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A comparative study of banana seed systems in Mbarara district, western Uganda and Mukono district, central Uganda

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Contents

Abstract

Seed system interventions aim to provide farmers with clean, high yielding planting material. In order to make such interventions successful it is important to understand the traditional seed systems in which the interventions are made. This report describes the results of a comparative study between the banana seed system in Central and Western Uganda. These regions differ in cultivation history, production objectives and previous seed system intervention. These characteristics result in a difference in management practices, seed sourcing strategies and selection processes of banana planting material. In both areas, on-farm cultivar diversity is high, and maintained to fulfill multiple end-uses as well as to spread risk. In Central Uganda some cultivars are maintained due to cultural beliefs and their use in rituals. In the western region such motivations for cultivar maintenance were not mentioned. In Western Uganda farmers kept their banana mats small by regular de-suckering, which makes uprooting and replacing a mat easier. Selection of planting material in the western region is much focused on keeping existing mats healthy, whereas in the central region farmers focused mainly on the distinction between sword and water suckers. These insights into differences in preferences and motivations behind the selection of planting material and seed sourcing strategies can facilitate future seed system interventions and facilitate adaptation to farmers' needs.

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A comparative study on banana seed systems in Mbarara district, western Uganda and Mukono district, central Uganda

INTRODUCTION

The East African Highlands are home to over 100 locally evolved banana cultivars generally known as the East African Highland Bananas (EAHBs) (Karamura et al. 2012). In this region, Uganda is the leading producer and consumer of banana (Gold et al. 2002a). The majority of bananas produced and consumed in Uganda are not sweet, yellow bananas eaten as fruits, but harder green bananas used as a staple food which is locally referred to as 'Matooke'. In the central region of Uganda, banana is the traditional staple crop and has been grown for hundreds of years (Bagamba et al. 2008). Over the last three decades, banana production in the central regions of Uganda has declined, whereas banana production has expanded considerably in the southwestern regions (Gold et al. 2000; Rietveld and Farnworth 2018). The major reasons behind the decline in banana production in central regions identified by farmers were reduced labor availability and management, an increase in pest pressure (banana weevils) and declining soil fertility (Gold et al. 1999). Nevertheless, over the same period of time, the demand for banana increased due to expansion of urban markets which has driven the expansion of banana production into the southwestern regions (Gold et al. 1999).

The increased market demand, coupled with improved infrastructure, led to improved market access for farmers in southwestern regions, and stimulated both expansion of banana cultivation and increased commercialization of banana. Banana became the main income source of many households and has had a pivotal role in raising income from farming. It is even said that a new class of 'rich farmers' has emerged in some of these regions, such as in Isingiro district (Rietveld et al. 2016). Banana management in the southwestern regions is more intensive compared to Central Uganda, with high labor and manure input investments to produce the large bunches which the market prefers. (Rietveld et al. 2016). There are concerns that the cultivation of cooking banana in the Southwest will undergo the same cycle of decline as experienced in central regions.

New developments in banana propagation material, such as disease or drought resistant cultivars, could potentially help prevent another decline in banana production. Currently, the common way for farmers to acquire banana planting material is the use of suckers which the farmers obtain from their own farm or fellow farmers such as neighbors and friends. This informal way of obtaining planting material has several benefits for the farmers as it is usually for free, or at a very low cost, and the material is adapted to local agro-ecological and socio-economic circumstances. Seed multiplication and exchange also has a downside. The sanitary quality of the planting material can decrease rapidly when pathogens accumulate after planting material from the same crop population is used for several successive cycles. This is referred to as seed degeneration (Thomas-Sharma et al. 2016). These pathogens can spread when infected planting material is exchanged. In addition, vegetative multiplication is slow in comparison to true seed crops, and genetics remain the same. This makes it difficult for farmers to find planting material adapted to sudden changes in for example the climate or soil quality. To help farmers overcome these challenges, seed system interventions

are made. This usually involves the establishment or strengthening of the formal seed sector, which is characterized by extensive breeding programs, seed production, distribution of tested seed and approved cultivars, and the use of strict quality control (Almekinders and Louwaars 1994). Previous seed system interventions in Uganda include the introduction of a hybrid line of banana cultivars called FHIA, and the establishment of production sites and marked pathways for tissue culture (TC) banana plantlets (Albertson 2016; Kikulwe 2016).

To make this type of intervention successful, it is important to understand the current dynamics of the seed system in which the interventions are made (Almekinders et al. 2019). In this report we describe differences and similarities in cultivar use, mat management, seed sourcing and selection of planting material between banana farmers from two districts, one in the central region and one in the western region of Uganda. Since historical context and cultivation objectives differ between these two regions, we hypothesize finding different seed sourcing strategies and management of banana planting material per region.

METHODOLOGY

RESEARCH AREAS

The study was conducted in the Mukono district in Central Uganda and in Mbarara district situated in Western Uganda (figure 1). Mukono's climate is characterized by moderate temperatures ranging between a mean annual minimum of 15ºC and a mean annual maximum of 30ºC. Mbarara has a hillier landscape and higher altitude than Mukono. Temperatures are consequently slightly lower in Mbarara and the amount of annual precipitation is slightly higher than in Mukono. In Uganda, two rainy seasons are known, one of which starts in March and ends in May, locally referred to as the April rains, and one starting in October and ending in December, which is referred to as the November rains. Data in Mukono was collected between September and December 2016, in five villages situated in the sub-counties Ntenjeru and Nakisunga. In Mbarara, data was collected in October 2017 in the villages Nyakasa and Kyesika, situated in the sub-counties of Kashari and Rwampara. In both areas, the majority of the farming population consists of smallholders.

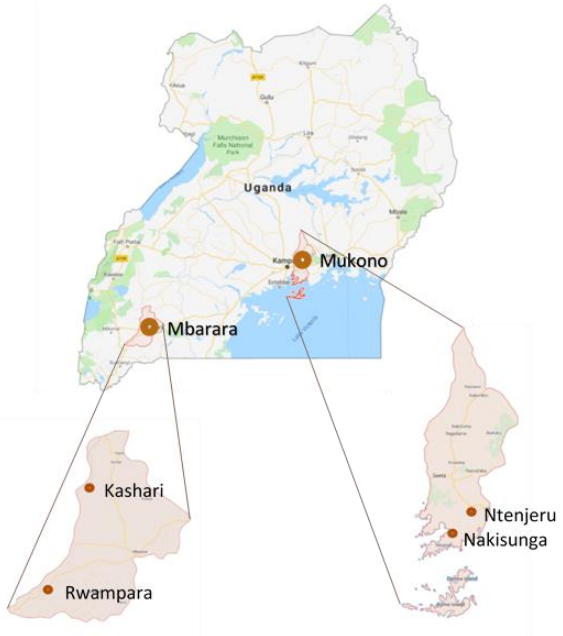

Figure 1

RESEARCH AREA

The research was conducted in the sub-counties Ntenjeru and Nakisunga in Mukono district, situated in Central Uganda, and in the sub-counties Kashari and Rwampara in Mbarara district, situated in the southwest of Uganda

FOCUS GROUP DISCUSSIONS ON BANANA DIVERSITY AND USE

An adapted version of the four-square analysis (Grum et al. 2008) was used to understand which banana cultivars farmers grow in the study area, what their uses are, and what farmers' perceptions are on the strengths and weaknesses of these cultivars. In each study site four Focus Group Discussions (FGDs) were conducted with four different social groups divided on basis of sex (M/F) and age-group (18-40 years or 40-70 years old). Each group had 6-8 participating farmers and the FGD lasted between two and three hours. All participants were involved in banana production. In Mukono all participants lived in Gonvé village, situated in Ntenjeru sub-county, and all the participants from Mbarara lived in Nyakasa village situated in Kashari sub-county. In Mukono no formal lists of names could be identified to aid the selection of participants. The farmers were mobilized by our local key informant and entry-point into the village: a well-known lady who had previously been involved in government and NGO banana programs in the village. The mobilizer was asked to gather farmers of different economic status and banana farm size. In Mbarara a random sample among banana cultivating households was chosen from a list established during an earlier baseline study. Each FGD in Mukono was held in October 2016 and in Mbarara in October 2017. Each FGD followed the same protocol consisting of three parts. First, participants compiled a list of all the cultivars known to be cultivated in the community. Secondly, for each cultivar listed, participants discussed main objectives for cultivation, other uses, and strengths and weaknesses. Thereafter, participants were asked to place each cultivar in one of the following 'squares': 1) cultivar grown by many farmers on a large area, 2) cultivar grown by many farmers on a small area, 3) cultivar grown by a few farmers on a large area and 4) cultivar grown by few farmers on a small area (figure 2, fictive example).

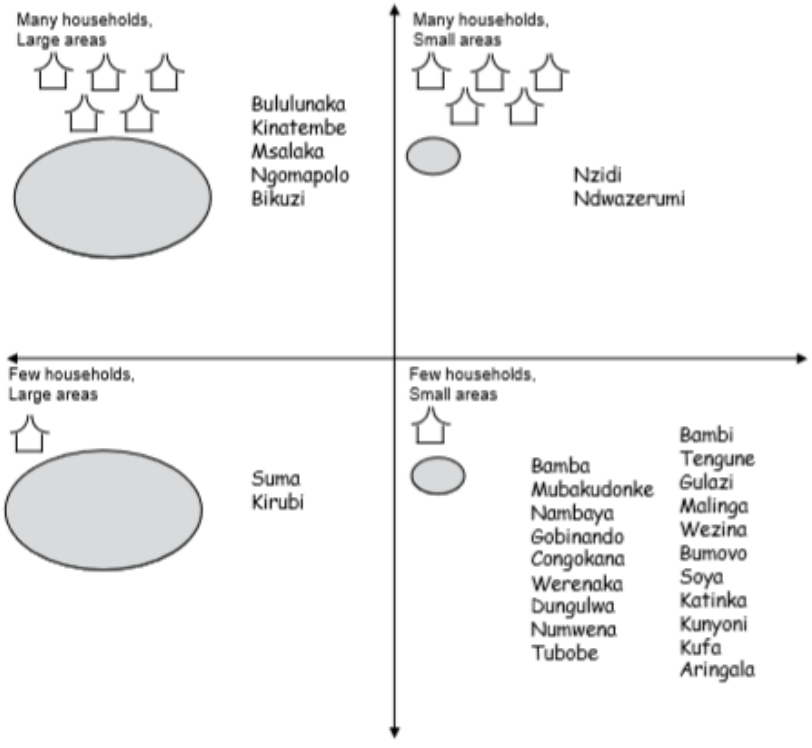

Figure 2

EXAMPLE OF A PARTICIPATORY EXTENT AND DISTRIBUTION ANALYSIS

Farmers place varieties in one of the four squares, based on the area under cultivation and the number of households growing the cultivar. This figure represents a fictive example of the outcome of a four-square analysis. Source: Grum et al. 2008

INTERVIEWS ON SEED SOURCING STRATEGIES

Semi-structured interviews were carried out with individual male and female farmers who belonged to households of different wealth classifications. In Mukono 23 farmers, ten women and thirteen men, were interviewed. In Mbarara 20 farmers were interviewed, nine women and eleven men. Since no identification lists were present to choose households in a random fashion, the participants in Mukono were identified by the research team on a basis of house-type, livestock holding, farm type, and size of the banana plantation. The research team aimed for socio-economic and agro-ecological diversity as much as possible while selecting the households. In Mbarara participants were selected randomly from a list of households. Each interview lasted 2-3 hours and the type of questions followed a similar sequence. After collecting the basic information on the household and farm, the regular cultivation practices and input use were discussed while 'walking the farm'. During this walk, a maximum of sixteen banana mats were selected according to cultivar name, age, and origin. This resulted in data collection on seed sourcing of 279 sampled individual banana mats in Mukono, and of 239 mats in Mbarara. The last part of the interview dealt with seed sourcing strategies, sucker management, and farmers' perceptions of quality regarding planting material.

DATA ANALYSIS

The results of all four FGDs per area were combined to provide an overall picture of use of banana diversity in each area. Results of separate groups per group were compared, to identify gender or age-group specific differences between groups. Because cultivars have different local names the classification made by Karamura et al. 2012 was used to identify cultivars listed in both areas but with a different local name.

The survey information was differentiated for gender, age and wealth. Sex of both the participant and the household head were noted. Farmers aged between 18 and 30 were classified as young farmers, farmers aged between 31 and 50 were classified as middle-aged farmers, and farmers above 50 were classified as older farmers. Wealth was determined on the basis of type of house, number of livestock and landholding area (Table 1). Most data collected was qualitative. Responses were coded and clustered when comparable. Thereafter, the data were analysed using frequency of answers to identify trends and patterns. The qualitative data were used to support and explain visible trends in the quantitative data. Due to the relatively small sample sizes, only descriptive statistics were used.

Table 1. Classification of farmers according to their assets in housing, livestock and landholding.

Asset	Poor	medium	rich
Roof type	Grass – iron	Iron	Iron - roof tiles
Walls	Mud – brick	Brick	Brick - plaster
Floor	Earth – cement	Cement	Cement/elevated cement/tiles
Number of cows	<1	1-5	>5
Number of pigs	<2	2-10	>10
Number of goats	<4	4-15	>15
Number of poultry	<5	5-20	>20
Area of landholding	<1.5 ha	1.5-5 ha	>5 ha

RESULTS

HOUSEHOLDS AND CULTIVATION CHARACTERISTICS

In total 43 farmers were interviewed; 23 in Mukono and 20 in Mbarara. Ten of the farmers interviewed in Mukono were women, of which seven were head of the household (table 2). The remaining 16 households were male-headed and, apart from one, these men were living together with their wife. In Mbarara nine women were interviewed, of which two were head of the household. The area each household cultivated with banana ranged from 0.1 to 2.5 hectare in Mukono district, and from 0.2 to 2.0 hectare in Mbarara. The average size of a banana plot was 0.64 ha in Mukono, and 0.65 ha in Mbarara. In both areas young farmers had smaller banana farms compared to middle-aged and older farmers, and rich farmers had larger farms compared to other wealth classes. The average age of the banana plantation in Mukono was 19 years ranging from 2 to 46 years, and in Mbarara 20 years ranging from 2 to 45 years. In both areas the banana plantations of young farmers were younger. For some farmers it was hard to estimate in which year the banana plantation had been planted, since most of the banana plantations were inherited and had already been there for as long as they could remember. Therefore, not every farmer was able to estimate their banana plantation's year of establishment. In every household, banana was among the three most important crops for income and consumption.

Table 2. Characteristics of the participants (gender, age, wealth) in relation to their banana plantation (farm size and the average year of banana plot's establishment of the banana plot) in the study area in Mukono (MUK) and Mbarara (MBA).

	Total respondents n		Male n		Female n		Mean age Respondent		Mean farm size (ha)		Mean age farm	
	MUK	MBA	MUK	MBA	MUK	MBA	MUK	MBA	MUK	MBA	MUK	MBA
Gender												
Male respondents	13	11					45	42	0.86	0.53	1995	1991
Female respondents	10	9					48	39	0.36	0.80	1998	2005
Male headed households	16	18					44	41	0.73	0.60	1996	1994
Female headed households	7	2					48	38	0.37	1.07	1999	2016
Age												
Old farmers	11	7	6	5	5	2	58	58	0.68	0.68	1985	1981
Middle aged farmers	7	6	4	2	3	4	44	40	0.77	0.84	2003	1998
Young farmers	5	7	3	4	2	3	27	24	0.36	0.46	2012	2005
Wealth												
Rich households	7	5	6	3	1	2	50	41	1.04	1.05	1996	1994
Medium wealth households	11	9	6	5	5	4	47	45	0.43	0.67	1997	2002
Poor households	5	6	1	3	4	3	43	34	0.53	0.28	1996	1993
Farm size												
Large scale banana farms	5	5	5	4	0	1	47	50	1.42	1.34	1995	1982
Medium scale banana farms	9	8	6	4	3	5	53	40	0.66	0.63	1994	2002
Small scale banana farms	9	7	2	3	7	4	41	35	0.18	0.21	2000	1999
Total	23	20					47	41	0.64	0.65	1996	1997

MANAGEMENT OF THE BANANA FARM

In Mbarara, individual households cultivated between one and four plots with banana. The total number of plots with banana was 43. Twenty of these plots consisted of banana mono-culture, fourteen plots were intercropped with beans, three with coffee, and five with both coffee and beans. In Mukono, only information about the plot located at the homestead (home plot) was

obtained. On three of 23 home plots, banana was grown in mono-culture. On seventeen plots, banana was intercropped with coffee, sometimes in combination with a third and fourth crop such as beans, cassava or vanilla. It was observed that banana plantations in Mukono and Mbarara look different. In Mbarara, spacing between plants appears to be lower, although we did not measure this. Also, the mats in Mbarara appear smaller as they have fewer stems per mat. In Mukono, the number of stems per mat varies largely depending on the cultivar. Whereas some cultivars might only have two or three stems, cultivars such as Bogoya and FHIA tend to have ten or more. In Mbarara, the mats of all cultivars are kept small through regular de-suckering (removal of new sprouts to direct energy to production of large bunches instead of plant growth (Figure 3).

Figure 3. Left: In Mukono spacing between the banana mats is usually bigger and mats tend to have more stems per mat. Right: In Mbarara spacing between plants appears to be lower and mats have few stems because they are regularly de-suckered.

GENDER AND ROLES IN BANANA CULTIVATION

There were differences among households as to who was involved in the management, who was involved in the decision making about planting material, who was involved in sales of banana products, and who was in control over revenues of banana products. In all female headed households, except one, the woman alone was responsible for all these tasks. In the male headed households, there were differences in task division. In some households only the man was responsible for all tasks. In some households both men and women were responsible, and in some households only the women. In those male headed households where only the woman was responsible, the men were usually involved in other activities which were the main source of income for the household.

Table 3. Allocation of roles regarding decision making about banana cultivation among male and female farmers in male and female headed households in the study area in Mukono district (MUK) and Mbarara district (MBA)

	Involved in management		Makes decisions about planting material		Involved in sales of banana products		Gains revenues of banana products	
	MUK	MBA	MUK	MBA	MUK	MBA	MUK	MBA
Female-headed households								
Female only	7	1	7	1	7	1	7	1
Family	0	1	0	1	0	1	0	1
Male-headed households								
Man only	7	2	7	9	7	4	7	4
Woman only	3	3	3	2	4	3	4	3
Both man and woman	6	12	6	6	5	10	5	10
Family	0	1	0	0	0	0	0	0

PRODUCTIVITY OF BANANA FARMS

In both study sites, the households consumed about half of the bananas produced and sold the other half to local traders. In Mukono, farmers harvested about 66 bunches/ha and in Mbarara 77 bunches/ha during the last cropping season. The productivity of older farmers was lower compared to middle aged and young farmers, especially in Mukono. The total number of bunches harvested by large-scale farmers was higher compared to small-scale farmers (Table 4). The number of bunches harvested per hectare was much higher among small-scale farmers in both areas; most likely because small-scale farmers manage their plot more intensively.

Table 4. The number of bunches harvested in total, per Hectare (ha) and the % of harvested bunches consumed by the household for different social groups in the study area in Mukono district (MUK) and Mbarara district (MBA).

	Total number of bunches harvested		Number of Bunches harvested/ha		% of bunches consumed by HH	
	MUK	MBA	MUK	MBA	MUK	MBA
Total	24	44	66	77	46%	65%
Male HHH	27	44	71	71	42%	68%
Female HHH	19	48	55	46	53%	36%
Old farmers	18	42	31	67	57%	74%
Middle aged farmers	35	67	79	81	34%	54%
Young farmers	25	27	125	84	37%	65%
Rich HH	30	65	66	59	47%	48%
Medium wealth HH	27	47	77	75	43%	68%
Poor HH	12	22	40	95	49%	76%
Large scale banana farms	35	73	29	50	29%	42%
Medium scale banana farms	26	46	42	72	53%	65%
Small scale banana farms	16	22	111	105	47%	80%

INPUT USE FOR BANANA CULTIVATION

Inputs that are commonly used in both areas are different types of organic fertilizers. Chemical fertilizers were only used by one farmer in Mukono. The majority of the farmers mulched their banana plantation with vegetal waste sourced from their own farm, such as old banana leaves. Most farmers (25) used cow manure to fertilize their banana farm. In Mbarara the majority of farmers used coffee husks. Insecticides, pig manure and foliar fertilizer were only used by farmers in Mukono. Mulching with hay, on the other hand, was only done by farmers in Mbarara (Table 5). Most of the organic fertilizers used originated from animals on the farmer's own farm. In Mukono four out of the 23 farmers mentioned sometimes using off-farm sources to obtain fertilizers, but those fertilizers were still organic fertilizers. In Mbarara all the animal fertilizers used were collected on the farmer's own farm, whereas coffee husks and hay were always an off-farm input. However, in Mukono, coffee husks were obtained from the farmer's own farm.

Table 5. Number of farmers using different types of inputs for the cultivation of banana in Mukono and Mbarara.

Type of input	Number of farmers using the input in Mukono (n=23)	Number of farmers using the input in Mbarara (n=20)	Total number of farmers using the input (n=46)
Cow manure	18	7	25
Coffee husks	5	10	15
Goat manure	7	8	15
Poultry manure	8	2	10
Insecticides	8	0	8
Herbicides	4	1	5
Mulching with hay	0	5	5
Pig manure	2	0	2
Chemical fertilizer (foliar application)	1	0	1
Chemical fertilizer (soil application)	0	0	0

USE AND DIVERSITY OF BANANA CULTIVAR

DIVERSITY AND ABUNDANCE OF BANANA CULTIVAR

During the focus group discussions (FGDs) in Mukono district, 30 banana cultivars were identified by farmers. During individual interviews, ten additional cultivars were named. This means that a total of 40 different banana cultivars were identified in the study area in Mukono district. For 20 of these cultivars the main use is cooking. Five cultivars were dessert bananas, three were for making juice or beer (brewing) and for one the main use was roasting. The cultivar FHIA refers to a line of hybrid cultivars which includes cooking, beer and dessert cultivars. Cooking and dessert cultivars were represented in squares 1, 2 and 4. Juice and roasting type cultivars were only placed in square 4) 'grown by a few farmers on a small area'. None of the cultivars was placed in square 3) 'grown by a few farmers on a large area' (Table 6). Farmers in Mukono cultivated between four and 16 banana cultivars on their farm with an average of ten.

Table 6. Four square analysis of banana cultivar and their abundance, type and year of introduction estimated by farmers in Gonvé village, Mukono district. Cultivars with a symbol are recognized as introduced cultivars by: ● young man ○ old man ◆ young woman □ old woman. Cultivars which are underscored are recognized by farmers as improved cultivars.

Square 1. Many farmers – Large area

Local cultivar name	Type of banana	Year of introduction
Bogoya	Dessert	Indigenous
Tombadala●□◆○	Dessert	2006
Kibuzi	Cooking	Indigenous
Kisansa□◆○	Cooking	1970
Mpologoma●□◆○	Cooking	2000
Nakitembe	Cooking	Indigenous

Square 2. Many farmers – Small area

Local cultivar name	Type of banana	Year of introduction
FHIA●□◆○	All	1998
Kibuzi black	Cooking	Indigenous
Kivuvu	Cooking	Indigenous
Musakala	Cooking	Indigenous
Muvubo	Cooking	Indigenous
Ndiizi	Dessert	Indigenous

Square 3. Few farmers – Large area

Local cultivar name	Type of banana	Year of introduction

Square 4. Few farmers – Small area

Local cultivar name	Type of banana	Year of introduction
AGT●	Cooking	2004
Bogoya red	Dessert	Indigenous
Gonja	Roasting	Indigenous
Kayinja□○	Juice	1970
Kisubi	Juice	Indigenous
Luwaata	Cooking	Indigenous
Lwandungu●	Cooking	2011
Mbidde	Juice	Indigenous
Mwazirume	Cooking	Indigenous
Nakabululu	Cooking	Indigenous
Nakawere	Cooking	Indigenous
Nakytengu	Cooking	Indigenous
Nambi	Cooking	Indigenous
Namwezi	Cooking	Indigenous
Nandigobe	Cooking	Indigenous
Nsalwagiri	Cooking	Indigenous
Nfuuka	Cooking	Indigenous
Ndiizi Mfungu●	Dessert	1998

In the study area in Mbarara, 36 banana cultivars were identified during the FGDs and an additional five were named during the individual interviews, bringing the total of identified cultivars to 41. Of the cultivars named during the FGDs, the main use for 20 cultivars is cooking, two cultivars are dessert cultivars, and seven are juice/beer cultivars. Four cultivars are used for dessert as well as juice, and for three cultivars the main use was roasting. Square 1, 'many farmers on a large area', was only represented by cooking cultivars. Cooking cultivars were also placed in square 2 and 4, in which dessert cultivars were also classified. Roasting cultivars and cultivars purely used for juice were only represented in square 4. Similarly, as in Mukono, none of the cultivars were placed in square 3. However, here the FGD participants said that some of the cultivars should be represented in two squares because these cultivars are usually present in low numbers on many banana plantations but are also cultivated by some farmers in large quantities (Table 7). In Mbarara the number of cultivars per farm ranged from four to 12 with an average of nine.

Table 7. Four square analysis of banana cultivar and their abundance, type and year of introduction estimated by farmers in Nyakasa village, Mbarara district. Cultivars with a symbol are recognized as introduced cultivars by: ● young man ○ old man ◆ young woman □ old woman. Cultivars which are underscored are recognized by farmers as improved cultivars.

Square 1. Many farmers – Large area

Local cultivar name	Type of banana	Year of introduction
Embururu●	Cooking	1915
Enyeru	Cooking	Indigenous
Entaragaza	Cooking	Indigenous
Kibuzi	Cooking	Indigenous
Rwamugongo●○	Cooking	1950

Square 2. Many farmers – Small area

Local cultivar name	Type of banana	Year of introduction
Bogoya○	Dessert	1948
Enkyayaya	Roasting	Indigenous
Enywamaizi	Juice/Dessert	Indigenous
Kabalagala○	Dessert	1948
Kawanda◆□	Juice/Dessert	2000
Mbwazirume●	Cooking	Unknown

Square 3. Few farmers – Large area

Local cultivar name	Type of banana	Year of introduction

Square 4. Few farmers – Small area

Local cultivar name	Type of banana	Year of introduction
Bukunku	Cooking	Indigenous
Butobe	Cooking	Indigenous
Ekijunku	Juice	Indigenous
Ekitetengwa○	Cooking	1964
Embururu entanga	Juice	1915
Endirira	Juice/Dessert	Indigenous
Enjagata●	Cooking	Unknown
Enshembashembe	Cooking	Indigenous
Entukura/engambani	Juice/Dessert	Indigenous
Entukura(b)	Cooking	Indigenous
Entundu	Juice	Indigenous
Entundu embururu	Juice	Indigenous
Enyakinika	Cooking	Indigenous
Enzirabushera	Cooking	Indigenous
Gonja○	Roasting	1948
Kasenga	Cooking	Indigenous
Katera-ljju ○	Cooking	1960
Kazirikuwe	Cooking	Indigenous
Kisubi	Juice	Indigenous
Makunen	Roasting	Indigenous
Mpologoma●	Cooking	2000
Mujuba	Cooking	Indigenous
Musa ○	Juice	1950
Mushankara	Cooking	Indigenous
Mutungankobe●	Juice	2000

ORIGIN OF BANANA CULTIVAR

Most of the banana cultivars (≈75%) identified during the FGDs in Mukono district belonged to the East-African Highland bananas (AAA-EAHB) group. Seven cultivars were recognized by farmers as introduced to the area. These cultivars originated from formal sources including National Agricultural Research Organization (NARO), National Agricultural Advisory Services Program (NAADS) and Agro-genetic Technologies Ltd (AGT). The remaining cultivars were described as indigenous to the area. However, not all groups named the same cultivar as being introduced. Some cultivars described by older farmers as having been introduced around 40-50 years ago, were not recognized as such by younger farmers. On the other hand, cultivars described as recently introduced by younger farmers (1-5 years ago) were not mentioned at all by older farmers (Table 6). In Mbarara district 13 cultivars were identified as introduced during the FGDs. Only the cultivar 'Kawanda' was said to have come from formal sources, namely NARO which has a base in Kawanda, which is why the cultivar is referred to as Kawanda. This cultivar, or more precisely cultivars, are also known as FHIA in Mukono district, and refer to a line of hybrid banana cultivars. It was not specifically explained which of the FHIA hybrids the farmers referred to. The remaining cultivars which farmers identified as introduced came from other Ugandan Kingdoms: two from Ankole, two from Bunyoro, one from Toro and seven from Buganda. Mukono district belongs to the Buganda kingdom were most cultivars identified as introduced in Mbarara district originate from (figure 4). Both young and old women participating in the FGDs in Mbarara identified solely the cultivar Kawanda as being introduced in the area. The remaining 12 cultivars were all described by the men as introduced (Table 7).

Figure 4

KINGDOMS OF UGANDA

Map showing the Ugandan kingdoms Ankole, Toro, Bunyoro and Buganda. Banana cultivars from these kingdoms have been introduced in the southwestern study area. Souce: Meier zu Selhausen (2014).

Banana cultivars usually have a local name. Some cultivars were identified by farmers with the same name in both areas, whereas others had different names (Table 8). The most popular cultivar in

Mukono district was Nakitembe. During the FGDs the cultivar was placed in square 1 and while listing cultivars during individual interviews, this was the only cultivar grown by all 23 farmers. In Mbarara, Nakitembe is referred to as Entaragaza or Eshembashembe (Karamura et al. 2012). During the FGD, Entaragaza was placed in square 1 and Eshembashembe in square 4. It is possible that Entaragaza and Enshembashembe refer to slightly different banana cultivars. Farmers in Mukono described Nakitembe as also being known to have five slightly different variants, such as Nakitembe-Nakawere. Entaragaza was grown by 15 of the 20 farmers interviewed in Mbarara, and averagely represented 19% of the mats on the farm. Enyeru was also grown by 15 farmers, but represented on average 30%. The cultivar grown by most farmers in Mbarara (18 out of 20) was Kibuzi, on average representing 19% of mats on the farm. Kibuzi was placed in square 1 in Mukono as well. Kibuzi is popular with traders and retailers as it has a longer shelf-life than other cultivars.

Table 8. Banana cultivar named both in Mukono and Mbarara districts. Some cultivars are referred to with a similar name in both areas, whereas others are known by a different local name. (*) Cultivar is recognized as introduced in the study area.

Cultivar name Mukono	Cultivar name Mbarara
Bogoya	Bogoya*
Butobe	Butobe
FHIA*	Kawanda*
Gonja	Gonja
Kabula	Enywamaizi
Kayinja	Musa*
Kibuzi	Kibuzi
Kisubi	Kisubi
Kivuvu	Katera-Ijju*
Mbwazirume	Mbwazirume*
Mpologoma*	Mpologoma
Muvubo	Mujuba
Nakabululu	Embururu*
Nakitembe	Enshembashembe/Entaragaza
Nandigobe	Enjagata*
Ntukura	Engambani
Nabusa	Enyeru
Nakyetengu	Ekitetengwa*
Ndyabalangira	Enzirabushera

USE AND CULTURAL IMPORTANCE OF BANANA CULTIVAR

The classification of banana into cooking, dessert, roasting and beer types only indicates the main use of the banana bunch. However, the banana bunch, and indeed the entire banana plant, have multiple other uses. Both in Mukono and Mbarara farmers described the pseudo-stem of the banana being used as animal fodder, packaging and mulch. Fibres from the pseudo-stem are used for fire-making, ropes, mats, and baskets. Banana leaves are used for mulching, for packaging, and as wrapping for food to be steamed. In particular, the use of banana leaves for food preparation is important to farmers, but not all cultivars produce suitable leaves. Farmers in Mukono mentioned Bogoya and Ndiizi as currently grown cultivars with good leaf properties; they give the food a nice aroma and colour it yellow. In Mbarara, leaves of cultivars suitable for cooking are not only used at home but also marketed. Leaves of the cultivar Gonja, Bogoya, Enshembashembe, Musa (Kayinja) and Kivivu are marketed. Some cultivars are valued for their medicinal properties. In Mukono, Gonja is for instance used to hasten healing of new-born babies' belly-buttons, and Mbidde to prevent vomiting. In Mbarara, Ekijunku is said to have medicinal powers, and is used to improve overall health and to clean the blood.

In Mukono district, bananas are associated with many cultural traditions, ceremonies and rituals. For example, it is tradition to bring a banana bunch - or multiple bunches depending on the wealth of the person - to social gatherings such as weddings. When a baby girl is born, the placenta is buried beside a mat of Nakitembe, and for a boy this is done beside a mat of Mbidde or Kayinja. In Buganda the placenta is seen as a twin to a baby who has been born. Out of respect, the placenta has to be given a burial. Moreover, the burial is believed to protect it from animals and from people who might use it for rituals to harm the child. The cultivation of banana itself is also subjected to traditional rules and beliefs. The plantation is considered almost as a living organism which requires communication and respect. One female respondent said for instance:

> *"Because the banana plantation knows me, I am the only person uprooting suckers from my plantation. If I allow fellow farmers to uproot in my garden, I might anger my plantation. Whenever I want to uproot suckers, I first inform my plantation I am going to take some of her children away. I do so by cutting off the tops of a few suckers the night before I want to uproot. It is a kind of 'death announcement' I make to the plantation for taking the children away."*

Also, the arrangement of cultivars within the plantation is specific. Food cultivars are traditionally grown in mixtures; in the middle of the plantation at least one mat of Mbidde should be present and this mat represents "the man of the plantation". Some cultivars are considered to be a 'bad neighbour' to other cultivars and are planted at the boundaries of the plantation. This is, for instance, the case for the dessert cultivar Bogoya, Ndiizi and Gonja which are usually taller than food cultivars. Gonja is also placed at the boundaries, as it is said to protect the plantation against thieves. Some farmers grew dessert and brewing cultivars on remote fields because they need less management and inputs. The plantations in Mbarara also had a specific lay-out. However, this was only done to improve plantation performance, and not because of cultural beliefs such as protection from thieves.

Bananas are also not used for any other kind of cultural beliefs and rituals in Mbarara district. When one of the female farmers was specifically asked if there were any of these kind of practices, she replied: *"No, these kind of things are for witches who do sorcery, we don't do that here."* Only traditional uses were described in Mbarara where, similar to in Mukono district, banana bunches are given at social gatherings such as weddings and funerals.

MAT MANAGEMENT AND REPLACEMENT

Bananas are tree-like perennial herbs which do not have a fixed lifespan. Managing a banana plantation does not involve a sowing period like most other crops. A banana mat continuously produces new suckers and when the mat is managed well, this process of regeneration is continuous. When farmers in Mukono were asked about the lifespan of a specific cultivar's banana mat , the responses were diverse, ranging from five years for cultivars Nandigobe and Mpologoma, to 83 years for the cultivar Bogogya. Despite being unable to estimate a lifespan, many farmers in Mukono assured us that, under the right conditions and management, a banana mat can live forever. For this very reason all farmers in Mbarara said they could not possibly give us an estimation of the average lifespan of a certain cultivar. However, poor management, disease infestation or

unfavorable climate and environmental conditions, were all named as causes for reduced productivity or death.

When needed, new banana mats can be established by detaching a banana sucker from another banana mat and planting it elsewhere. The mixed cropping pattern, the differences in strengths and weaknesses of the cultivar, and the high diversity of cultivar used make it very uncommon for large areas of banana mats to show a reduction in productivity or die at the same time. For this reason, banana farmers more often refer to “gap filling” instead of planting: the gaps created by mats that died are filled with a new sucker. Gaps in the plantation are also created by the movement of mats. Each time a new sucker comes up, it appears a few inches from the mother plant. When this process is repeated over a few growth cycles, the banana mat has actually moved from its original place. The plantation is thus kept vital in two ways: 1) by managing an existing banana mat in such a way that it keeps regenerating and 2) by planting banana suckers to fill gaps in the plantation, to establish new banana plantations or to replace lesser productive mats (figure 5).

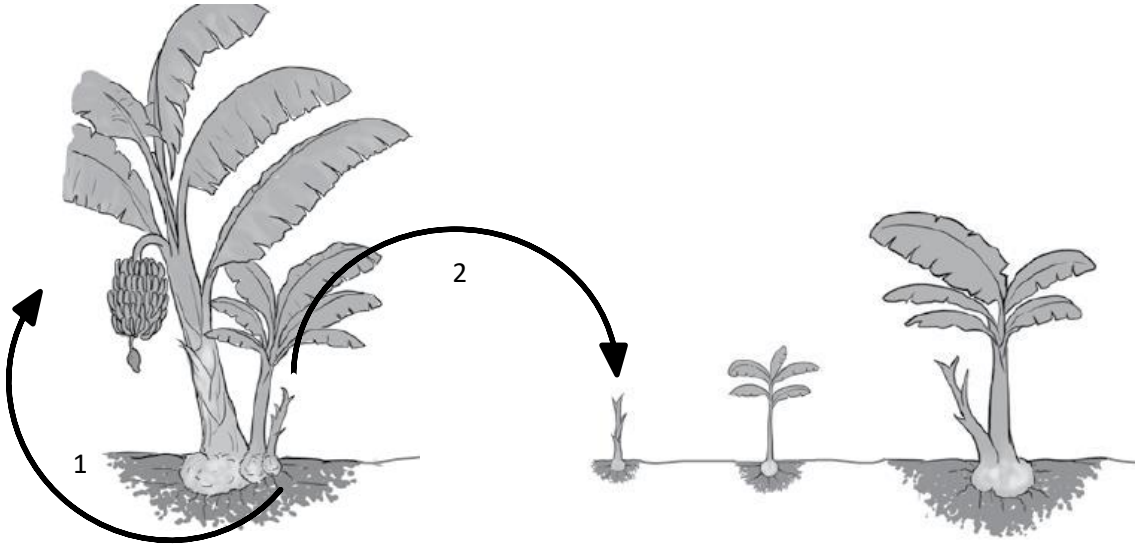

Figure 5. Two ways to maintain vitality of a banana plantation. 1: Under favorable circumstances and proper management a banana mat continuously produces new suckers. These suckers will follow up on the mother plant after a bunch has been harvested. 2: A new banana mat can be established by uprooting a sucker from the mat and planting it elsewhere. The sucker will eventually grow out as a new banana mat. Source: Adapted from: Wairegi et al. 2016.

We therefore explored farmers’ reasons for uprooting and replacing an existing banana mat with a new sucker, as some farmers have a more intensive replacement management compared to others. In Mukono, especially elderly farmers and women tend to fill up gaps rather than uprooting low productivity mats to replace them with a new sucker. Their motivation was that uprooting and replacing a banana mat requires a lot of time and physical strength. The farmers that did replace lesser producing mats explained that decline in productivity was generally attributed to the age of the mat, pest and disease infestation, competition from other banana mats, and soil unsuitability. In Mbarara, all farmers, including elderly and women, said they uprooted and replaced diseased mats. The difference in de-suckering management, which results in smaller mats in Mbarara, might make replacement of mats less labor intensive.

NEED FOR SUCKERS AND THEIR SOURCING

In Mukono, farmers planted nineteen suckers during the last planting season on average, which means that per hectare an average of 52 suckers were planted. In Mbarara, fifteen suckers were planted on average i.e. 30 suckers per hectare (Table 9). In both areas, in poor households and on small farms a lower number of suckers was planted. However, the number of suckers planted per hectare was higher for poor households in Mbarara district, and for small scale farmers in both areas. In Mukono, older farmers planted fewer suckers compared to other age groups. For Mbarara, no large differences in age groups were identified. In Mukono district, older farmers shared fewer suckers, whereas in Mbarara younger farmers shared fewer suckers. In both areas, poor households and small-scale banana farmers shared few suckers.

Table 9. The average number of suckers planted in absolute numbers and per hectare, the number of farmers who provided fellow farmers with suckers last planting season, and the average number of suckers they provided for each social group in the study area in Mukono (MUK) and Mbarara (MBA).

	Average number of suckers planted		Number of suckers planted/ha		Number of farmers that shared suckers		Average number of suckers shared	
	MUK	MBA	MUK	MBA	MUK	MBA	MUK	MBA
Male headed households	20	15	34	31	5	6	20	8
Female headed households	16	6	67	6	3	1	7	35
Old farmers	9	17	17	29	1	3	1	12
Middle aged farmers	34	19	69	24	4	3	45	15
Young farmers	15	8	64	37	3	1	13	2
Rich households	17	26	22	32	3	2	34	21
Medium wealth households	26	13	70	19	2	4	10	10
Poor households	8	9	13	44	3	1	9	1
Large scale banana farms	30	21	25	17	3	1	48	12
Medium scale banana farms	17	15	39	20	2	4	10	13
Small scale banana farms	14	11	58	52	3	2	8	3
Total	19	15	52	30	8	7	17	8

In both study areas a similar percentage of banana mats originated from the farmer's own farm; 68% of 279 sampled mats in Mukono, and 71% of 239 sampled mats in Mbarara. In Mbarara, a larger share of the mats originating from the farmer's own farm was already present at the time the land was acquired (referred to as inherited). In Mukono, of the 32% of mats originating from off-farm sources, 26% came from informal off-farm sources, and 6% came from formal off-farm sources. Most of the mats sourced from formal sources came from governmental programs in which banana planting material was distributed (4%). In Mbarara district, 29% of mats originated from informal off-farm sources, and none of the mats were sourced from formal sources (figure 6). In Mukono, 27 mats were sourced outside the community. In Mbarara only two mats were sourced outside the community.

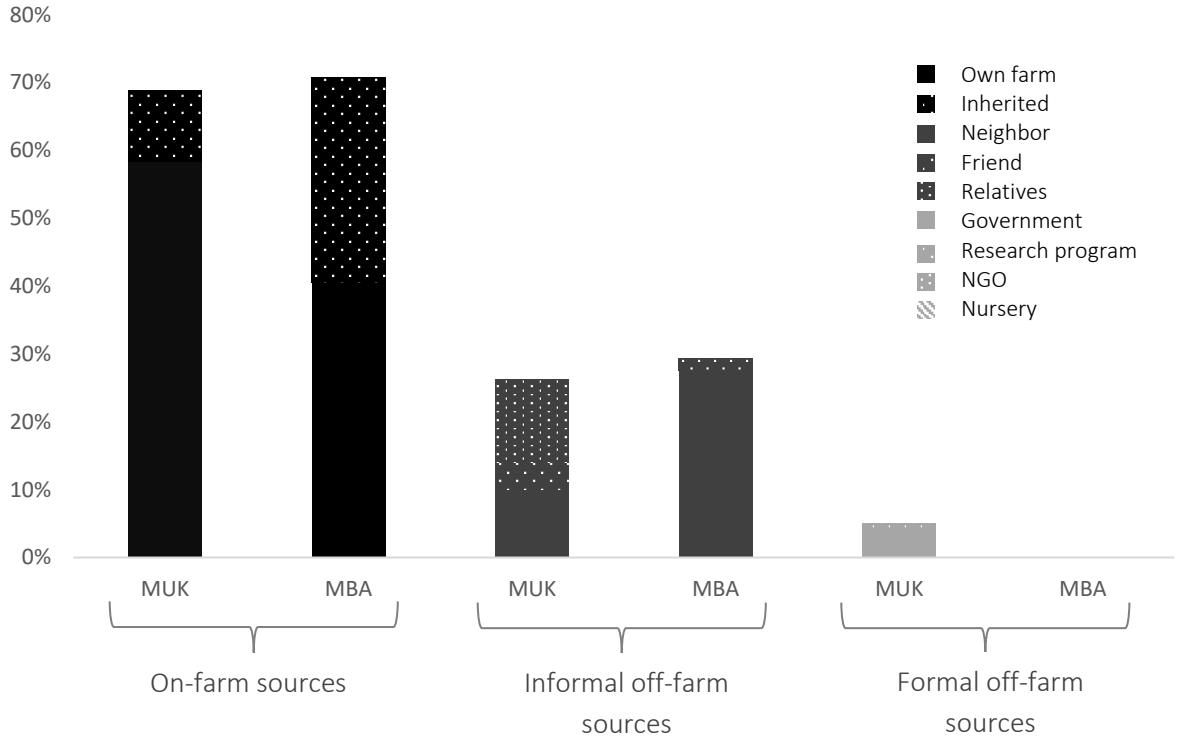

Figure 6. Source in % of each sampled mat in Mukono (MUK) (n=279) and Mbarara (MBA) (n=239). Black bars are on-farm sources, grey bars are informal off-farm sources and light grey bars are formal off-farm sources. The pattern inside the bar indicates the exact type of source.

SELECTION OF PLANTING MATERIAL

Farmers assess the quality of a sucker before they uproot it on basis of various traits in the mat, the mother plant, and the sucker itself (Table 10). The traits most frequently mentioned in Mukono were related to the sucker itself; leaf shape and size, pseudo-stem shape, sucker size and weevil damage. Leaf shape and size, pseudo-stem shape and sucker size in relation to the age of the sucker are characteristics used to determine if a sucker is a so-called 'sword' or 'water' sucker[1]. The distinction between sword and water suckers can therefore be considered as the main criterion for farmers in Mukono for selecting a sucker. In Mbarara, only the size of the sucker was frequently mentioned. Other criteria often mentioned were related to the mat and mother plant. The mat trait most often mentioned by farmers in both areas was the regeneration or continuity of the mat, which refers to the number of growth cycles of a mat. Farmers can contribute to mat continuity by leaving the 'right' number of suckers on the mat, removing superfluous suckers through de-suckering. Farmers explained that the removal of too many suckers weakens the mat and can drive it to an early death. On the other hand, leaving too many suckers on the mat reduces productivity because too much carbohydrate is withdrawn by the suckers (Robinson and Nel 1990). Especially for farmers in Mbarara the continuity of the mat was an important characteristic which was named by half of the

[1] Water suckers have a thin stem and develop broad leaves at a young age due to a shallow connection with the mother corm. Sword suckers on the other hand are cone shaped with a broad firm base and develop spear shaped leaves.

farmers. The placement of the new emerging suckers on the mat was mentioned by even more farmers in Mbarara, whereas it was only named by one farmer in Mukono. The farmers in Mbarara explained that the movement of the mats on their plantation is very important for them and has to follow a certain pattern to make sure that mats do not come too close together. This implies a difference in management style between farmers in Mukono and Mbarara. The approach of farmers in Mbarara seems to be more focused on maintaining existing mats, whereas farmers in Mukono also aim to maintain their mats but focus on selecting the best suckers for the establishment of new banana mats too. When farmers in Mbarara select a sucker, they mostly consider the size of the sucker and the size of the bunch given by the mother plant. Bunch size of the mother plant is also an important selection criterion for farmers from Mukono.

Table 10. Characteristics taken into account while selecting a sucker and the number of farmers naming each characteristic in Mukono (MUK) and Mbarara (MBA).

Category	Characteristic	MUK	MBA	Total
Sucker	Size of the sucker	9	9	18
	Shape of the pseudo stem	13	3	16
	Leaf shape and size	14	0	14
	Weevils and/or boreholes in corm/stem	9	2	11
	Color of the leaves	6	0	6
	Health of the sucker	5	0	5
	Color pseudo stem	4	0	4
	Number of leaves	2	2	4
	Depth of roots	1	2	3
	Age of the sucker	1	2	3
	Position of leaves along the pseudo stem	2	0	2
	Cigar leaf coming up vertically	1	0	1
	Reddish color base of leaves	1	0	1
	Color corm after paring	1	0	1
	"Ash" on the base of the leaves	1	0	1
Mat	Generation or continuity of the mat	5	10	15
	Place on the mat where sucker appears	1	14	15
	Age of the mat	2	0	2
	Distance between the sucker and the mother plant	1	0	1
	Total number of suckers on the mat	1	0	1
	Corm of mat above soil surface or not	1	0	1
Mother plant	Bunch size given by mother plant	6	12	18
	Health of mother plant	4	6	10
	Weevil infection mother plant	5	0	5
	Diameter pseudo stem mother plant	2	0	2
	Size of fingers mother plant	1	0	1

DISCUSSION

Banana production in Mukono and Mbarara has many similarities but there are slight differences in general management practices, seed sourcing strategies and selection of planting material. In both areas, banana is often intercropped; in Mukono with coffee and in Mbarara with beans. Farmers in Mbarara keep their banana mats small by regularly de-suckering, which changes the appearance of the banana plantations. In both areas, only organic fertilizers are used which mainly originate from the farmer's own farm. Besides fertilizers, farmers in Mbarara seldom use any other inputs on their

banana farms. In Mukono some farmers use insecticides against banana weevils. Farmers in Mbarara hardly had any weevil damage on their banana plots and used a specific management practice to trap weevils whenever they noticed any weevil damage.

In both areas on-farm banana diversity is high and cultivars are grown in a mixture. The composition of cultivars on the farm usually follows a specific pattern. In Mbarara this composition is maintained for production reasons, whereas in Mukono farmers also had cultural motivations behind their planting pattern. Reasons for farmers to maintain a high diversity are perceived differences in strength and weaknesses, security by spreading risk, and because of the multiple end uses of banana (Gold et al. 2002a, Kilwinger et al. 2019). Poorly producing cultivars are sometimes maintained for traditional, cultural or religious uses. Bananas were used for cultural and religious reasons, only in Mukono. In combination with the more market-oriented production goal of banana farmers in Mbarara district it is plausible that cultivar diversity is lower in Mbarara. Nevertheless, the total number of banana cultivars grown in the area, as well as the on-farm diversity of banana cultivars, hardly differed among the regions. In both areas, the majority of the cultivars were classified as grown by a few farmers on small areas, indicating that less popular cultivars are maintained in low quantities in both regions. This might be because most interviewed farmers produce around half of their bananas for home consumption. Farmers producing for both home consumption and market prefer to keep a high diversity of cultivar: cultivars with different maturity times and tasty fruits are preferred in order to provide the household with a continuous supply of food, and quick maturing cultivars giving a big bunch are preferred for market ends (Gold et al. 2002b). Yet, farmers producing more than two-third of their bananas for market purposes also kept a high on-farm diversity. This supports statements made in earlier research that farmers have multiple motivations to maintain a high on-farm cultivar diversity and that the adoption of a few ‘superior’ cultivars in terms of yield is unlikely (Gold et al. 2002a, Kilwinger et al. 2019). This is also supported by the fact that newly introduced cultivars were adopted by farmers in both areas, but were an addition to the cultivar portfolio rather than a replacement for (local) cultivars.

The number of cultivars described by farmers as introduced was higher in Mbarara compared to Mukono. The cultivars pointed out as introduced in Mukono mainly originated from the formal sector, whereas in Mbarara they mainly originated from other Ugandan kingdoms. This can be explained by the shift in cultivation from Central to Western Uganda since most of the introduced cultivars in Mbarara came from the Buganda kingdom which is in Central Uganda. Both in Mbarara district and in Mukono the largest share of the banana planting material originated from the farmer’s own farm. A larger portion of mats originating from the farmer’s own farm in Mbarara is inherited compared to Mukono. This could be the result of more intensive de-suckering practices and less pressure from weevils, which increases the lifespan of banana mats. Most of the remaining mats, in both Mukono and Mbarara, originating from off-farm sources were acquired from informal sources within the community such as relatives, neighbors and friends. In Mukono a few farmers used formal sources to obtain planting material. Due to a lower amount of interventions, formal sector production and distribution pathways are hardly present in the study area in Mbarara. This explains the higher number of cultivars introduced via the formal sector and the larger number of mats sourced from the formal sector in Mukono.

In both areas, farmers aimed to increase the productive lifespan of banana mats as much as possible. When a mat declines in productivity, or gets affected by pests or diseases, farmers can uproot banana mats and replace them with a new sucker. In Mukono, farmers described uprooting

and replacing mats as a very labor intensive practice. For that reason, especially women and elderly farmers pointed out that they usually do not to replace a mat, but rather wait until a mat dies and has left a gap. Instead of actively replacing low producing mats with new suckers, they thus only plant suckers when gaps are created naturally. In Mbarara all farmers said they replaced diseased mats. This could be due to the difference in de-suckering management between the areas. In Mbarara, banana mats are kept relatively small by regularly de-suckering the mats, making it less labor intensive to uproot a mat.

In Mukono, the number of suckers planted per hectare was higher compared to Mbarara. The difference in de-suckering management, higher soil fertility and lower weevil pressure might increase the productive lifespan of banana mats in Mbarara leading to less need for establishing new banana mats. These differences in management style also reflected on selection procedures for planting material. In Mukono, farmers described traits classifying suckers into either 'sword' or 'water' suckers as the most important selection criteria, followed by indication of weevil infestation. In Mbarara these traits were only named by a few farmers. Farmers in Mbarara were more focused on leaving healthy suckers on the mat for its continuity, and considered the placement on the mat where new suckers appeared. The difference in management style thus leads to a difference in farmers' sucker selection procedure in both study areas.

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