1057.1	14.3	12.8	69.3
	2	321.0	143.7	75.9	57.7	9.7	3.3	7.2	2.9	12.5	7.3	0.0	15.0	19.0	8.5	10.9	2067.0	13.2	12.6	93.2
	3	321.0	143.7	75.9	57.7	9.7	3.3	7.2	2.9	12.5	7.3	8.6	15.0	15.4	10.9	13.1	1595.0	13.1	98.8	80.3
	Av	311.8	143.7	70.9	54.4	9.5	2.9	8.6	2.8	11.5	7.0	2.9	45.0	15.6	8.6	11.5	1573.0	13.5	41.4	80.9
Muracho	1	316.2	177.3	79.7	61.6	9.8	3.7	9.8	3.1	4.3	6.6	0.0	15.0	14.9	6.8	12.9	1443.1	12.8	11.1	105.7
	2	350.5	177.3	80.4	63.9	9.6	3.1	8.2	2.3	4.6	7.6	0.0	13.0	18.1	7.5	12.5	1334.0	13.1	14.6	99.6
	3	350.5	177.3	80.4	63.9	9.6	3.1	8.2	2.3	4.6	7.6	7.7	15.0	18.7	11.5	14.4	1510.0	14.4	149.1	96.7
	Av	339.1	177.3	80.1	63.2	9.7	3.3	8.7	2.5	4.5	7.3	2.6	43.0	17.2	8.6	13.2	1429.0	13.4	58.3	100.7
Pisang Papan	1	217.4	89.8	69.9	50.2	9.3	1.1	10.2	4.5	18.3	5.5	0.0	15.0	10.4	8.3	15.5	1083.1	9.4	9.8	127.8
	2	359.2	89.8	84.5	68.6	11.3	2.9	8.2	3.3	5.7	8.3	6.0	15.0	18.5	10.0	16.8	953.3	12.3	11.8	162.5
	3	359.2	89.8	84.5	68.6	11.3	2.9	8.2	3.3	5.7	8.3	7.4	15.0	21.0	13.3	11.8	1351.0	11.8	70.1	131.9
	Av	311.9	89.8	79.7	62.5	10.6	2.3	8.9	3.7	9.9	7.4	4.5	45.0	16.6	10.5	14.7	1129.1	11.2	30.6	140.7
To'o	1	199.1	80.5	54.7	33.0	7.8	2.1	8.7	5.3	33.9	4.4	0.0	15.0	2.6	4.0	10.5	421.1	11.5	8.6	45.5
	2	234.5	80.5	60.8	48.1	9.1	3.0	5.7	2.7	12.8	7.2	4.5	15.0	4.7	4.1	8.9	560.7	12.7	9.4	41.7
	3	234.5	80.5	60.8	48.1	9.1	3.0	5.7	2.7	12.8	7.2	8.1	15.0	4.5	8.4	14.4	456.0	14.4	65.0	37.7
	Av	222.7	80.5	58.8	43.0	8.7	2.7	6.7	3.5	19.9	6.3	4.2	45.0	3.9	5.5	11.3	479.3	12.9	27.7	41.6
Tumbago	1	205.2	96.7	57.1	41.6	8.6	1.8	10.8	4.0	7.8	5.6	0.0	14.0	5.0	7.1	11.9	527.8	8.8	8.8	85.6
	2	263.2	96.7	64.2	49.5	9.1	2.8	7.9	2.0	3.5	6.8	0.0	14.0	8.1	6.9	11.9	608.7	10.4	8.6	84.4
	3	263.2	96.7	64.2	49.5	9.1	2.8	7.9	2.0	3.5	6.8	1.1	14.0	9.4	10.4	10.7	665.0	10.7	81.9	79.5
	Av	243.9	96.7	61.8	46.9	8.9	2.4	8.9	2.7	4.9	6.4	0.4	42.0	7.5	8.2	11.5	600.5	10.0	33.1	83.2
Nshakara	1	289.1	175.8	68.9	47.3	8.9	3.3	10.0	3.3	1.3	4.0	0.0	15.0	12.1	6.4	9.9	1479.8	19.0	14.3	62.5
	2	310.2	175.8	69.2	55.6	7.7	2.0	5.2	3.5	7.1	4.8	1.0	13.0	23.1	8.1	11.1	1680.0	18.7	14.6	98.2
	3	310.2	175.8	69.2	55.6	7.7	2.0	5.2	3.5	7.1	4.8	11.9	15.0	18.1	9.7	14.9	1367.0	18.7	123.9	85.7
	Av	303.2	175.8	69.1	52.8	8.1	2.4	6.8	3.4	5.1	4.5	4.3	43.0	17.8	8.1	12.0	1508.9	18.8	50.9	82.2
Nyoya	1	282.2	157.0	59.6	43.4	8.2	3.2	9.8	2.3	1.1	5.1	0.0	15.0	10.4	5.5	10.4	894.9	13.9	11.6	63.1
	2	292.4	157.0	63.5	53.0	7.5	1.9	5.7	3.0	11.9	4.7	3.0	15.0	14.3	8.1	10.3	1259.0	15.7	14.2	99.9
	3	292.4	157.0	63.5	53.0	7.5	1.9	5.7	3.0	11.9	4.7	8.1	15.0	16.0	12.4	15.1	1276.0	15.1	113.5	100.1
	Av	289.0	157.0	62.2	49.8	7.7	2.3	7.0	2.8	8.3	4.9	3.7	45.0	13.5	8.7	11.9	1143.3	14.9	46.4	87.7
Nshasha	1	265.7	165.5	60.7	44.5	8.1	4.3	8.5	1.6	2.4	4.4	0.0	15.0	9.5	5.4	12.3	1019.8	13.0	12.1	66.6
	2	284.2	165.5	63.5	50.1	7.9	2.7	5.7	3.3	12.2	5.7	0.5	14.0	12.9	7.7	10.5	1443.0	15.2	13.7	96.8
	3	284.2	165.5	63.5	50.1	7.9	2.7	5.7	3.3	12.2	5.7	10.4	15.0	16.3	11.9	14.5	1106.0	14.5	111.2	89.4
	Av	278.0	165.5	62.5	48.2	7.9	3.2	6.7	2.7	8.9	5.3	3.6	44.0	12.9	8.4	12.4	1189.6	14.2	45.7	84.3

MISSENYI Cultivar	Cycle	Plant height (cm)	Time flowering to harvest (days)	Plant girth - base level	Plant girth - 1m level	Functional leaves	Dead leaves	No. functional roots	No. dead roots	Root necrosis %	Sigatoka	Weevils %	No. of bunches	Bunch weight (kg)	No. of hands	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	Total No. of fruits
Apantu	1	309.9	112.9	78.6	59.3	9.3	2.7	7.6	1.6	3.9	7.4	0.0	15.0	19.8	8.1	11.8	1324.0	20.6	13.6	104.5
	2	320.0	115.6	77.8	56.8	8.7	2.6	7.3	3.5	7.4	6.7	9.4	12.0	21.0	8.2	11.7	1412.0	18.6	13.7	102.1
	Av	315.0	114.3	78.2	58.1	9.0	2.7	7.5	2.5	5.6	7.0	4.7	27.0	20.4	8.1	11.8	1368.0	19.6	13.7	103.3
Bira	1	339.0	83.1	84.0	65.3	9.6	4.7	8.4	2.3	4.3	6.7	0.0	15.0	14.0	8.8	10.3	1401.0	13.9	12.2	93.4
	2	342.0	90.9	83.0	65.1	10.0	5.1	7.4	2.9	0.7	6.9	6.0	13.0	13.9	8.7	9.7	1347.0	13.8	12.4	88.5
	Av	340.5	87.0	83.5	65.2	9.8	4.9	7.9	2.6	2.5	6.8	3.0	28.0	13.9	8.7	10.0	1374.0	13.8	12.3	91.0
Pelipita	1	330.8	98.3	84.0	58.5	8.8	2.4	7.1	2.4	1.9	7.5	0.0	15.0	19.0	8.5	11.2	2067.0	14.3	14.2	96.5
	2	341.8	118.5	83.1	58.9	8.1	2.4	6.5	4.9	1.2	5.9	6.8	14.0	22.3	9.1	11.5	1777.0	14.1	14.1	103.9
	Av	336.3	108.4	83.5	58.7	8.5	2.4	6.8	3.6	1.5	6.7	3.4	29.0	20.7	8.8	11.4	1922.0	14.2	14.2	100.2
Muracho	1	378.9		84.4	60.9	10.3	2.9	7.3	0.3	1.9	6.9	0.0	15.0	23.9	8.1	14.3	1649.0	14.7	14.5	104.0
	2	361.9	145.3	78.8	56.4	9.5	2.9	7.7	1.9	0.6	5.5	6.2	15.0							
	Av	370.4	145.3	81.6	58.6	9.9	2.9	7.5	1.1	1.2	6.2	3.1	30.0	23.9	8.1	14.3	1649.0	14.7	14.5	104.0
Pisang Papan	1	325.1	72.4	79.3	57.3	9.1	3.9	8.3	2.0	2.7	7.7	0.0	15.0	19.3	10.2	15.1	1708.0	11.6	10.1	162.5
	2	308.8	84.1	79.6	58.1	8.9	3.9	8.1	1.9	0.4	7.5	8.3	15.0	27.9	11.5	13.9	1517.0	13.0	11.6	158.9
	Av	317.0	78.3	79.5	57.7	9.0	3.9	8.2	1.9	1.6	7.6	4.2	30.0	23.6	10.8	14.5	1612.5	12.3	10.9	160.7
To'o	1	278.4	65.9	68.1	50.2	8.6	3.4	6.5	2.4	3.1	6.4	0.0	15.0	4.5	4.9	10.1	393.0	14.1	10.6	50.7
	2	281.5	72.7	68.0	47.1	8.1	3.8	6.9	3.1	4.2	5.9	10.2	15.0	4.6	4.7	9.5	471.0	14.5	11.1	45.4
	Av	280.0	69.3	68.0	48.7	8.3	3.6	6.7	2.8	3.7	6.2	5.1	30.0	4.5	4.8	9.8	432.0	14.3	10.8	48.1
Tumbago	1	295.9	74.9	74.4	57.2	9.5	3.2	9.1	2.3	2.7	6.3	0.0	15.0	8.3	8.3	12.2	427.0	12.0	9.7	108.5
	2	292.0	81.2	74.1	57.0	9.5	3.9	8.2	2.4	0.2	7.2	1.3	12.0	7.9	8.5	12.1	421.0	11.9	9.0	109.1
	Av	294.0	78.1	74.3	57.1	9.5	3.6	8.6	2.4	1.5	6.8	0.6	27.0	8.1	8.4	12.1	424.0	11.9	9.4	108.8
Nshakara	1	348.2	130.4	81.3	61.5	8.8	2.7	5.9	1.2	2.5	6.8	0.0	15.0	23.0	8.3	11.3	1754.0	18.3	14.5	102.4
	2	356.0	125.1	78.7	62.3	8.3	3.1	6.3	2.9	1.4	4.5	10.5	11.0	20.8	8.2	9.6	1541.0	19.4	14.7	79.1
	Av	352.1	127.8	80.0	61.9	8.6	2.9	6.1	2.1	2.0	5.7	5.2	26.0	21.9	8.2	10.5	1647.5	18.9	14.6	90.8
Nyoya	1	353.2	130.3	75.7	57.3	8.4	3.1	6.7	2.2	3.9	7.0	0.0	15.0	16.1	8.4	10.9	1065.0	15.5	14.1	107.2
	2	364.3	128.0	74.6	55.4	7.9	3.1	6.7	2.2	2.1	4.4	10.0	13.0	16.4	8.5	13.2	1178.0	15.1	13.8	114.0
	Av	358.8	129.2	75.2	56.3	8.2	3.1	6.7	2.2	3.0	5.7	5.0	28.0	16.2	8.5	12.0	1121.5	15.3	13.9	110.6
Nshasha	1	348.7	120.5	73.8	55.7	9.5	2.5	6.8	2.6	3.9	7.1	0.0	15.0	13.8	7.8	11.1	1503.0	15.1	13.6	100.2
	2	350.5	122.5	75.3	53.4	8.0	2.7	6.7	2.9	4.0	3.5	9.5	11.0	19.4	7.8	12.8	1281.0	15.2	14.0	102.1
	Av	349.6	121.5	74.6	54.5	8.7	2.6	6.8	2.8	3.9	5.3	4.7	26.0	16.6	7.8	12.0	1392.0	15.1	13.8	101.2

Appendix 4. Average agronomic parameters for different cycles in Uganda

Cultivar	cycles	No. of suckers removed	Plant height (cm)	Plant girth - base level	Plant girth - 1m level	Functional leaves	Dead leaves	Root necrosis %	Sigatoka	Fusarium	Weevils % infestation	Number of bunches	Bunch weight (kg)	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits	Flowering to harvest (days)
Apantu	1	3.3	303.4	67.3	48.2	9.0	1.1	4.07	4.1	0.4	16.3	10.0	14.9	11.5	1.5	22.1	12.9	6.9	87.9	139.0
	2	2.0	353.2	63.6	49.2	8.8	1.2	4.73	3.3	0.0	55.5	4.0	13.2	11.0	1.3	22.3	11.6	7.0	73.7	121.7
	Av	2.8	322.1	65.9	48.6	8.9	1.2	4.40	3.8	0.3	25.5	14.0	14.4	11.4	1.4	22.1	12.6	6.9	84.6	135.0
Bira	1	4.7	337.6	68.7	53.9	12.3	1.6	1.33	3.6	0.0	14.7	15.0	11.8	10.8	1.2	16.1	12.1	7.6	90.3	71.0
	2	4.4	439.9	83.4	69.1	11.6	1.4	9.40	4.4	0.0	16.2	13.0	17.0	12.5	1.0	16.5	12.7	9.4	114.8	70.0
	3	3.0	351.9	69.2	52.3	11.0	1.0	0.40	3.0	0.0										
	Av	4.6	511.5	76.4	61.7	11.9	1.5	5.48	4.0	0.0	15.2	28.0	14.4	11.6	1.1	16.3	12.4	8.5	102.6	70.6
Lahi	1	4.6	359.2	87.9	63.7	9.1	1.5	3.73	5.0	0.4	13.2	14.0	19.5	12.6	1.6	17.4	14.6	8.9	110.9	118.0
	2	2.6	395.0	88.3	65.3	10.4	1.5	6.00	5.2	0.0	7.1	9.0	17.7	12.4	1.2	17.1	13.7	8.8	109.3	122.2
	Av	3.7	375.1	88.1	64.4	9.7	1.5	4.87	5.1	0.2	10.6	23.0	18.8	12.6	1.4	17.3	14.2	8.8	110.3	119.7
Pelipita	1	6.7	331.7	76.4	56.3	11.6	2.0	2.93	4.6	0.0	6.5	15.0	15.9	11.9	1.5	18.7	14.7	7.1	82.3	165.0
	2	2.9	362.5	77.8	57.6	11.6	1.7	6.13	4.5	0.0	5.9	12.0	17.1	12.0	1.7	17.9	14.3	7.8	94.1	162.7
	Av	5.0	346.3	76.7	57.0	11.6	1.9	4.53	4.5	0.0	6.4	27.0	16.5	12.0	1.6	18.2	14.6	7.4	88.3	163.9
Muracho	1	6.6	383.7	86.2	64.4	9.1	1.6	2.40	4.2	0.0	4.8	14.0	17.6	13.8	1.6	19.1	13.5	7.5	106.5	134.2
	2	3.0	411.2	99.0	79.5	9.0	2.0	1.80	5.0	0.0	6.0	1.0	10.2	12.0	1.0	17.7	12.2	6.0	77.0	217.0
	Av	6.3	385.5	87.0	65.5	9.1	1.6	2.10	4.2	0.0	4.8	15.0	17.1	13.7	1.5	19.0	13.4	7.4	104.5	139.7
Lai	1	4.9	388.8	83.4	65.7	7.7	1.5	1.87	3.7	0.0	6.7	8.0	12.7	14.4	1.9	18.1	13.7	5.4	76.3	136.5
	2	1.0	457.3	86.5	66.8	9.0	1.3	7.73	4.0	0.0										
	Av	4.1	402.5	84.0	65.9	7.9	1.5	3.53	3.7	0.0	6.7	8.0	12.7	14.4	1.9	18.1	13.7	5.4	76.3	136.5
Pisang Papan	1	7.9	339.3	79.6	58.1	12.1	1.6	4.38	3.7	0.0	4.6	15.0	15.4	17.3	1.8	12.8	9.9	8.9	157.5	75.4
	2	4.5	417.7	86.2	61.9	12.1	1.1	6.33	4.0	1.0	6.4	14.0	16.6	20.5	0.9	12.9	9.8	11.1	211.4	76.1
	3	4.0	471.2	75.8	54.7	13.0	0.5	0.33	4.5	0.0		29.0								
	Av	6.1	383.2	82.4	59.6	12.2	1.3	3.33	3.9	0.5	5.6	0.0	16.0	18.9	1.4	12.8	9.9	10.0	183.6	75.8
To'o	1	3.8	235.1	52.2	35.2	11.4	1.5	0.80	4.7	0.0	2.3	12.0	4.0	6.8	0.6	17.1	10.2	3.0	24.2	60.0

Cultivar	cycles	No. of suckers removed	Plant height (cm)	Plant girth - base level	Plant girth - 1m level	Functional leaves	Dead leaves	Root necrosis %	Sigatoka	Fusarium	Weevils % infestation	Number of bunches	Bunch weight (kg)	No. of fruits 2nd lowest hand	Weight 2nd lowest hand (gm)	Length of fruit (cm)	Girth of fruit (cm)	No. of hands	Total No. of fruits	Flowering to harvest (days)
	2	5.9	262.3	55.1	39.4	10.5	1.1	4.80	4.9	0.0	8.6	15.0	4.6	9.1	0.8	18.3	10.0	4.0	34.9	58.7
	3	3.7	234.8	56.4	38.1	9.8	1.6	2.79	4.9	0.0	11.3	9.0	4.8	7.2	0.5	18.8	12.1	3.8	24.9	57.9
	Av	4.6	245.5	54.3	37.5	10.7	1.4	1.07	4.8	0.0	6.7	36.0	4.5	7.9	0.7	18.0	10.6	3.6	28.8	58.9
Tudlo Tumbaga	1	6.5	250.7	62.7	45.2	10.9	1.5	4.60	5.5	0.0	4.2	15.0	6.9	11.7	0.5	12.9	14.6	6.9	80.1	64.6
	2	5.6	330.3	68.0	52.3	9.4	1.6	0.73	4.8	0.0	5.6	13.0	7.6	12.1	0.5	12.9	9.5	7.5	89.2	65.5
	3	4.2	341.7	69.4	49.6	9.6	1.8	2.13	5.8	0.0	7.3	5.0	7.9	13.3	0.7	13.6	9.7	6.7	90.0	69.4
	Av	5.8	296.9	65.9	48.8	10.1	1.6	4.07	5.2	0.0	5.3	33.0	7.4	12.1	0.5	13.0	11.8	7.1	85.3	65.7
Mbwazirume	1	4.5	301.7	72.0	54.3	7.0	1.7	5.60	2.8	0.6	10.7	14.0	12.8	12.6	1.0	16.1	11.8	6.9	91.4	98.9
	2	2.9	352.9	77.5	59.6	6.6	1.6	1.20	3.2	0.0	17.6	14.0	14.3	13.1	1.3	16.3	13.4	7.3	98.0	144.5
	3	3.2	387.1	84.5	67.4	8.2	0.8	3.62	2.2	0.0	9.0	1.0	17.2	14.0	1.6	19.5	14.2	7.0	116.0	156.0
	Av	3.6	335.3	76.1	58.4	7.0	1.6	1.33	2.9	0.3	13.8	29.0	13.7	12.9	1.2	16.3	12.6	7.1	95.4	122.9
Gonja	1	7.0	333.4	74.1	56.2	11.3	1.0	4.73	4.9	0.0	14.6	11.0	17.4	11.5	1.5	20.2	12.0	9.0	134.7	174.6
	2	3.4	370.2	77.6	61.5	10.2	1.6	5.27	4.1	0.0	16.0	5.0	16.5	13.2	1.3	20.0	12.8	9.0	145.0	164.4
	Av	5.7	347.2	75.4	58.2	10.9	1.2	3.78	4.6	0.0	14.9	16.0	17.1	12.0	1.4	20.1	12.2	9.0	137.9	171.4
Sukali Ndizi	1	4.0	256.4	54.2	38.5	8.9	1.9	1.40	4.1	0.1	8.5	14.0	7.4	11.7	0.6	12.3	10.8	6.7	77.6	125.9
	2	3.3	304.1	58.1	38.9	8.8	1.3	5.67	5.3	0.0	4.8	9.0	6.9	11.9	0.6	12.3	10.2	7.1	77.3	127.6
	3	3.5	318.1	65.0	44.8	8.0	1.5	2.13	4.5	0.0										
	Av	3.7	280.4	56.5	39.1	8.8	1.6	3.07	4.6	0.0	6.8	23.0	7.2	11.8	0.6	12.3	10.6	6.9	77.5	126.6