VITAMIN A RICH BANANA-ADOPTION IN GITEGA AND CIBITOKE, BURUNDI

Field diagnostic study report

Transforming Agri-Food Systems in West and Central Africa

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ABSTRACT

Vitamin A deficiency (VAD) is a widespread problem in the sub-Saharan Africa (SSA). Here the population is predominantly reliant plant-based diets. Thus, identification of popular food sources with higher vitamin A contents is a suitable means for addressing VAD. For example, Burundi has a VAD prevalence of 46%. In this region, bananas and plantains are a cheap staple food crop and therefore, offer a good avenue for supplying vitamin A in the diets. To address VAD in the region, Bioversity International under through Consortium for Improving Agriculture-based Livelihoods in Central Africa (CIALCA) and HarvestPlus grants undertook studies to fast-track deployment of native and introduced pro-vitamin A rich bananas. Through the OneCGIAR – West and Central African Food Systems and CIALCA bridge year funds, the Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT) undertook an adoption study of the VABs in the pilot sites in Burundi to inform plans for a wider scaling effort. The study interviewed 332 household heads, had qualitative discussions in four focus groups. A positive perception was observed among farmers growing the VABs due to their early maturity, high vitamin A content, and long storage life. Adoption rates among initial beneficiaries were 45% in Gitega and 12% in Cibitoke. These rates could have been higher if not for the impact of COVID-19 that interrupted project activities and prevented additional support to the farmers, just after accessing the plantlets. For example, some farmers were skeptical of the small macro-propagated plantlets as they were used to using suckers, and as such failed to plant them. Some lost plants due to the dry spell, yet simple practices such as mulching could have sustained the plants. In Cibitoke, the government policy assigning the region to rice production led to uprooting and abandonment of banana by most households, including those in the pilot area, leading to the low adoption. However, willingness to adopt these materials was high, varying between 86-90% across the sites. The adopters were observed to have expanded the area under the VAB. Diffusion from the adopters to other farmers was also high, with two farmers reporting to have shared over 200 suckers with over 70 farmers in Gitega. Alternative uses including beer making had been identified by farmers at the time of the study. Access to planting materials and awareness on the nutritional value of the VABs, especially among indirect beneficiaries, were a major stumbling block to VAB adoption,

expansion, and use. Thus, scaling efforts will need to focus on establishing robust seed systems and enhancing community awareness on the importance of vitamin A in their diets. Some farmers were observed to have a large influence on the dissemination of planting materials, thus, could be targeted as conduits in a more sustainable and robust seed system. Ongoing efforts to co-invest with partners such as ENABEL, World Vision, and the NARS will be handy in furthering the adoption and use of these varieties.

1. INTRODUCTION

Banana and plantains (hereafter banana) is the leading fruit crop and ranked as the fourth most important global food crop in terms of gross value of production (Woldu et al, 2015; Alemu, 2017). Due to its nutritional and richness in vitamin, banana is recommended for prevention of some disease (Engelberger, 2003). Apart from being an important food crop, banana is also an important source of income to producers (including low-income households) and many along the value chain of the crop (Karamura et al, 1998; Alemu, 2017). The Sub-Saharan Africa alone, produces a quarter of world banana production (FAO, 2021), and East and Central Africa produced 15 to 18% of world production in a period of ten years (FAO Stat, 2001-2011). Burundi is among the top twenty producers of banana and plantains and among largest producer in SSA (Jagwe, 2014; FAO, 2021). Compared to other crops, banana occupies 29% of the total area cultivated in Burundi (FAO, 2010; Baramburiye et al, 2012). Most banana farmers are smallholders, producing for home use or local market and the crop accounts for 45% of the total food production in volume, and 30% of the smallholders' incomes (Jenicek et al., 2015). The contribution of banana in the diet was reported to have increased at a rate of 11% over a fifteen-year period (Ndayiragije et al, 2017).

Banana thus plays a key role as a food, nutrition, and cash crop in Burundi where the food security situation is alarming. In fact, Burundi has one of the highest rates of all forms of malnutrition in the world (Odjidja et al., 2022). Majority of Burundians are living in alarming levels of food insecurity, with more than a half of children under 5 years being stunted, mostly in the rural area (WFP, 2022). According to Global Food Security report (2018), half of the population of Burundi is chronically food insecure. The prevalence of vitamin A deficiency is 46% and significantly exceeds the WHO average of 30% (Fongar et al., 2020). The malnutrition situation above has ramifications including long-lasting harmful consequences, like poor child development with diminished mental and learning capacity which leads to poor school performance during childhood and increased risks of nutrition-related chronic diseases. The problem of vitamin A deficiency alone can lead to severe consequences like visual impairment and preventable blindness in children; compromised immune system, significantly increasing inability to fight severe illnesses and even death from childhood diseases (Fongar et al., 2020).

Both research- and non-research-based efforts have been devoted to the alleviation of the situation like the implementation of a multisectoral community-based nutrition interventions by UNICEF to tackle the issue of malnutrition. It contributes also in implementation of a stunting prevention program for children aged under 5 years using specialized nutritious foods for children and pregnant and breastfeeding women by WFP. In 2015, the government of Burundi included nutrition services into the pre-existing performance-based financing free health care policy to contribute to the alleviation of the nutrition status of under 5 children.

Plant sources account for over 80% of vitamin A intake in low-income countries (Van den Berg et al. 2000). The promotion of diets that contain provitamin A-rich food crops is considered as a more sustainable strategy for combating VAD. Given the importance of banana in the production and food systems of Burundi, it could offer a good avenue for delivering vitamin A within households. Some banana varieties have been shown to be rich in provitamin A and can potentially help in alleviating Vitamin A deficiency (VAD). (Englberger, 2003; Ekesa et al., 2015; Blomme et al. 2019).

To fast track, the alleviation of vitamin A deficiency, in Burundi the Alliance of Bioversity International and CIAT through the HarvestPlus and CIALCA projects have promoted a range of pro-vitamin A rich banana cultivar in pilot rural sites with high VAD in Burundi. Promotional activities of the vitamin A bananas (VAB) included on farm assessment for agronomic performance and consumer acceptability, and demonstration of agronomic practices at the different trial sites, including on farmer's plots. Farmers were later trained on the cultivation techniques, methods of cooking and the nutritional and health benefits of the VABs. At the present, nothing is known about the situation of these varieties on field. For a wider scaling, it was crucial to determine the level of acceptability of the VABs and potential challenges to adoption. We thus conducted a study to determine the i) perceptions towards the VAB; willingness, level and determinants of adoption of vitamin A rich banana in the two sites; ii) sources of the planting material and their flow within the community; iii) utilisation of the different VAB varieties by farmers; and iv) challenges to the adoption of the VAB.

2. METHODOLOGY

2.1 Geographic location of the two sites

This study was conducted in two Provinces precisely Rugombo Commune in Cibitoke Province and Giheta Commune in Gitega Province (Fig. 1). Rugombo commune is located in the western part of Cibitoke Province. Its area is estimated to be 215.70 km^2, or 13.18% of the province (1635.52 km^2) and 0.7% of the country (27,834 km^2). To the South-West, the Rugombo Commune borders with the Democratic Republic of Congo (DRC). The commune of Rugombo is administratively subdivided into two zones (Cibitoke and Rugombo) and six Collins. The sites of intervention of the project were Kagazi, Mparambo and Munyika and are spread out in the two zones (Cibitoke and Rugombo) of Rugombo Commune. Giheta Commune is located in the northern part of Gitega Province. It has an estimated surface area of 155.56 km^2 or 7.8% of the area of the province (1978.96 km^2) and 0.56% of the area of the country. Administratively, it's subdivided in to three zones: Giheta, Kabanga and Kiriba. Muremera and Gwingiri were two sites of intervention of the project and were located in the zones of Giheta and Kiriba, respectively.

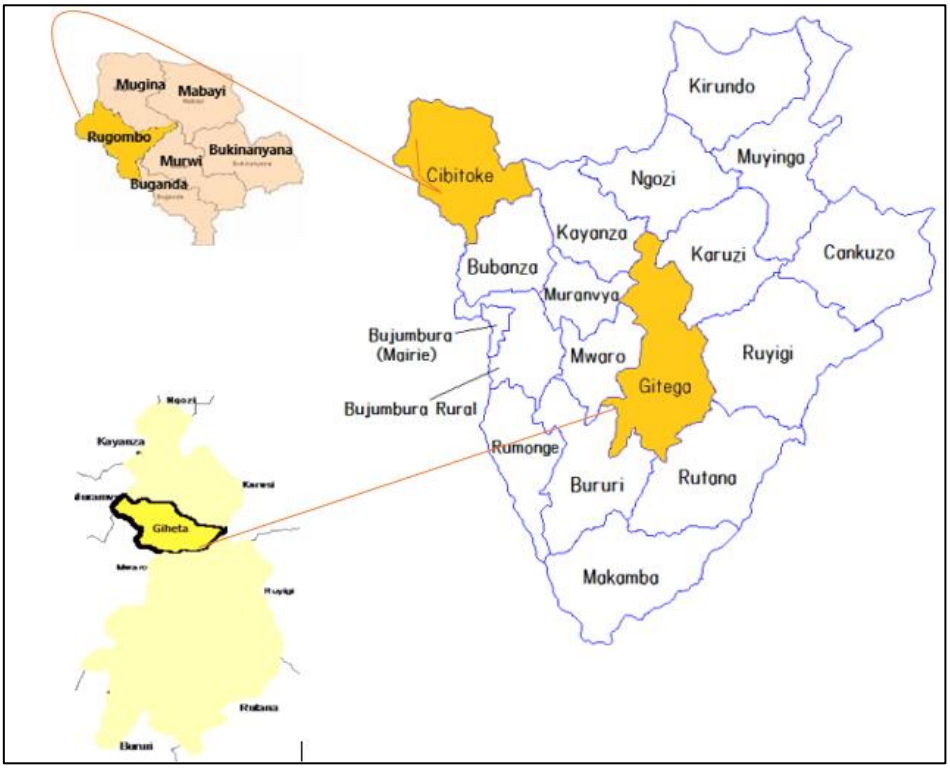

Figure 1. The map of the two sites of intervention. *Source*: Fonger et al. (2019)

The Rugombo commune is in the Imbo region characterized by an altitude between 800 m and 1,000 m, a tropical climate, an average annual rainfall of 900 mm, a network watershed formed by the waters of the Rusizi river and a savannah grassland vegetation.

Giheta commune is in the Kirimiro region characterized by an altitude varying between 1,600 m and 2,000 m; a tropical climate; an average annual rainfall of about 1200 m; an average annual temperature of 19°c; and important hydrographical networks of rivers.

2.2 Importance of banana in the two communes

The importance of the banana could provide information on how far this crop can get more attention to growers based on the use in the community and household level Rugombo commune ranks third in banana production out of six communes in Province and has a production 35,934 tonnes annually (9.9% of total production of the province). Banana is the most important crop in the commune, contributing annually for 48% in the total production of food crops in the commune.

In Giheta commune, bananas are grown throughout the commune and constitute a very valuable culture for the population. Banana production ranks third most important food crop in the commune and contributes 1.7% of the province's banana production. Its production is estimated at 4,846 tonnes per year.

2.3 Sampling and data collection

The study used a mix of qualitative and quantitative methods to collect the data. The methods used for data collection included survey questionnaires (for quantitative data) and Focus Group Discussion and Case stories (for qualitative data). The households involved in this study were banana growers in the two sites of study. The latter were divided into two major groups: beneficiaries of the project and non- beneficiaries of the project. Among beneficiaries of the project, we had 2 subgroups: farmers who received the vitamin A rich banana from the project and those who were only trained by the project.

Among non-beneficiaries of the project, we had 2 subgroups also: those who adopted but were not direct beneficiaries of the project, and those who do not have VABs in their farm to check their awareness and willingness to adopt.

The banana farming households involved in this study were selected using the simple random sampling technique. A list of project beneficiaries was used to determine the sample size, applying the formula by Yamane 1967:

$$n = \frac{N}{1 + N(\mathrm{e})^2}$$

With “n” the sample size, “N” the population size and “e” the desired level of precision. By using the level of precision (10%), we obtained the sample sizes presented in the table below. The lowest sample sizes were then harmonized to make uniform with those of the site with the largest sample size.

Table 1: Detailed sample size

	Farmers		**Trainees**	
	Cibitoke	Gitega	Cibitoke	Gitega
Population size	139	211	500	500
Sample Size	58	68	83	83
Harmonization	83	83	83	83

The selection of beneficiaries from the lists for interview was done in Excel using the "Randbetween" command. With this, all the beneficiaries were attributed codes and excel was used to generate a randomized list of famers where the sample size will be selected. This resulted in a total of 41 respondents per category type i.e. training and plantlet beneficiaries, training beneficiaries without plantlets, indirect adopters, other non-beneficiaries. The surveys attempted to obtain information on some variables hypothesized to have an influence on farmer’s adoption or dis-adoption of the VABs. These variables are described in Table 2.

Table 2: Determinants of adoption

Education	The level of education of a farmer influences his/her capacity to obtain and use information relevant to adoption of a new technology	+
Age	Older farmers are more likely resistant to new technology than young famers	-
Gender	Burundi men have better access to agriculture resources than women, while the adoption of new technology depends on these resources like land, labour, etc. Thus, adoption will not be equal between men and women.	+ if male, - if female
Household size	A household with a high number of adults have an advantage in terms of labour and are likely to adopt VABs.	+
Off-farm income	Farmers with off-farm source of income are expected to have alternative source of liquid capital for purchasing improved inputs.	+
Objective of banana farming	The farmers who grow banana for income purposes are hypothesized to adopt VABs.	+
Farm size	Farmers with large farm size are likely to plant VABs, since they can use a part of their land to attempt new technology	+
Type of labour used	Household with a dependence on hired labour are less likely to adopt VABs.	-
Experience in farming	A Household with many years of experience in farming is expected to have more chances to adopt VABs	+
Experience	A household with many years' experiences in banana farming is more likely to adopt VABs.	+
Beneficiary of project	Household beneficiaries of the project are expected to be well informed and have access to VABs; hence more likely to adopt.	+
Membership in Farmer Association/Cooperatives	Famers in cooperatives or Association are more likely to get informed about new technology, which increases their chances of adoption	+
Livestock ownership	In addition to being a source of manure, livestock are an asset that indicates the level of household wealth. It is expected to have an influence on the adoption of VABs.	+
Plantlet affordability	High price of VAB plantlets is expected to have a negatively influence on its adoption	-
Early maturity	Farmers, who have a positive attitude on early maturity of VABs varieties, are expected to adopt VABs.	+
Farmer perception on VABs	The perception of farmers on VABs based on its attributes can positively or negatively influence its adoption.	+

2.3.1 Quantitative data collection, cleaning. and Analysis

The present study used smartphones to collect quantitative data. The questionnaire was designed and integrated into smart phones using kobo collect tool. Enumerators were then recruited and trained on the use of the kobo collect tool on smart phones. A pre-test was conducted to address concerns in the content of the survey tool and address any glitches in the survey tool. The local administrations together with field project technicians, at zone level were involved in the identification of the households for the study.

Data were cleaned and organized in excel before the analysis, excel was also used to generate some graphs. Stata 16 was used as software of analysis of the level of adoption and its determinants using probit model; it was also used to generate frequencies. R software was used to do seed social network analysis in the communities.

2.3.2 Qualitative data

The FGD sessions were conducted in the two sites to capture complementary information to quantitative data. Most informed farmers about VABs were identified during the quantitative data collection and were invited to participate in the sessions of FGDs. This activity was conducted in one of the participants home to make a fair environment for them to feel at ease. This even in some cases helped when they wanted to show examples to support their arguments or explanations. These sessions were led by a consultant supported by a researcher from the Alliance of Bioversity and CIAT to take notes and a voice recorder. In total, 4 FGDs were conducted, 2 in each province, and 10 participants in each session which makes a total of 40 participants. In each group at least three women participated to get a variation of intervention based on gender. Some stories were also collected from some farmers who were willing to share their experiences in cultivation of vitamin A rich banana.

Figure 2. An ongoing Focus Group discussion

3. RESULTS

3.1 Socio-economic and demographic characteristics of respondents

Table 3 below presents the socio-economic and demographic status of households visited, in the two sites geographically distinct sites i.e. the lowland Province of Cibitoke and the central highland Province of Gitega. The average age in Cibitoke (50.7) and in Gitega (50.2) were more or less the same. The household size in Cibitoke (6.3 people) was larger than that in Gitega (5.1) and these values are close to the sub-Saharan average household size of 6.9 which is the largest in the world (Statista, 2022). The education level is very low in the two sites where the project intervened, with the highest level for more than 80% of the visited household being the primary education level.

Table 2. Socio-economic and demographic situation of respondents. In brackets are the frequencies.

Province	Mean age	Mean HH size	Sex		Education					Are members of an association
			M	**F**	**None**	**Informal**	**Primary**	**Secondary**	**Univ.**	
Cibitoke	50.7	6.3	75 (135)	25 (46)	27 (49)	14 (25)	45 (82)	13.995 (24)	0.005 (1)	55 (99)
Gitega	50.2	5.1	74 (150)	26 (52)	11 (22)	19 38	67 (133)	3 (6)	0	67 (135)

Except for the category 'Non adopters' that dominated the none educated and those who attained primary education, the disaggregation of the level of education by category of farmers surveyed shows a more uniform distribution across the sites (Fig. 3A). Male respondents dominated in all the categories surveyed, with a profoundly higher number of males among those who received plantlets (Fig. 3B). This can be attributed to the fact that the survey targeted household heads and male respondents predominantly own land in Burundi. On-Farm activities was the main source of income for 94-97% of the visited household while only about 50% of the households were members of an association or cooperative.

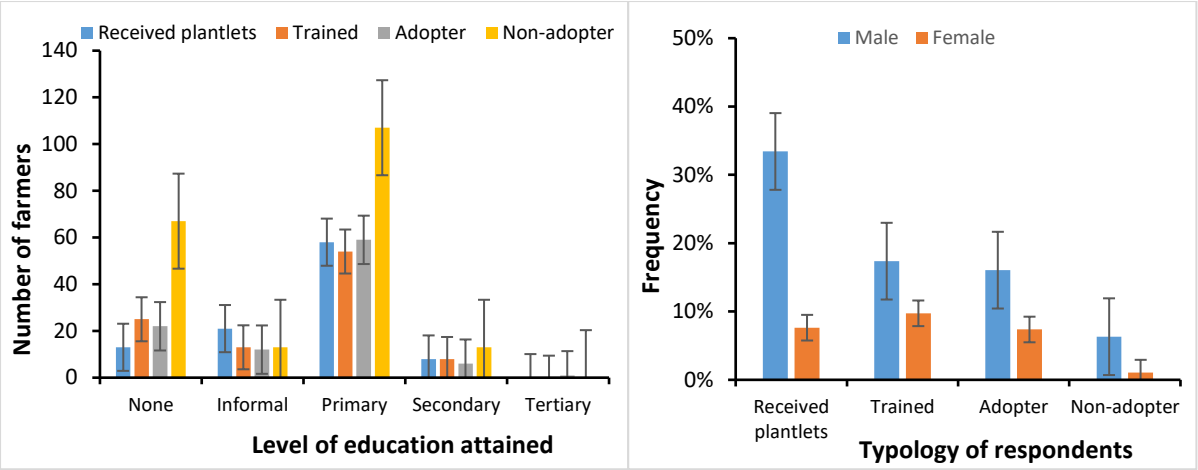

Figure 3. Disaggregation of respondents by adoption status and education level (left) and by gender and access to plantlets (right).

Different mode of land acquisition was identified during the survey. Heritage (55% in Cibitoke and 47% in Gitega), Bought (18% in Cibitoke and 5% in Gitega), Hired (3% in Cibitoke), Heritage and hired, Heritage and Bought (12% in Cibitoke and 43% in Gitega), Heritage-Bought and Hired. More than 45% of household on average in the two provinces, cultivate on the farms inherited from their parents, and more than 10% on average in the two provinces have extended their inherited farms by buying and this happened mostly in Gitega (Appendix 1).

The role of livestock in income generation and agricultural development is doubtless. More than 40% of the households owned livestock. More households from Gitega owned poultry and livestock than households from Cibitoke, while Cibitoke had more cattle (Fig. 4).

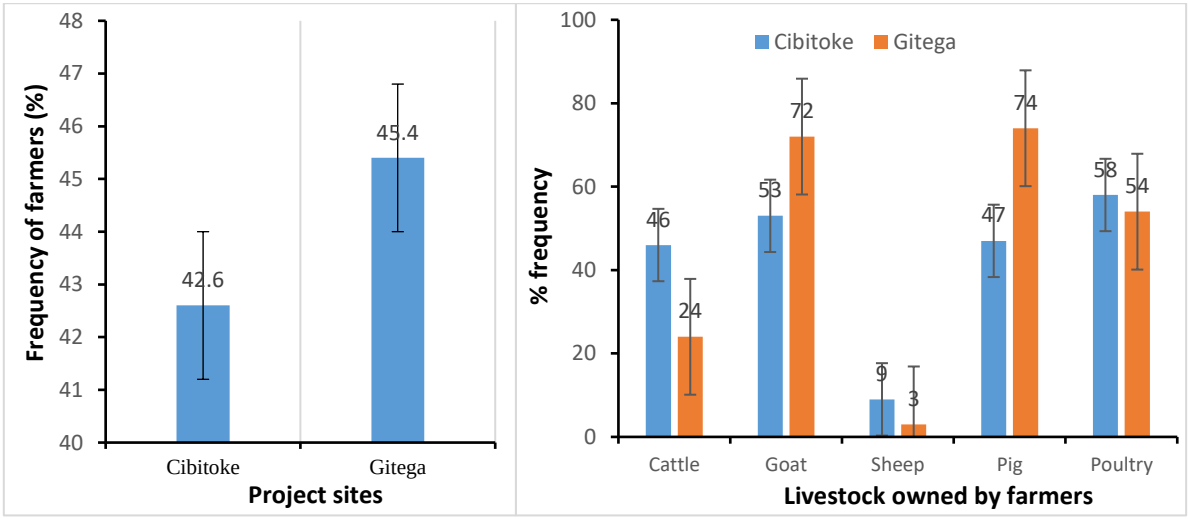

Figure 4. Livestock ownership (left) and types (right) in Cibitoke and Gitega project sites.

3.2 Banana farming in the areas of study

Banana plays a very important role in the two sites as a source of income and food (Fig. 5). The findings from survey show that on average, banana is a source of income for more than 80% of household in the two sites. The importance of banana can also be seen in allocation of agricultural land to banana plant. On average more than 39% of the agricultural land is allocated to the banana crop across the two sites.

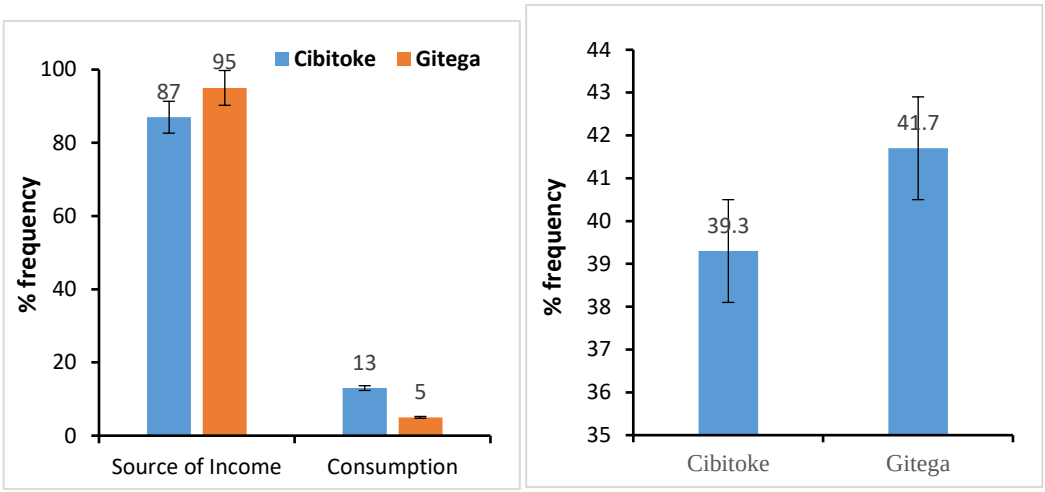

Figure 5. Farmers' objectives of banana farming (left) and land allocated to banana (%) (right)

Majority, of the surveyed household depended on family labour on their banana farms. In Cibitoke 62% of the household used family labour compared to 77% in Gitega. In Cibitoke, external labour was financed from sale of other agricultural products (51%) while in Gitega it was sourced from banana sales (56%) (Table 3). The average years of experience in banana farming was 20 years in Cibitoke and 24 years in Gitega.

Table 3. Banana farm characteristics

Province	Mean number of years farming banana	Average land allocated to banana (%)	Labour		Financing for external labour (%)		
			Family	External	Banana sales	Sales of other agricultural product	Off-farm activities
Cibitoke	20	23	62	38	42	51	7
Gitega	24	30	77	23	56	28	16

The level of fertiliser use in banana varied between the two sites of the projects. In Gitega, 95% of the household visited used the organic fertilizer predominantly sourced from their own farms (95%), with the remaining 5% buying from outside. In Cibitoke, 89 % of the

households used organic fertilize with 84% and 16%, respectively, sourced from own-farm and bought it. In general, 42% of the respondents used mineral even though on very small quantities.

3.3 Local and other non VAB banana cultivar seed (variety, type, source, and mode of acquisition)

Twenty-nine (29) indigenous banana and other non-VABs cultivars were reported across the two project sites (Fig. 6). Fourteen cultivars were common to the two provinces while others were just found in either of the sites.

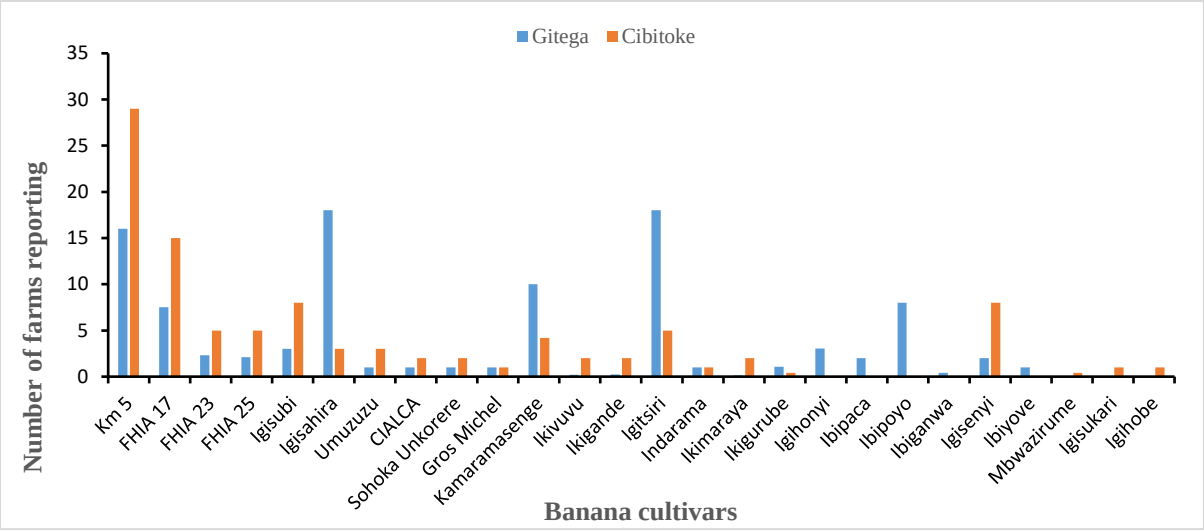

Figure 6. Number of farms reporting different local and other non-pro-vitamin A rich banana cultivars in Gitega and Cibitoke pro-vitamin A rich banana project sites

Three of the four most dominating cultivars KM5 (Musa AAA), FHIA 17, IGITSIRI (AAA) are beer types. The variety Umuzuzu (Plantain, AAB) which is among the cultivars preferred in the market and more expensive ranked among those least cultivated because it could not grow in the two sites of the project. On average each household/ farm had at least 3 and 5 cultivars (Fig. 7) in Cibitoke and Gitega, respectively. Banana cultivation for beer production dominated across the study sites (Fig. 7).

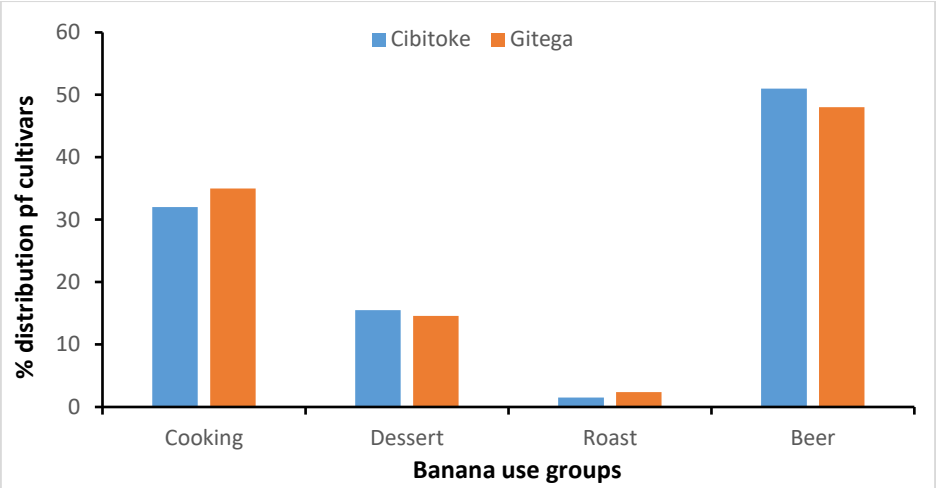

Figure 7. Banana cultivar distribution by utilisation

Type of planting material to support the indigenous and other non VAB cultivars was dominated by suckers (73% in Cibitoke and 81% in Gitega). Macro-propagated plantlets accounted for 21% and 16% in Cibitoke and Gitega, respectively, while tissue cultured plantlets respectively accounted for 8 and 3% of plantlets.

The plantlets were obtained from various sources including from own-farm (40%), friends/neighbours/relatives (27%), research institutions (21%), NGOs (4%) and local seed multipliers (3%). The rest (8%) got their plants from combined sources of own farm, research institutions; NGOs and local seed multipliers, etc. (5%). ISABU and IRAZ were the most cited research institutions to have supplied planting material while Bioversity International, CIALCA, PNSADRIM and ENABEL were the most cited NGOs.

Friends, neighbour, and relatives played very important role in seed exchange, for a matter of understanding of the network, respondents were asked to provide both name and gender of the person who gave them the plantlets and from where they get them. The graph below shows the seed flow in general in the two provinces. More than 250 farmers participated in sharing banana seed. The size of the nodes area reflects the level of importance of a farmer in the seed network. The graph shows that there are very few farmers who are influential in seed sharing network (Fig. 8).

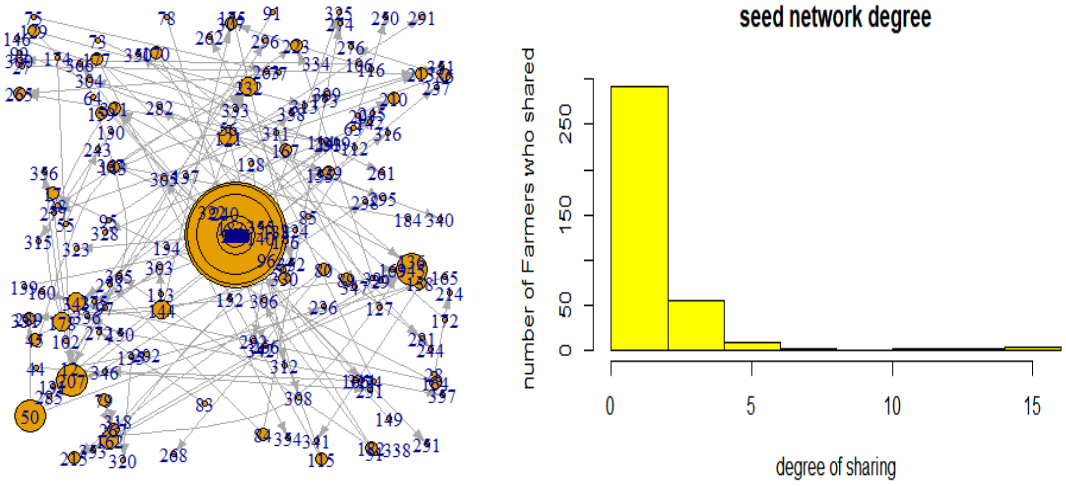

Figure 8. Local and non-pro-vitamin A banana seed network

The analysis of centrality helped to detect farmers that were able to spread very efficiently banana seed to others. Some farmers (codes 12, 28, 74, 75, 295, 296, 300, 315 etc.) had a low closeness score, suggesting that they shared more planting material. Betweenness centrality measure was also performed to check farmers that were influential in the banana seed network. Farmers with codes 11 and 17 were the most influential within the network of seed exchange. These farmers could be targeting for future scaling of banana seed. Gender did not have significant impact in the seed exchange with 85% of women farmers receiving seed from men, and 16% of men receiving plantlets from women. In contrast, 75% men received plantlets from men while 15% of women received from fellow women. More than 90% in the farmers in the network in the two provinces acquired the plantlets as a gift or free, only less than 6% bought.

3.4 Pro-vitamin A rich banana in Burundi

3.4.1 Awareness on VABs among non-beneficiary farmers

The level of awareness on VABs was assessed among non-project beneficiaries to gauge diffusion of information on the cultivars within project sites. About 70% of non-beneficiary farmers were not aware of the VABs though over 85% of them are willing to adopt VABs (Fig 9). The willingness to adopt was a decision taken after being told the attributes of VABs. Nutritional attribute of VABs was the major reason behind the willingness to adopt VABs for most of them, regardless the yield.

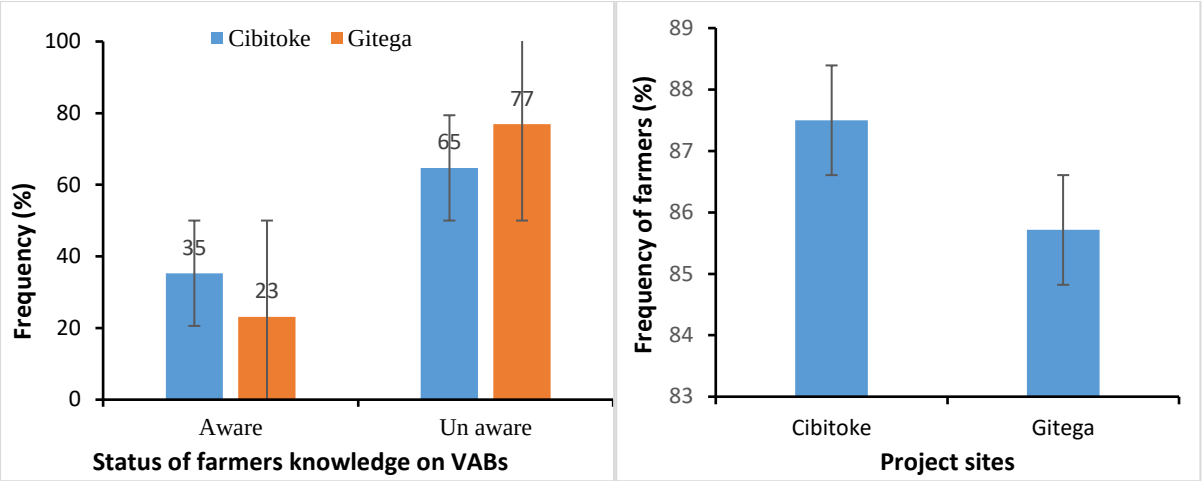

Figure 9. Level of awareness on VABs among non-beneficiaries (left) and their willingness to adopt

The 13% who were not aware of the VABs and still not willing to adopt even after being told the attributes of VABs attributed it to the smallness of their farms. Some of the others not willing to adopt VABs cited the small bunch yield (size of bunches) of most of the VABs varieties that they observe in their neighbourhoods, which they judge to be low.

3.4.2 Perception of farmers on VAB varieties

The decision of adopting a new technology vis-à-vis to the existing ones is highly influenced by a lot of factors including their perception on the said technology. In the case of VABs, farmers who have at least planted and harvested or have up to now VABs were required to provide their perception of VABs by comparison to existing varieties based on the use.

VABs for cooking: Generally, farmers had a good perception of the cooking type VABs due to their nutritional richness (85%), early maturity (82%), number of hands per plant (56%), length of fingers (57%), size or weight of banana (55%) and storage life (56%) (Fig. 1**0**). The most important constraint facing these VABs was the in-availability of plantlets (71%).

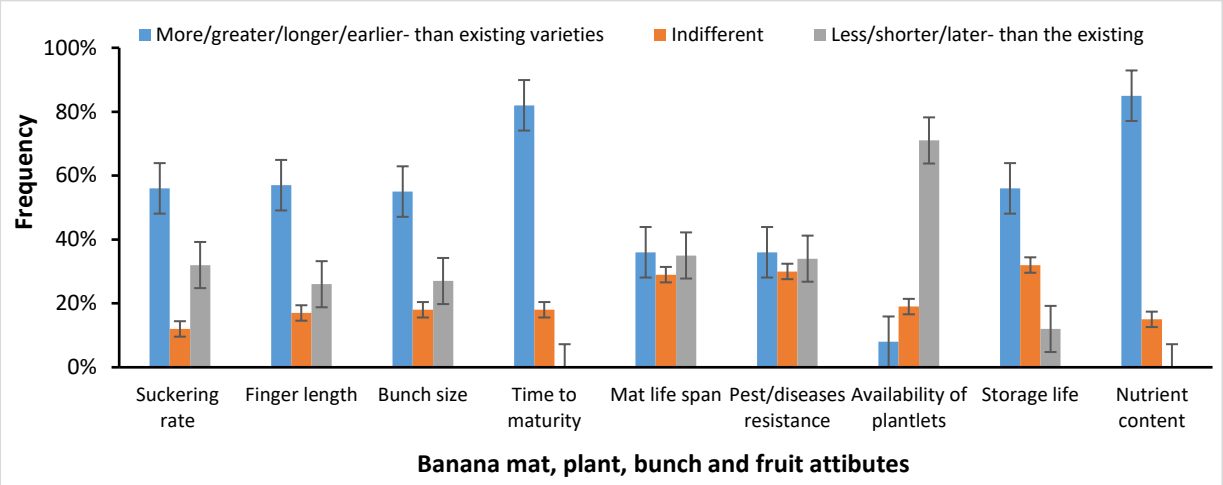

Figure 10. Perception of farmers on cooking type pro-vitamin A bananas

During the FGD, farmers likened Pelipita to local varieties called “Igisahira” and “Poyo”. These three were reported to be early maturity and drought resistance while Pelipita was additionally reported to be more tolerant to diseases and to produce more suckers. When cooked or roasted pelipita was reported not to become mashed as other known local varieties do, but also to have good taste. Once harvested, Pelipita was reported to have a long storage life compared to the local cooking types. Pelipiata’s main undoing was its small buncg compared to existing local varieties “Igisahira’’ and “Poyo”.

Dessert VAB types: The perception of farmer on VAB cultivars for dessert compared to other existing dessert cultivars was also positive. This was attributed to their nutritional richness (89% of farmers), early maturity (76%), long storage life (66%) and number of banana bunch harvest per mat over the same time frame **(Fig. 11)**. The availability of plantlets was a major limiting factor reported by 68% of the farmers.

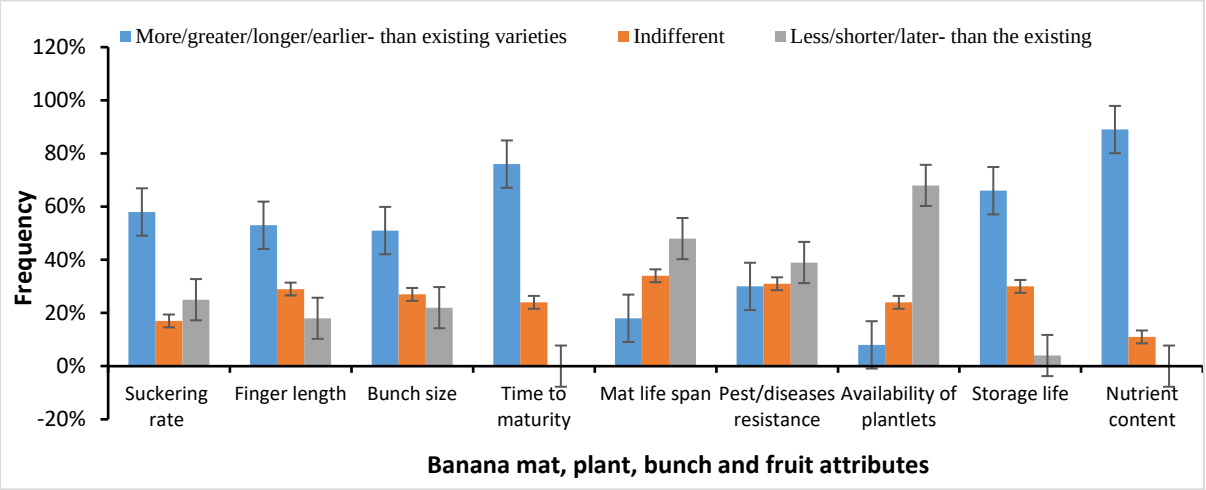

Figure 11. Farmer perceptions on dessert type pro-vitamin A rich cultivars

The dessert type VABs received a mixed perception for attributes such as the longevity of mats on farm, resistance to pest/diseases and size or weight of banana bunch. The FGD sessions helped to provide more insight about these. For example, Pisang Papan when compared to the local cultivar "Akaramasenge" was perceived to have a very good taste but have a very small bunch. LAI another VAB was compared to "Ikigande" in Cibitoke and "Igisukari" in Gitega. LAI was reported to have a very good taste and aroma compared to both. LAI was also reported to outperform the two with respect to yield. In contrast, 'Ikigande' and 'Igisukari' were reported to be more resistant to drought, pests and diseases.

> *"Pisang papan and our indigenous dessert types mature late but LAI matures a bit earlier than "Igisukari". Both (indigenous dessert types and VABs) can resist drought, pest/diseases and are harder to get suckers because they have many and deeper roots"*

The VAB Muraco was reported to be comparable to "Ikigurube". Muraco fruits were reported to be very sweet and to have a good taste compared to "Ikigurube". Muraco was also reported to have big fingers. Both were reported to resist diseases, pest and drought. Ikigurube was however reported to have a higher yield compared to Muraco.

VABs for roasting: As for other VAB types, the VABs for roasting were highly ranked with respect to their nutritional value (83%), early maturity (85%) and finger length (69%). However, less than 50% of respondents rated them highly for turnover rate (bunch harvests per mat per annum, 45%) and long storage life (44%) (Fig. 12). For example, Apantu compare well with the local Plantain cultivar "Umuzuzu". However, Apantu was reported to have fragile roots and pseudostem, thus if not supported it can easily snap down. Apantu however rated higher for bunch yield, suckering rate and resistance to diseases and drought compared to Umuzuzu.

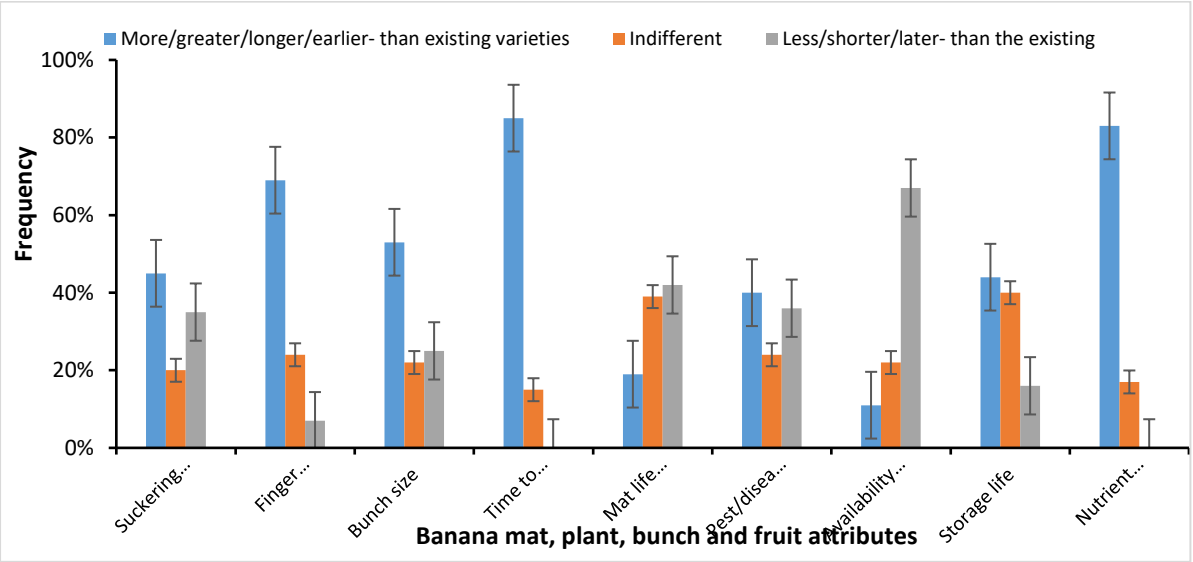

Figure 12. Farmers perception on novel pro-vitamin cultivars processed through roasting

3.4.3 Level of preference among pro-vitamin A banana cultivars

The level of acceptability and use of the VABs cultivars differed greatly (Fig. 13). The mode of use or the availability of some of them can be the reason behind the higher level of use of some of the cultivars relative to others.

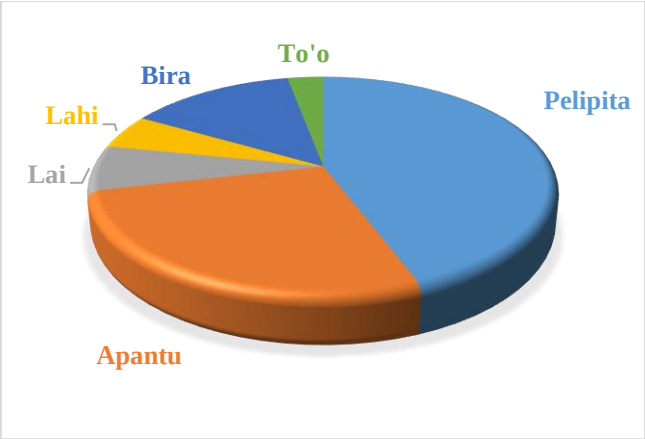

Figure 13. The actual level of use of pro-vitamin A cultivars across two pilot site in Burundi

The VAB cultivars Pelipita, Apantu and Bira were the most dominant across the two sites. To ascertain if the level of use reflected the level of preference of the varieties FGDs ordered the varieties by order of preference with supporting reasons (Table 4). The FGD results suggest that the level of cultivation and use of the VAB could have been mainly due to the availability of planting materials.

Table 4. Farmers ranking of pro-vitamin A banana cultivars according to their level of preference during FGDs in sites within Cibitoke and Gitega, in Burundi.

CIBITOKE		***GITEGA***	
Order of preference	***Reasons***	**Order of preference**	***Reasons***
APANTU	*-It's the only kind of plantain that can grow in our area,* *- can have high yield and* *- can last/stay longer in the far) compared to other types of plantain.*	*PELIPITA*	*It is early maturing* *- has multiple way of being consumed.* *- can resist drought more than other VABs.* *-has a big bunch weight- can go up to 25 kg.* *-produce a lot of suckers and* *- last longer in the field than any other VABs.*
PELIPITA	*It doesn't mash once cooked* *- has a good yield.* *- long life span in field* *- resists drought, pest and diseases.* *- It is very important in household food security ("Three fingers with one glass of water is enough to get satisfied" said a respondent in Cibitoke).*	*APANTU*	*- It is like plantain (we have been trying to plant plantains since without success. Itis a variety we wished to have and we now have it).* *-it has a lot of market opportunities (e.g. "During the period of Muslim fasting, we don't need to go to market, they look for us"*
PISANGI	*It's close to a variety called "Akamaramasenge" which has never grown in our area and has a good market opportunity.* *- can be used to improve banana beer quality and processing.*	*BIRA*	*-has a very early maturity compared to the rest of VABs. It gives a very quick response to food insecurity".* *- has a very good taste.* *- first cooking.*
Cultivar not highly accepted/preferred			
To'a	*It is late maturing* *-the bunch is very small.*	*To'a*	*- It is not compatible with our soil,*

	- It has a very long tree which makes it vulnerable to wind. "igitumba caco ni magoyagi" said a farmer which means that its stem is very fragile. *- it is not compatible with our soil.*		*- it can hold two to three hands only, "What it does is just generating a lot of suckers as if it is what we need". Said a farmer*
LAHI	*-It has a very small bunch with very small fingers.* *- Once peeled it has some seeds inside the fruit. "It's like a guava inside once peeled" said a farmer.*	*LAHI*	*- it has a very low yield with very small hands and fingers.* *- You will never know if it ready for harvest or not due to the size of its fingers.*
CHIBULANGOMBE	*It has a bad taste and gives a very bitter beer.* *- Once cooked it has a black soup and once peeled it has a lot of sap.*	*PISANGI*	*- it has a very long tree which makes it sensitive to wind* *-it is very sensitive to diseases.* *- It can hold a banana but its fingers are empty once peeled.*

3.4.4 Utilisation of VABs cultivar in the sites of project intervention

The project trained farmers on the use of different varieties of VABs before the distribution of the plantlets. During this session, farmers were shown the best use of each variety. Surprisingly, beneficiaries (farmers) have added their own ways of using the VABs. For example, in both sites, Pelipita and Bira which were initially distributed as a cooking type, are also eaten as dessert, roasted, or when fried. These varieties were also used as input in processing local banana beer. The beer from the combination of local beer type banana and VABs varieties, was reported to last longer than banana beer mixed with other non-VABs varieties.

> "*I have personally tried Pelipita and Bira in beer processing, every client that comes to my bar ask first if it stills there before he can take the normal banana beer they are used to"* said Ludoviko a banana farmer and local beer processor.

Apantu which was initially considered as cooking is also consumed when roasted or fried. Lai that was promoted as a dessert, has also been consumed after cooking in Gitega though it is highly appreciated as dessert because its sweetness. The juice processed from Lai is very sweet while it beer is tasty.

> "*Lai juice and beer are indicated by their sweetness, which gives it a high value in terms of price*" said Georgette a banana farmer and local beer processor.

Pisangi papan which was promoted as dessert variety is also being cooked.

> "*Once cooked it has a good taste but eating like fruit is far better*" said Felix.

3.4.5 VAB seed network

On average in Cibitoke every VAB farmer that participated in our survey on average had received 7 plantlets of cooking type, 5 of dessert type and 4 of roasting type VABs. In Gitega on average each farmer had received 4 plantlets of cooking type, 3 of dessert type and 3 of roast type VABs (Table 5). Most of the plantlets were from macro propagation (53% in Cibitoke and 72% in Gitega). These materials were majorly sourced from Bioversity International (88% in Cibitoke; 90% in Gitega) and friends/neighbour or relatives (11% in Cibitoke and 8% in Gitega). The third source was ISABU/IRAZ (1% in Cibitoke and 2% in Gitega).

Table 5. Number and type of VABs planting material received by farmers

Province			Cooking	Dessert	Roast
Cibitoke	Number of plantlets	Average	7	5	4
		Max	30	22	18
		Min	1	1	1
	Type of plantlets	TC	32%	37%	39%
		Suckers	9%	14%	11%
		Macro-propagated	59%	49%	50%
Gitega	Number of plantlets	Average	4	3	3
		Max	17	19	15
		Min	1	1	1
	Type of plantlets	TC	13%	28%	8%
		Suckers	5%	4%	5%
		Macro-propagated	82%	68%	67%

To get an insight into social influences, connectivity, and patterns of relations influencing seed sharing, a network analysis was performed showing the flow of banana seed in the two sites (Fig. 14). The size of the nodes and corresponding numbers, shows the degree of participation of a particular farmer in the network.

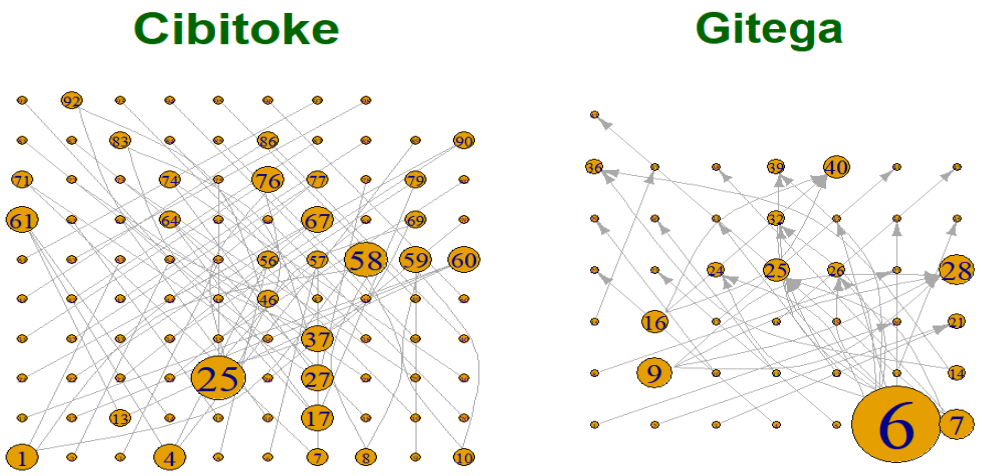

Figure 14. Pro-vitamin A banana seed networks in Cibitoke (left) and Gitega (right)

Some measures of centrality were performed for a better interpretation of the VAB seed networks.

A degree centrality of a node: - defined as a number of edges a node has. In this case it is the number of direct connections or links that a farmer has. A farmer with a high degree of centrality or more links is nodal farmer. From the graph, farmer number 25, 58, 59 are nodal farmers in Cibitoke, while in Gitega, farmer number 6, 7, 9 and 28 are nodal farmers (Fig. 14).

Betweenness centrality:- is a measure that is used to capture a person's role in allowing the exchange of information from one part of the network to the other**.** A high betweenness centrality score means that a farmer has a central place in the network or subnetwork through connecting other farmers. The farmer with high score indicates has more control of power or information in a network. While in Gitega farmers number 6, 7 and 21 have the highest betweenness score, in Cibitoke, farmers number 4, 7, 13, 17, 27, 56, 60, 61, and 71 have the highest betweenness centrality (Fig. 15). These farmers act as “bridges” in the banana seed exchange network. Betweenness centrality also identifies the above farmers as the shortest paths for banana seed exchange (Fig. 15).

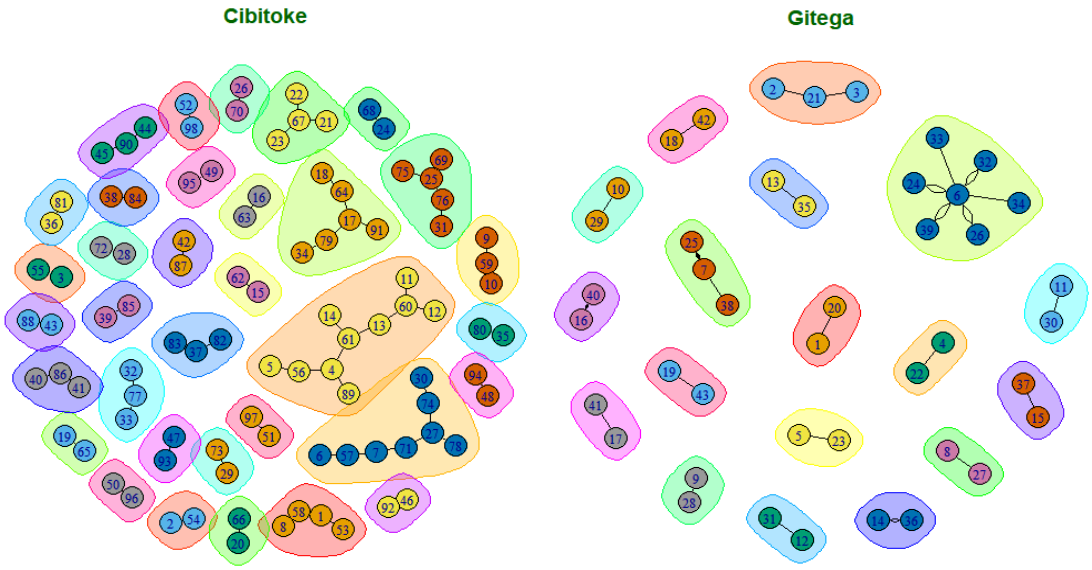

Figure 15. Betweenness centrality of banana seed exchange between farmers in in Cibitoke (left) and Gitega (right).

Closeness centrality: Closeness centrality indicates how close a farmer is to all other farmers in the network, in other words, it helps to capture the average distance between each farmer and every other farmer in the network. A low score of closeness centrality means that a farmer is directly connected to most of other farmers in the network. In this case we can cite some farmers like 5, 6, 11, 12, 14, 30, 56, 60, 89 in Cibitoke and 24, 26, 32, 34 and 39 in Gitega (Fig. 15).

Some farmers are either nodal (farmer with many connections) plus bridging farmers, or nodal, or bridging farmers in the network. For example, farmers 4, 61, 27, in Cibitoke while farmers 6 and 7 in Gitega fit this description.

Such type of farmers can be both points of strength and weakness, strength through the use of their influence to facilitate seed flow in a network and a point of failure for the social network if they leave farming, migrate to other place, or die. The later was the case with Telesphore who using his great influence supported the promotion of VAB planting material through farm trials and demonstrations but died before project completion. Maintaining chain of seed supply after his death was a serious challenge in his location.

Social-economic information related to the farmers with good centrality scores is provided in Table 6. Characteristic to these farmers is that they cultivate banana as a commercial

enterprise, suggesting the production objective plays an important role in seed dissemination. Surprisingly farmers with a high centrality in Cibitoke were not a member of any group whereas those in Gitega were groups. However, as anticipated, farmers in groups had large nodes. The education level had no association to node and centrality strength. Also noted is that all the farmers were above 40 years of age. Interesting young farmers in seed supply is crucial for sustainability of the seed systems.

Table 6. Socio-economic characteristics of farmers with a high centrality

Farmer	Education level	Education level of spouse	Purpose of planting banana	Age	% of land allocated to banana	Membership in a group
Cibitoke						
25	Primary	None	Income	61	20	Yes
27	Primary	Primary	Income	65	25	No
58	Informal	Informal	Income	50	12.5	Yes
60	Informal	Primary	Income	50	25	No
7	Primary	Informal	Income	75	40	Yes
4	Primary	Primary	Income	58	30	Yes
61	None	None	Income	50	20	No
Gitega						
6	Primary	Secondary	Income	44	35	Yes
7	Primary	Informal	Income	65	10	Yes

3.4.6 The role of gender in seed exchange

Men played a greater role in seed exchange compared to women, with 59% and 83% of men sourcing planting material from fellow men in Gitega and Cibitoke, respectively. The situation was the same for household led by women. For example, in Cibitoke, 14 % of women sourced planting material from men while only 8% sourced from their fellow women (Fig. 16). In the context of Burundi, this is expected because banana is considered a crop for men. More still, land is predominantly owned by men. The process of uprooting suckers for planting is considered as men activity as it is energy demanding.

3.4.7 Level adoption of VABs in project sites

To determine the level of adoption, farmers who received plantlets from the project or other sources were interviewed. Only 12 and 44% of the sampled farmers in Cibitke and Gitega, respectively, still had the VABs on their farms (Fig. 16).

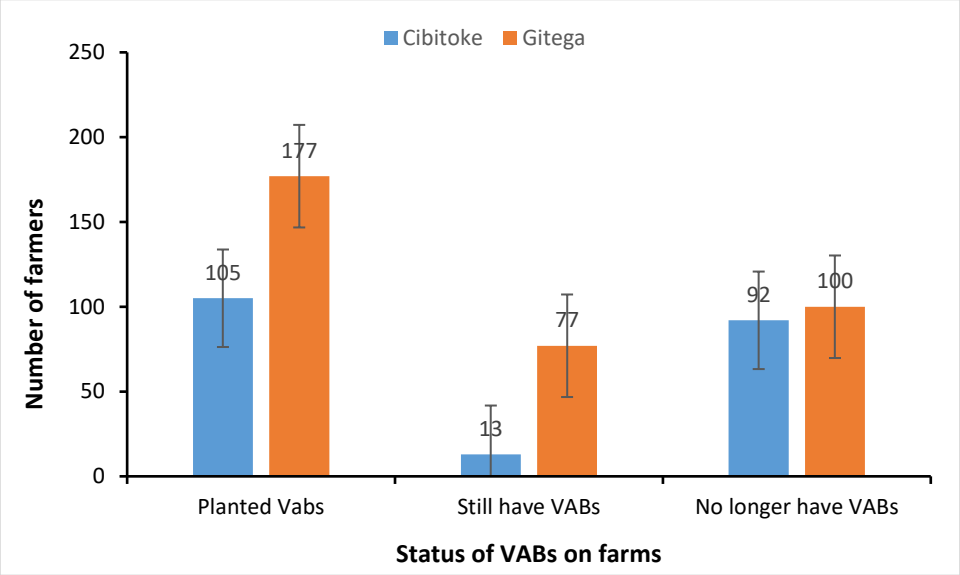

Figure 16. Farmer access and adoption levels of pro-vitamin A bananas (VABs) at sites in Cibitoke and Gitega

Farmers attributed the low adoption to the wrong timing of the distribution of the plantlets was not suitable. They reported the distribution of plantlets to have been in the dry season (i.e. in July while a the rainfall starts in October). Given macro-propagated plantlets and tissue culture plantlets were used and farmer predominantly rely on rainfed production, these plantlets were vulnerable to desiccation by heat and water stress. Only few farmers were able to irrigate.

> *"Mwabiduhaye mugihe kitarico mukwezi kwa 7 ariko igihe ciza co gutera nimukwacumi" said a farmer during FGD session, meaning that the period of distributing plantlets was not suitable.*

In Gitega, the size of the plantlets made them susceptible to pest including rats. The nature of soil in one area in the site of Muremera in Gitega, is sandy and irrigation could not as such help in the dry season (Fig. 17).

Figure 17. A farm with sandy soils in Gitega close to Muremera. The nature of the soils was a major hindrance to the establishment of plantlets.

In Cibitoke there was particularity a conflict arising from two projects. Beneficiaries of VAB-plantlets in one of the three project sites Munyika in Cibitoke was located in the area which was identified by another project as a potential area for rice production. The later project carried out some activities like development of marshes and irrigation canals, to promote rice crop. These initiatives were carried out around banana farms as consequence this caused repetitive flooding of their banana fields and destroyed their crops, finally leading to replacement of banana (VABs and local cultivars) with the rice crop. This was a major setback as this also affected the VAB demonstration fields.

> *''Even the few that remain are planted in our home backyards because we know its health importance''. "Uwutakiriye canke uwutaronkejwe inyigisho zijanye n'akamaro kaco, ntiyagihurumbiye". Which means those who have never tasted or got informed about its health importance did not keep them, said a farmer.*

Despite the challenges reported by some farmers that failed to keep VABs in their farms, those who were able to keep them, have expanded their VAB fields and added in more cultivars. In fact, 46 % of those who still have VABs in Cibitoke, 40% in Gitega have added additional VABs varieties in their farm as indicated in figure 19 below. It should be noted that those who kept and extended the VABs in their farm in Cibitoke are mostly from the site of Kagazi and Mparambo. Those who were expand VABs on their farm, got the suckers from

their own-farm, neighbours, and relatives. The major challenge still faced is the unavailability of VAB planting material.

3.4.8 Determinants of VAB banana adoption

Table 7 shows the findings from the probit analysis of the factors that influenced the adoption of the VABs. Out of 17 variables explored, 9 were found to influence significantly ($p < 0.05$) the level of adoption of VABs across the two sites.

Being a project beneficiary increased the chances of adopting at least one of the VABs varieties. This can be attributed to their access to information on the materials and free planting materials. Men are more likely to adopt VABs compared to female banana farmers. This may be due to the fact that banana is considered a male crop in Burundi and the limited access women have to land. The level of education of the head of household has significant effect on VABs. The higher the level of education, the higher the chances of adopting the Vitamin A rich banana. However, the household size was found to negatively affect the level of adoption. The higher the size of household, the less likely the household head is to adopt the VABs. This finding is ambiguous because some studies found larger household size to positively influence the adoption of new banana varieties due the advantage of family labour availability (Sanya et al., 2020; Akankwasa et al., 2016). But our findings corroborate with the findings of Kabunga (2014) who considered the aspect of income and found a negative relationship between household size and per capita farm and household income and hence extra charge to the household.

Farmers with experience in banana farming were found to more likely adopt at least one variety of VABs in the two provinces where the study was conducted. This finding corroborates with the findings of Sanya et al. (2020) who found that experienced farmers are more likely to adopt hybrid banana varieties in Uganda compared to unexperienced, and Perdsen (2012) who found that any intervention in improved banana varieties that ignore farmers experience during its design, it's exposed to failure. Households that cultivate banana as a source of income were found to likely adopt at least one variety. This may be because some farmers VABs like Apantu that are grown for roasting had established well unlike similar

Plantains (*Musa* AAB types) from within the region that had failed to establish despite their high market potential. Secondly most of the VABs can be used in local beer processing, adding value to the local beer and hence bringing in better premiums.

Some varieties were judged to have higher yield compared to existing varieties of banana based on the use, however, this perception on yield was found insignificantly affecting the level of adoption of VABs in the two provinces but instead the early maturity of VABs varieties increased their chances of being adopted.

Table 7. Determinants of pro-vitamin A banana adoption across Gitega and Cibitoke in Burundi

Variables	**Marginal Effect**	**P>|Z|**
Category	0.30***	0.000
Age	0.006***	0.001
Sex (Male)	0.177**	0.003
Education		
Informal	0.14**	0.04
Primary	0.17***	0.003
Secondary	0.26*	0.015
Household size	-0.027**	0.005
Banana production objective	0.16**	0.007
Experience in agriculture	-0.01***	0.000
Experience in banana farming	0.004*	0.06
Early maturity of cultivar	0.07*	0.08
Livestock ownership	-0.19*	0.006
Number of obs = 308	***=Significant at 1%	
LR chi2(22) = 118.26	**=Significant at 5%	
Prob > chi2 = 0.0000	*=Significant at 10%	
Log likelihood = -109.53579		
Pseudo R2 = 0.3506		

Variables such as farmer's perception on the yield, resistance to diseases and pests, membership in a farmers group, reliance on off-activities as main source of income, the size of land allocated to banana did not influence the adoption of the VABs.

3.4.9 Constraints to the adoption of VABs

- The nutritional values of the VABs is not widely known hamperting both uptake and marketing.

- Lack of planting material - to meet the needs of the trained beneficiaries. Some farmers a willing to buy cannot find suppliers of the seeds.
- Covid 19 outbreak occurred at the critical time initiating of the VAB scaling efforts, hampering seed supply and trainings to support the seed system and general agronomic practices.
- The period of distribution of planting materials (i.e. during the dry season) was in appropriate for the vulnerable macro-propagated and tissue culture plantlets. Most farmers could not afford to irrigate the plantlets.
- The conflict of interest between interveners in agriculture sector. This is the case in Cibitoke where the project intervention was failed by another intervention.

3.4.10 Case story in Gitega

Credit: Alliance of Bioversity and CIAT/S. Bisoza

Banzizubusa Georgette got fully involved in banana production after the death of her husband. She now has 32 years of experience in banana farming. Georgette received 20 vitamin A rich banana (VAB) plantlets from the Alliance of Bioversity International. She now has over 100 VAB mats. She has also shared at least four VAB suckers each with over 50 neighbours, friends, and relatives.

"I was at first afraid of adopting these new varieties of banana due to lots of questions that lingered in my mind. I, however, gave it a try, thinking if they don't grow or give a low yield, I will abandon them. This is very normal and natural because everybody has a fear of trying something new".

Georgette got so surprised by many things with respect to these varieties. First, the yield was almost the same as for the varieties she was used to. She felt insured because she knew that the slightly lower yield would be compensated for by high nutritional value. Secondly, she found the VAB to have a very good taste compared to all other varieties she knew or had before.

"When my neighbour tasted Pelipita for the first time, he was always invigilating my farm to check if there are some which are ready for harvest to notify me. I am a witness of the importance of the VABs on health, food stability and family economy".

Georgette reported the VAB to significantly contribute to her family income because she can now grow plantain which is a variety that has a lot of market opportunities but could not grow in her area. She also uses some of the VAB varieties to add value to the local beer she processes. She gets a better price of 800 BIF instead of 600 BIF a bottle, when the VAB are added.

Her food security has improved because, the VAB mature earlier than the local varieties on her farm. *"Since I started planting this type of banana, the children never ask me again what they will eat at night. It has highly contributed to food stability in my household."*

She also reported the VAB to have impacted positively on the health of her family. *"Before I started eating VAB I had a problem with my eyes. They would itch and I used to feel like scratching them every time. It felt as if I had pepper in my eyes. I had to scamper for fresh air at dawn because of the pain in my eyes. But since I have started eating vitamin A rich banana, this problem has progressively disappeared. Even my last born could not move outside without putting glasses on, but he no longer uses them*. "*I invite others to adopt these varieties because of its economic and nutritional advantages*".

The farmers only challenge is accessing clean planting material of the VAB varieties she wants, especially to replace that deteriorate.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

- The level of awareness on vitamin A rich bananas is still very low within the two sites where the project intervened by non-beneficiaries even though there are some non-beneficiaries who adopted the VABs.
- Most non-beneficiaries (85%) that don't have VABs are willing to adopt these varieties and their decision is driven by the nutritional attribute of VABs regardless the yield. The VABs were reported to have a long storage life (55%) and mature early (81%).
- Access to planting materials is a core gap if addressed will hasten the adoption and use of the VABs.
- Apantu and Pelipita are the most preferred varieties of Vitamin A rich banana varieties. Early maturity, multiple ways of consumption, yield, taste and drought and diseases resistance were the major reasons behind the high preference of Pelipita compared to the rest of VABs varieties. While Apantu was has similarity to a local variety Plantain (*Musa* AAB) that could not grow in the two sites.
- Vitamin A Rich Banana planting material were majorly sourced from the project and friends, neighbours or relatives. Men played a greater role in seed exchange. Some farmers seem to play a major role in seed exchange and could be targeted in promotion of the VABs and other banana cultivars.
- The experience in banana farming, the level of education, the dependence of banana as source of income, the attitude towards the early maturity of the VABs, and gender, were found to significantly influence the level of adoption.
- Farmers have found extra ways of utilization of banana other than the those officially promoted, including for improvement of beer quality

4.2 Recommendations

- Given the target of project of reducing diseases related to vitamin A deficiency, there is need for an increased awareness on the nutritional value of the cultivars along the value chain of the crop.
- The permanent availability of planting material is very crucial in increasing the level of adoption. Strategies like youth business models dealing with seed multiplication, should be explored and supported for sustainable multiplication and selling at

affordable price of VABs and other banana cultivars. Training of community members on community-level micropropagation coupled with mother gardens are also alternative seed multiplication models that can be explored.

- ❖ Farmers should be trained on different ways of processing and consuming the vitamin A banana. The diverse ways of consumption through processing can attract farmers to the VABs. The new use methods need to be studied for their effects on the vitamin A availability and if viable /
- ❖ The promotion of the plantlets need to be accompanied with capacity building on good agronomic practices.

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APPENDICES

Appendix 1. Land Acquisition mode

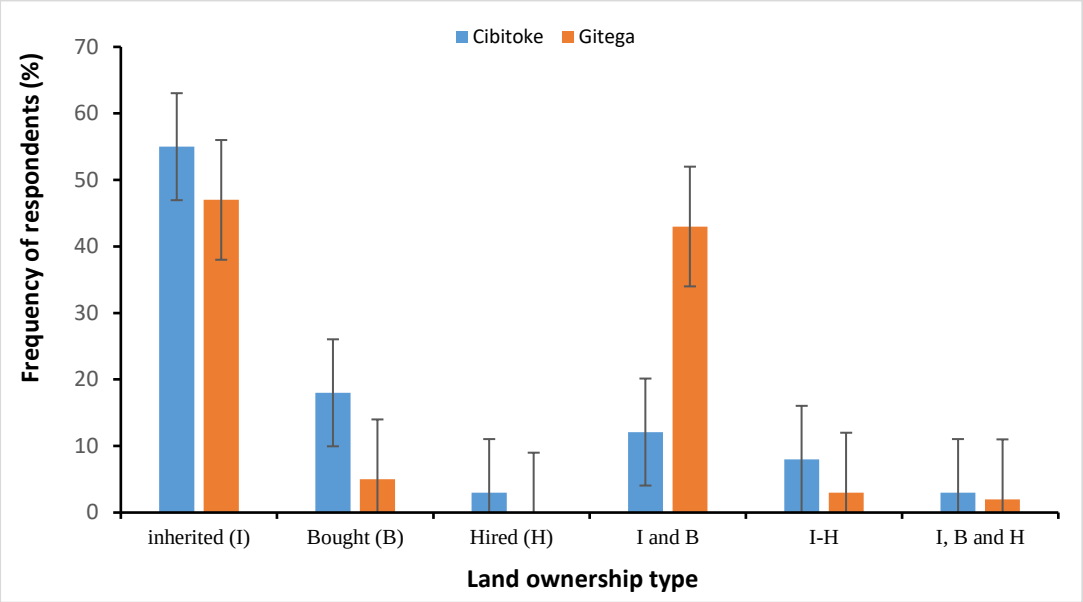

Figure. Different modes of land acquisition by banana farmers

Appendix 2: Questionnaire (Quantitative data)

I. FARMER IDENTIFICATION

a). Name of the head of household:
b), Age of the head of household:
c). Sex of respondent: Male, Female
d). Education level of household head: None, Informal, Primary, Secondary, University
e). Spouse Education level: None, Informal, Primary, Secondary, University
f). Household size:
g). Main occupation of the head of household: 1. Farming, 2. Off-farming,
h). Main occupation of the spouse: 1. Farming, 2. Off-farming,
j). Ownership of land: 1. Own, 2. Hired, 3. Heritage
k). Are you a member of Cooperative/Association of farmers? 1. Yes, 2. No

I. GENERALITY IN BANANA.

II.1. For how long have you been practicing agriculture (in years)?

II.2. What is your total farm size (in ha)?
II.3. What is the size allocated to banana (in ha)?
II.4. For how long have you been involved in banana production?

II.5. What is your main banana production objective?

i). income; ii). food; iii) environmental conservation; iv) others (specify)

II.5.1. Is banana your main source of Income?

II.5. Kindly tell me the 5 main banana varieties you grow on your farm in the last three years.

Specification of Variety (This section is repeated in case a Farmer have more than 1 variety)

II.6. How many (varieties) do you actually have in your farm?

II.7. What is the name of the variety?

II.8. What is the use of the variety? 1) Beer; 2) Cooking; 3) Dessert; 4) Roasting; 5) Mixed

II.9. What is the type of seed used for the variety? 1) Tissue Culture; 2) Suckers; 3) Macro propagation
II.10. How many plants do you have for this variety?
II.11. What is (was) the source of the seed you planted? 1) Own farm; 2) Friends/Neighbour/relatives (here need to state the names to allow record for network analysis even the gender); 3) Local Market (here also, it is needed to state the exact name for the purpose precise above); 4) Research Institutes (1. Bioversity International (Alice), 2. ISABU, 3. IRAZ, 4. Universities); 5) NGO (To be specified by the farmer); 6) Other sources (To be specified)

II.12. How did you acquire it? 1) Exchange/Barter; 2) Gift; 3) Purchase; 4) Other (Specify)

II. VITAMIN A RICH BANANA (VABS) TYPE

III.1. Do you grow or have you ever grown Vitamin A rich (orange coloured pulp) banana plants on your farm?1. Yes, 2. No
III.2. Have you received VABs from Bioversity?

1. Yes, 2. No

III.2.1. if yes, what is the use group of the stated VAB variety? 1) Cooking; 2) Dessert; 3) Roasting
III.2.2. if yes, how many did you receive
III.2.3. What is the name of the variety?

1. BIRA, 2. APANTU, 3. LAHI, 4. LAI, 5. PELIPITA, 6. To'o, 7. Other

III.2.4. What is (was) the source of the seed you planted?

1) Own farm; 2) Friends/Neighbour/relatives *(please specify the name, gender);* 3) Local market; 4) Bioversity International (Alice); 5) ISABU; 6) NGO *(To be specified by the farmer)*; 7) Other sources *(To be specified)*

III.2.5. What is the type of seed you used? 1) TC; 2) Suckers; 3) MP
III.2.6. How did you acquire it? 1) Exchange/Barter, *please give a name and gender;* 2) Gift, *please give a name and gender;* 3) Purchase, 4) Other (Specify)
III.3. Do you have actually VABs in your farm? 1. Yes, 2. No
III.4. What is the use group of the stated VAB variety? 1). Cooking; 2). Dessert; 3) Roasting
III.5. Which variety do you actually have for the selected type?

1. BIRA, 2. APANTU, 3. LAHI, 4. LAI, 5. PELIPITA, 6. To'o, 7. Other

III.5. How did you acquire it? 1) Exchange/Barter, *please give a name and gender*; 2) Gift, *please give a name and gender*; 3) Purchase; 4) Other (Specify)
III.6. Have you added some plants of VABs? 1. Yes, 2. No
III.6.1. How many have you added since you started planting VABs?
III.7. What is the use group of the stated VAB variety? 1) Cooking; 2) Dessert; 3) Roasting
III.8. Which variety did you add for the selected type?

1. BIRA, 2. APANTU, 3. LAHI, 4. LAI, 5. PELIPITA, 6. To'o, 7. Other

III.9. What is the type of seed you used? 1) TC; 2) Suckers; 3) MP
III.10. How did you acquire it? 1) Exchange/Barter, *please give a name and gender;* 2) Gift, *please give a name and gender*; 3) Purchase; 4) Other (Specify)
III.11. Do you plan to expand any of the VAB varieties? [1. Yes, 2. No]
III.12. if yes, state for each variety the reason?
III.13. What is your main source of information related vitamin A banana?

1. Bioversity International (Alice)/CIALCA; 2) ISABU; 3) Extension Agent from NGO; 4) Extension Agent from Government service; 5) Fellow famers; 6) Other (to be specified)

III.13. How often do you receive a visit from extension agents providing banana specific services?

1. Monthly, 2. Once every three months, 3. Once every six month, 4. Once in a year, 5. Not at all

III.14. How do you rank the importance of the visit of the extension personal to support banana activities?

1. Useful, 2. Quite useful, 3. Not useful

III.15. What subjects did you discuss with respect to the VABs and banana in general?

- Good agronomic practices
- Marketing of banana
- Food preparation methods
- Multiplication of planting materials
- Processing?
- Others (specify)

III.16. Do you buy VABs Plantlets? 1. Yes, 2. No

III.16.1. if yes, what is your source of money to purchase the plantlets?

1. Credit, 2. Off-farm activities, 3. Income from banana sold

III.16.2. Did you have to transport it? 1) Yes; 2) No
III.17. if yes, how? 1. By Head, 2. By Car, 3. By Bicycle
III.1.7. Do you own cattle? 1. Yes, 2. No
III.1.7.1. if yes how many do you have
III.1.7.2. How old are they (for each)?
III.1.7.3. Do you own goat, sheep or pig? 1. Yes, 2. No
III.1.7.4. if yes how many (per type if they are of different type)?
III.1.7.5. How old are they (for each)?
III.1.7.6. Do you own poultry? 1. Yes, 2. No
III.1.7.7. if yes how many?
III.1.7.8. How old are they?
III.18. Did you use manure? 1. Yes, 2. No [if yes, specify the source: 1. From own farm, 2. Market, 3. Other (to be specified)]
III.19. Did you use mineral fertiliser? 1. Yes, 2. No [if yes, specify the type]
III.20. What is your main source of labour? 1. Family Labour, 2. External labour
III.20.1. If external labour, where do you get money to pay external labour?

SHARING BANANA PLANTLETS

III.21. Have you shared VABs with any of your friends either by selling or donate, out of this location?

1. Yes 2. No

III.21.1. if yes, could you state the name and gender of your recipient?
III.21.1. if yes, Which variety?
III.21.2. if yes, what was the type of the shared banana? 1) Cooking; 2) Dessert; 3) Roasting
III.21.3. if yes, how many did you share of the selected type?
III.22. Where are the farmers you shared with located?

1. Same location (Village), 2. Different village

NON-ADOPTERS

III.23. Have you tried vitamin A rich banana variety but decided to drop it meanwhile?

1. Yes, 2. No

III.23.1. if yes, which of the following reasons support your decision to drop the VABs:

The availability of planting materials [1. Yes, 2. No]
The affordability (Expensive) of planting materials [1. Yes, 2. No]
The vulnerability to diseases and pests [1. Yes, 2. No]
Lower yield or bunch size [1. Yes, 2. No]
Long time to maturity [1. Yes, 2. No]
Shorter storage Life of bunches [1. Yes, 2. No]
Lack of market for the bunches [1. Yes, 2. No]
Nutritional attributes [1. Yes, 2. No]
Organoleptic traits [1. Yes, 2. No]
III.25. what are the major challenges or constraints do you face related to VABs?

III.26. if the Answer from III.1. is no, Are you aware of the VABs variety? 1. Yes, 2. No

III.26.1. if yes, are the following the reasons for your failure to plant VABs?

Is the availability of planting material a reason? [1. Yes, 2. No]
Is the affordability (Expensive) of planting material a reason? [1. Yes, 2. No]
Is the vulnerability to diseases and pest reason? [1. Yes, 2. No]
Is the yield a reason? [1. Yes, 2. No]
Is maturity a reason? [1. Yes, 2. No]
Is storability a reason? [1. Yes, 2. No]
Market of harvest [1. Yes, 2. No]
Nutritional attributes [1. Yes, 2. No]
Organoleptic traits [1. Yes, 2. No]

III.26.2. If No, *(The respondent will be told the attributes of VABs)*

1. Yield

	Cooking	Dessert
Flowering to maturity time	5	4.15
Bunch weight (Kg)/ size	25	19
Number of Hands	5.9	4.8
Number of Fingers on Bunch	65.9	49.3
Weigh of hands (Kg)	2.7	1.5
Fruits length (cm)	19.1	18

2. Nutritional attribute

It contains elements that are recommended intake of Vitamin A of children under 5 years and adult women

3. Utilisation

Cooking type: They can be cooked ripe or unripe, fried, roasted, steamed,
Dessert type: mainly consumed when raw and fully ripe

III.26.3. Are you willing now to adopt it? 1. Yes, 2. No
III.26.4. If Yes, what is the reason that attracts you the most?

1. Yield attribute, 2. nutritious attribute, 3. Utilisation.

If No, Why?

III. Farmers Perception on Vitamin A rich banana vis-à-vis to the existing plantlets

IV.1. What is your perception on the following attributes of Vitamin A banana varieties: *(This will be repeated by variety)?*

a. Yield (Number of Banana per plant)?
    1. Greater than existing varieties 2. Indifferent, 3. Less than Existing varieties
b. Length of fingers
    1. Greater than existing varieties 2. Indifferent, 3. Less than Existing varieties
c. Size/weight of the banana bunch?
    1. Greater than existing varieties 2. Indifferent, 3. Less than Existing varieties
d. Maturity
    1. Earlier than the existing varieties, 2. Indifferent, 3. Longer than the existing varieties
e. Duration (in farm).
    1. Longer than the existing varieties, 2. Indifferent, 3. Shorter than the existing varieties
f. Pest resistance
    1. Higher than the existing varieties, 2. Indifferent, 3. Less than the existing varieties
g. Diseases resistance
    1. Higher than the existing, 2. Indifferent, 3. Less than the existing
h. Availability (when needed)
    1. More available than the existing, 2. Indifferent, 3. Not available than the existing
i. Affordability (Cost)
    1. Expensive than the existing, 2. Indifferent, 3. Cheaper than the Existing
j. Storability
    1. Longer storage life/ shelf life than the existing, 2. Indifferent, 3. More perishable than the existing.
k. Nutrition's richness
    1. High nutrition value than, 2. Indifferent, 3. Less nutritious than
l. Tastiness
    1. Good taste than, 2. Indifferent, 3. Bad taste than
m. Quality of Juice
    1. Good quality of juice than, 2. Indifferent, 3. Less quality of juice than
n. Quantity of juice
    1. High quantity of juice than, 2. Indifferent, 3. Little quantity of juice than.

IV. MARKET IDENTIFICATION

I. Farmers / Trader

How do you perceive the distance from your home to where you are supposed to sell Vitamin A banana? 1. Far, 2. Closer, 3. Sell on Farm, 4. Never sold

How many minute does it take you to reach the market?

1. VABs cooking type

Who are your Clients for VABs cooking type?

Where are they located? 1) Local Area; 2) At the Centre of Province; 3) Bujumbura?; 4) Other

Is the price of the VABs cooking type higher compared to other type of cooking banana? 1. Yes, 2. No

If yes, what do you think is the reason of the price difference?

If No, what do you think is the reason?

How do you convince your client to move from their normal cooking banana to the VABs type?

What are the other use of the cooking VABs type out of cooking in your area?

2. VABs Beer type

Whom are your Clients for VABs beer type?

Where are they located? 1) Local Area; 2) At the Centre of Province; 3) Bujumbura?; 4) Other

Is the price of the VABs banana type higher compared to other type of beer banana? 1. Yes, 2. No

If yes, what do you think is the reason?

If No, what do you think is the reason?

How do you convince your client to move from their normal beer banana to the VABs type?

What are the other use of the cooking VABs type out of beer?

3. VABs Dessert type

Whom are your Clients for VABs dessert type?

Where are they located? 1) Local Area; 2) At the Centre of Province; 3) Bujumbura?; 4) Other

Is the price of the VABs cooking type higher compared to other type of dessert banana? 1. Yes, 2. No

If yes, what do you think is the reason?

If No, what do you think is the reason?

How do you convince your client to move from their normal dessert banana to the VABs type?

What are the other use of the dessert VABs type out of cooking?

II. PROCESSORS

1. Beer

1. Are you aware of VABs varieties? i) Yes, ii). No

2.If yes, what do you know about them?

3. if yes, have you ever tried to use them in processing beer? i) Yes, ii). No

4.If yes, do you still process it into beer? i) Yes ii). No

6.If yes, what is the level of preference of Beer from VABs compared to Beer from other type of beer banana? 1) Preferred than the other type of banana beer; 2) Indifferent; 3) Less preferred to other type of beer; 4) Not preferred at all.

7.If preferred, what do you think is the reason? 1) Nutrias Value; 2) Taste; 3) Cheaper; 4) Other

8.If not preferred, what do you think can be done to improve the competitiveness of juice from VABs?

9.Is the price for Beer from VABs higher than the one of Beer from other type of beer banana? 1). Yes, 2). No

10Is the beer from VABs exclusively destine to your local area? 1. Yes, 2. No

11.If no, where are located other client? 1) Local Area; 2) At the Centre of Province; 3) Bujumbura?; 4) Other

12. If, Q3 is yes and Q 4 is no, why?

13. Do you encounter any challenge related to your job?

V. Juice

1. Are you aware of VABs varieties?
   i. Yes, ii. No

2.If yes, what do you know about them?

3.if yes, have you ever tried to use them in processing Juice from it?
   i. Yes, ii. No

4.If yes, do you still process it into Juice?
   i. Yes ii. No

5. If No, why?

6.If yes, what method/how do you process it?

7.If yes, what is the level of preference of Juice from VABs compared to juice from other type of banana juice, from your client side? 1) Preferred than the other type of banana juice; 2) Indifferent; 3) Less preferred to other type of juice; 4) Not preferred at all.

8.If preferred, what do you think is the reason? 1) Nutrient value; 2) Taste; 3) Cheaper; 4) Other

9.If not preferred, what do you think can be done to improve the competitiveness of juice from VABs?
10.Is the price for juice from VABs higher than the one of juice from other type of juice banana? 1. Yes, 2. No
11.Is the juice from VABs exclusively destine to your local area? 1. Yes, 2. No
12.If no, where are located other client? 1) Local Area; 2) At the Centre of Province; 3) Bujumbura? 4) Other
13.Do you encounter any challenge related to your job?

III. CONSUMER COOKING BANANA

1.Are you aware of VABs cooking banana type? 1. Yes, 2. No
2.How did you hear about it? [quality, type]
3.What is (was) your source of information?
4.Can you differentiate it from other type of cooking banana? 1. Yes, 2. No
5.What makes it different from the rest? (attributes)
6.How do you prepare the VABs cooking varieties?
7.Is the required time to prepare it different from the other type of cooking banana?
1. Yes, 2. No
If ate, does it have a good taste compared to other type of cooking banana? 1. Yes, 2. No
Can VABs be found in the market as other type of cooking banana? 1. Yes, 2. No
If No, why?
Is the market price for VABs higher than other type of cooking banana?
1. Yes, 2. No
If yes, what makes you pay higher price for it?
Are you willing to continue to purchase this type of banana? Why?
If no, are you aware of its nutritional attributes? 1. Yes, 2. No
If No, in case you are told its attribute *(nutritious value),* are you willing to pay higher price than the other cooking banana?
1. Yes, 2. No
If Yes, how much are you willing to pay?

IV. CONSUMER OF BEER/JUICE

Are you aware of beer/juice from VABs? 1. Yes, 2. No
How did you hear about it? [quality]
What is (was) your source of information?
Have you ever drink beer/juice from VABs? 1. Yes, 2. No
Can you differentiate the beer/juice from VABs to the rest of banana beer/juice? 1. Yes, 2. No
What makes it different from the rest? (attributes)
Does it have a good taste compared to other type of banana beer/juice? 1. Yes, 2. No
Can find beer/juice from VABs in the market as other type of banana beer/juice? 1. Yes, 2. No
If No, do you think why?
Is the market price for beer/juice from VABs higher than other type of banana?
2. Yes, 2. No
If yes, what makes you pay higher price for it?
If no, are you aware of its nutritional attributes? 1. Yes, 2. No
If No, in case you are told its attribute *(nutritious value),* are you willing to pay higher price than the other banana beer/juice? 1. Yes, 2. No
If Yes, how much are you willing to pay?

V. VABs Dessert consumer

Are you aware of VABs dessert? 1. Yes, 2. No
How did you hear about it? [quality]
What is (was) your source of information?
Have you ever eaten VABs dessert banana? 1. Yes, 2. No
Can you differentiate it from other type of dessert banana? 1. Yes, 2. No
What makes it different from the rest? (attributes)
Does it have a good taste compared to other type of dessert banana? 1. Yes, 2. No
Can VABs dessert be found in the market as other type of banana dessert? 1. Yes, 2. No
If No, why?
Is the market price for VABs higher than other type of dessert banana? 1) Yes, 2). No

If yes, what makes you pay higher price for it?
If no, are you aware of its nutrias attributes? 1. Yes, 2. No
If No, in case you are told its attribute *(nutritious value),* are you willing to pay higher price than the other dessert banana?
1. Yes, 2. No
If Yes, how much are you willing to pay?

Appendix 3: Guide for Focus Group Discussion

FGD: VITAMIN A BANANA ADOPTION STUDY

Opening message

Good morning and welcome to our session. Thank you for accepting our invitation and join us to talk about the status of Vitamin A banana in your village. My name is …… and assisting me is …….. We're both from Bioversity International. As researchers, we need to get some information from you about your perceptions of the vitamin A banana. We want to know what worked, what didn't work, and what should be done to improve our intervention.

You were invited because you are beneficiary (of plantlet/Training) or non-beneficiary adopter of VABs or have participated in the recent survey.

There are no good or wrong answers but rather differing points of view. Please feel free to share your point of view even if it differs from what others have said.

You've probably noticed the microphone. We're tape recording the session because we don't want to miss any of your comments. You may be assured of complete confidentiality. The reports will help in planning future interventions.

I. **TARGET:** Understand the perception, adoption levels of the vitamin A rich banana plants on farms in the pilot sites/ communities.

1. You have all received the VABs,
1.1. how have you got informed about VABs?
1.2. by Who?
1.3. What kind of information did you receive?
1.4. Have you been given the plantlets or searched for yourself?
1.5. How did you get the plantlets? *(Mode acquisition)*
2. What made you adopt VABs?
3. Would you like to list all the varieties of VABs that you received?
4. What are the most preferred among the listed varieties and why?
5. Which ones were not preferred and why?
6. What is your perception regarding the level of adoption of VABs in your community?
7. Why?
8. From your points of views, what do you think the project has succeeded and where do you think it failed?
8.1. *In terms of sources of plantlets,*
8.2. *In terms of diseases/pest/dry resistance,*
8.3. *Period of distribution of plantlets*

II. **TARGET**: Understanding the utilization/ consumption of the cultivars in pilot sites/ communities

1. We now want to group all the varieties of VABs based on their utilization in your area. *(They should group all varieties of VABs they grow based on the common use in the area)*
1.1. Ask them why those varieties are used/consumed like that? (*Initially the project had perspective of use for each of the variety however, consumer may have found another way of consumption which we need to know why or what made them feeling comfortable consuming it such way) Use a table with*
1.2. Based on the group of use of VABs try to compare with other type of banana that have the same way of use so that we can get their perception of VABs on non-VABs.

What do you think should be done to improve the situation?