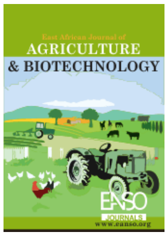

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Original Article

Understanding the Drivers of Adoption of Organic Banana Farming Technologies in Kajara County, South-western Uganda.

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ABSTRACT

This study aimed at identifying and characterising the major organic banana farming technologies used and assessing the drivers of adoption of the same in Kajara County. A total of 360 respondents were used to obtain primary data. As the study adopted a cross-sectional design, we used questionnaires, interviews, focus group discussions, and field observations to collect the required data. Data was analysed using descriptive statistics and the non-parametric (Chi-square) tests. Results indicate that the major organic banana farming technologies adopted in the study area were mulching, cover cropping, farmyard manure application, pest and weed management. The chi-square test revealed that the marital status, gender, and level of education of the farmers had significant positive effects on the adoption of organic banana farming technologies among the farmers. We concluded that, generally, the rate of adoption of organic farming technologies in Kajara County was low, and therefore, there is a need for emphasising the training of the farmers at local levels so as to equip them with information on the organic farming technologies for sustainable banana farming. We recommend that stakeholders who work on agricultural programs use model farmers in the area to educate and demonstrate the importance of organic banana farming technologies.

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INTRODUCTION

In many parts of the world, soil depletion and imbalanced nutrient use have become serious hindrances to agricultural development, in turn affecting food security and environmental stability (Sun and Cao 2018). A study by Powlson et al. (2011) indicated that the soil management techniques used in organic agriculture maintain a stable soil and nutrient balance in the environment, thereby making it a more sustainable way of exploiting the natural resource base. The absence of chemical inputs also implies less of a cost for the farmer since the manufactured fertilisers and pesticides that are usually imported will not be purchased. Organic products are noted to pose lesser health to the farmer and consumers, as observed in studies by Liu et al. (2018), where it is estimated that globally more than 350,000 people die from pesticide poisoning each year.

Dessart et al. (2019) observed that organic farming systems are suitable for smallholder farmers given that they rely on locally available resources and build on indigenous knowledge which allows for the development of highly productive farming systems that yield a variety of products and services to sustain the livelihood of farmers and also increases the food security of farmers' families while the international market for organic agricultural produce offers good value for their products. Apart from the financial gains of exports, organic production has several benefits for the producer country. Most importantly, it is a mode of production that puts less of a strain on the natural environment than conventional production. Organic production standards prohibit the use of inorganic inputs like artificial fertilisers and pesticides in growing crops, which implies that poisonous chemicals are not introduced into the ecosystem (Liu et al., 2018).

Despite the excess demand for organic products in developed countries, Collier and Dercon (2014) noted that African countries have not been able to expand the agricultural sector and benefit from agriculture the way other developing countries in Asia and Latin America have over the last 50 years. Many Sub-Saharan African countries have not managed to address ways of increasing crop yields, efficient land use, improved irrigation practices and development of infrastructures and as such organic farmers currently have trouble keeping up with demand which implies a gap in the supply and demand for organic products (Masanza et al., 2005). The question is therefore how this trend of agricultural stagnation can be turned around to foster positive and sustainable development.

According to United Nations Conference on Trade and Development (2015), there are almost 2.1 million hectares of organic agricultural land representing is 0.2% of the continent's total agricultural area and three percent of the global organic agricultural area having increased from the 52,000 hectares in 2000 (Collier and Dercon, 2014). In Africa, Uganda is the largest producer of organic commodities with about 210,352 organic farmers cultivating 19,052 hectares of land, representing 32.7% of arable land (Mwangi and Kariuki, 2015). With regard to banana production, Uganda ranked among the top ten banana-producing countries worldwide, down from the top five in the early 2000s, production is recorded to have reduced over time from 10.5 million tonnes in 2002 to 4.3 million tonnes in 2014 (Mwangi and Kariuki, 2015).

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Bananas in Uganda are one of the organically grown crops though at a small scale many times in association with other crops at low densities as shade trees for perennials like coffee or in commercial plantations at high density in a monoculture system. They further noted that the most widely grown cultivators are the cooking varieties that belong to the highland banana EAHB) subgroup including the desert species locally known as “Sukali ndizi” and “Bogoya” other varieties are those for roasting “Gonja” and “Kivuuyu” while “Kayinja” and “Kisubi” are mainly for making local beer (Wambedeet al., 2016). The EAHB cooking banana (AAA-EA group), locally known as “matooke”, is the leading staple food in Uganda with anannual production of over six million tonnes (Kayongo et al., 2015).

Despite this high demand and the involvement of Uganda in banana production, actual banana production in Uganda (5-20 $mg^{-1}ha^{-1}yr^{-1}$) is still below the estimated potential output (100 mg-1yr-1) despite the application of conventional methods like use of fertilisers (Mwangi et al., 2015). It was revealed that the use of organic farming technologies like mulching caused an increase in banana production in Western Uganda to 32 $mg^{-1}ha^{-1}yr^{-1}$ compared to the use of inorganic fertilisers that only caused an increase to 23 $mg^{-1}ha^{-1}yr^{-1}$(Kayongo et al., 2015). Despite the dominance of banana farming in Western Uganda and Ntungamo in particular, data on the scale of organic farming in the banana cropping system and the factors that affect the choice of organic farming technologies is scanty.

Studies conducted on banana farming systems in the Ntungamo district have focused on the effects of organic farming on banana weevils (Masanza et al., 2005; Gold et al., 2006); the role of agricultural extension services in ensuring food security in banana communities. None of these studies has focused on understudying organic farming technologies, yet this information is vital in determining the sustainability of farming in the banana cropping system. The current study therefore aimed at characterising the existing organic farming technologies and analysing the factors influencing their adoption by smallholder farmers in Kajara county, western Uganda.

MATERIALS AND METHODS

Study Area

The study was carried out in Kajara County, Ntungamo district in Western Uganda. It is located between 0.00° 55 00 - 0.9167°S and30° 6 28 - 30°10 00E (*Figure1*).The specific study areas were the villages of Kacuragyenyi, Nyabikiri, Kagorogoro, Karuka of Nyabubare parish, Karama, Kiina, Nyarubira, Bituntu in Rwanda parish in Bwongyera Sub-county and Omurutu, Kinyamoozi, Nyampikye, Nyamatongo, Bitokozi, and Kyabugimbi in Kitondo parish and villages of Katunga East, Kitojo, Namirembe, Kyamajumba and Kyenkuku in Butanda parish in Ihunga Sub County where banana growing specifically where organic farming technologies are evident.

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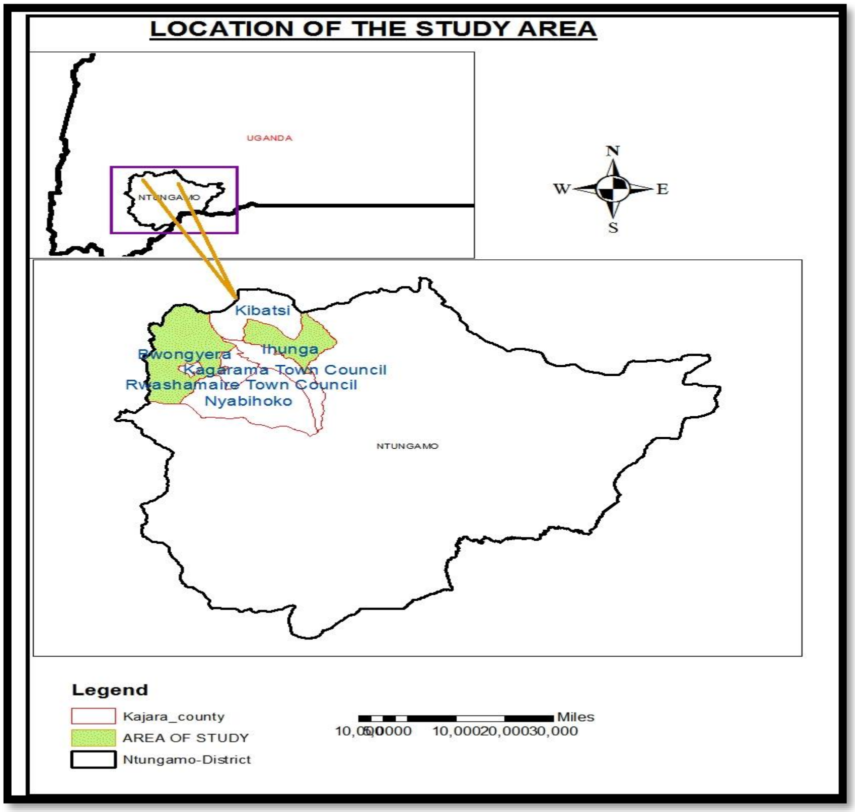
Figure 1: Location of Kajara County



The rainfall received is mainly convectional and averages about 900mm per annum. There are two wet seasons, one season begins in March to May and the other in August to November which is the largest. The study area experiences a mean annual temperature of 26ºC (East African Meteorological Department, 1975). The relief of the area is characterised by highlands, flatlands, and valleys with underlying impervious rocks.

The more pronounced natural water resources in the area include; Lakes Nyabihoko (Karengye) and Nyakiyanja adjacent to each other at the boundary of Rushenyi and Kajara countiesand River Kahengye that forms a boundary between Ntungamo and Rukungiri District.Soils of the area belong to Karagwe-Ankolean system dominated by reddish clay loams, shallow, dark-brown, sandy loams, yellowish-red clay loams, podsolised black sandy loams, stony loams and sandy to plastic clays which are hydromorphic, derived from the weathering of KA phyllites, Karagwe Ankolean schist's, sandstone and quartzite, granites, and hydromorphic/alluvial soils in areas under permanent waterlogged or impeded drainage conditions.

According to the Uganda Bureau of Statics (UBOS, 2014), Ntungamo District has 489,323 people whose main occupation is crop cultivation and livestock rearing. Crop farming involves mainly food crops such as banana, (matooke) maise, cassava, Irish potatoes, millet, matooke, beans, soya peas, groundnuts, whereas the animals reared under livestock include cattle, goats, sheep, and poultry. The district hosts a rich cultural heritage, consisting of several ethnic groups which include the Banyankole, Bahima, Banyarwanda, and Bakiga. However, the Banyakole form the most dominant ethnic grouping.

Data Collection

The study adopted a cross-sectional design. First, purposive sampling was applied to select the Ntungamo district from the western part of Uganda. The key reasons were that the district is the leading banana producing district in Uganda and it has a

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high population growth. Clustered sampling technique was also used to select four parishes out of 6 (*Figure1*). Given the similar approximate number of people and a land area in the Rwanda, Nyabubare and Butanda parishes (UBOS, 2014), 100 respondents were selected from each of these three parishes while the smaller number and size of Kitondo parish were based on to select 60 respondents from this parish giving a total of 360. The categories of respondents included smallholder farmers and the Key Informants (District Agricultural Officer, Sub County Agricultural Extension officers).

Respondents in each parish were selected randomly since we needed information about both adopters and non-adopters and any farmer was either an adopter or a non-adopter. Primary data was collected using a structured interview, focus group discussions and questionnaires. Three focus group discussions were carried out in each of the parish with between 5 - 10 people where gender balance was considered. Questionnaires interviews and discussions were used to obtain data about the demographic characteristics of respondents, e.g., age, sex, marital status, and other social characteristics of the respondents such as level of education, farmers annual incomes, accessibility to extension services, history of use of organic banana farming technologies, nature of adaptation practices and factors that influence farmers' adoption of these technologies in the area of study. Field observation was conducted in order to ensure the validity of the information obtained through discussion, interview and questionnaire. The questionnaires were administered by trained research assistants who were university graduate students and the researchers played the supervisory role.

Data Analysis

Data obtained from questionnaires was analysed using statistical techniques, while qualitative data collected by way of discussions, interviews and field observations were analysed thematically. Statistical analyses took the form of simple descriptive statistics, that is, frequencies and Per centages with the findings presented in tables. Owing to the categorical nature of the variables, a Chi-square (χ^2) test was adopted to examine the most important organic banana farming technologies adopted under the different parishes. In this test, we calculated the expected frequencies in each cell using the formula in equation (i).

$$\chi^2 = \sum \frac{(O-E)^2}{E} \qquad \text{(i)}$$

where χ^2 is the Chi-square, O is the observed cell frequency, E is the expected cell frequency, and Σ is the sum of all cells in the table.

RESULTS

Organic Banana Farming Technologies Used in Kajara County

A number of organic banana farming technologies were found in Kajara county. Their distribution in the different parishes was summarised in *Table1*.

Table 1: Distribution of Organic banana farming technologies employed in different parishes of Kajara County

Parish	Farming technologies									
	Farmyard Manure		Weed Management		Pest Management		Mulching		Use of Cover Crops	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Rwanda	15	27.3	23	38.3	8	25	34	21.7	5	22.7
Nyabubare	26	47.3	16	26.7	7	21.9	49	31.2	8	36.4
Butanda	6	10.9	12	20	9	28.1	43	27.4	6	27.3
Kitondo	8	14.5	9	15	8	25	31	19.7	3	13.6
Total	**55**		**60**		**32**		**157**		**22**	

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Mulching Technology

Mulching was revealed as the most commonly used organic farming technology employed by smallholder banana farmers in Kajara County and was highly used in the parishes of Nyabubare (31.2%) and Butanda (27.1%), while in Rwanda and Kitondo, only 21.7% and 19.7% of the farmers used mulching, respectively. The materials used by farmers to mulch their plantations included maize and sorghum straws, grass clippings, papyrus, reeds and elephant, spear grasses *(Plate 1)*.

Plate 1: Mulches using papyrus and maize straws applied in the banana plantation, Nyabubare Parish

Weed Management Technologies

Twenty-three farmers in Rwanda parish, 16 in Nyabubare, and 12 in Butanda engaged in weed management technologies (*Table 1*). This technology involved early spot weeding of invasive species like blackjacks before they bear fruits, consequently getting rid of it. In addition, when the weeds are spot weeded at a young age and heaped in one place, on rotting, they would turn into organic manure.

Organic Farm Yard Manuring Technology

The organic manure used was obtained from cow, goat, sheep, and pig dung, also used were poultry droppings. This practice was dominant in Nyabubare (47.3%), Rwanda (27.3%), Kitondo (14.5%) and Butanda (10.9%), as shown in *Table 1*. In this technology, animal waste was pilled in one place where it is left to decompose and later carefully applied in the plantation and a soil nutrient as seen in *Plate 2.*

Plate 2: Dry animal manure heaps in a banana plantation in Nyamatongo village Kitondo parish

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Pest Management Technologies

Pest management was found out to be most employed in Butanda parish (28.1%) followed by Rwanda and Kitondo parish at (25%) and was least applied in Nyabubare parish by (21.9%) as shown in *Table 1*. In this technology, farmers mixed animal dung, urine, red pepper, ash to form a concoction that was fermented for up to two weeks and later applied on banana plants to kill pathogens. The mixture killed various banana pests and infections in addition to improving the soil health since cattle and human urine are rich in nitrogen. The farmers also argued that early pruning of the dry banana leaves and fibres would destroy the nests for pests like weevils and nematodes.

Cover Cropping Technology

Cover crops were the least used organic farming technology employed by farmers. For example, it was used by Nyabubare farmers (36.4%), Butanda (27.3%), Rwanda (22.7%) and Kitondo (13.6%) as reflected in *Table 1.* This technology was mainly employed on newly planted banana plantations, where it is commonly termed as living mulching that is tilled into the soil or green manure. The technology helps add organic matter and nutrients to the soil. Crops planted included beans, tomatoes, and sweet potatoes on the edges of terraces, as shown in *Plate 3.*

Plate 3: Beans and Sweet potatoes planted as cover crops in the banana plantation in Rwanda parish

Drivers of Adoption of Organic Banana Farming Technologies in Kajara County

The drivers behind the adoption of organic banana farming technologies were categorised into two, i.e., the socio-economic and institutional drivers. The socio-economic drivers that were analysed included age of the farmer, gender, marital status, household size, level of education, land ownership, farming experience and off-farm income. While the institutional drivers included access to agricultural extension services, membership to a farming group and access to credit. The adoption rate of each of these was tested using the Chi-square test as follows;

Age and Adoption of Organic Banana Farming Technologies

Age was found to be a driver to the adoption of organic farming technologies. Old farmers were found to have gained knowledge and experience over time and were more able to evaluate given farming technologies information than younger farmers. The results obtained from the study are shown in *Table 2.*

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Table 2: Relationship between the adoption of farming technologies and age of the household head

Age of the household head	Adopters		Non-Adopters		Total
	Freq.	Percent	Freq.	Percent	
<30 Years	41	15.2	7	8	48
31-40 years	61	22.6	37	42.5	98
41-50 years	106	39.3	40	46	146
Above 50 years	62	23.0	3	3.4	65
Total	270	100	87	100	357

The results of the age of the household revealed that, out of the 270 organic banana farmers, 15.2 % were aged below 30 years, 22.6% were between 31 and 40 years, 39.3% were 41 and 50 years, while 23% were above 50 years. Among the non–adopters, 8 % were aged below 30 years, 42.5% between 31 and 40 years, 46% between 41 and 50 years and 3.4 % were aged above 50 years.

A chi-square test was thus run to test whether there were differences between adopters and non-adopters in relation to the age of the household head in relation to the adoption of the farming technology and results were summarised in *Table3.*

Table 3: Chi-Square test results for age of the household

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.509[a]	3	.000
Likelihood Ratio	30.921	3	.000
Linear-by-Linear Association	4.813	1	.028
No of Valid Cases	357		

Chi-square test results in *Table 3* showed a significance value of p <0.000 for the age of the farmer. This value was below the significance level of 5%, implying that there were significant differences between adopters and non-adopters in terms of age. This meant that adopters and non-adopters varied in terms of age.

Gender of the Farmers and Adoption of Organic Banana Farming Technologies

Based on different activities men and women do in the agricultural field, there was a difference in the levels of adoption of organic banana farming technologies and these were summarised in *Table 4.*

Table 4: Relationship between the adoption of farming technologies and gender

Gender of farmers	Adopters		Non-Adopters	
	Frequency	Per cent	Frequency	Per cent
Female	109	40.4	50	57.4
Male	161	59.6	37	42.6
Total	270	100	87	100

This study revealed that the gender of the farmer shad a strong effect on the response to the use of organic farming technologies. Analysis of data revealed that out of the 357 farmers, 55.5 % were male, and 44.5% were female. Among 270 organic farmers, 40.4% were female while 59.6 % were male; on the other hand, among the non-adopters,57.4% were female while 42.6 % were male. A chi-square test was thus run to test whether there were differences between adopters and non-adopters in relation to the gender of the farmer, as presented in *Table 5.*

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Table 5: Chi-Square test results for the gender of the farmer

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.790[a]	1	.005
Continuity Correction	7.113	1	.008
Likelihood Ratio	7.758	1	.005
Fisher's Exact Test			
Linear-by-Linear Association	7.768	1	.005
No of Valid Cases	357		

Chi-square results in *Table 5* revealed a significance value of p < 0.005, which implies that there were significant differences between adopters and non-adopters in relation to gender. It was also noted that; male-headed households were more involved in more organic farming technologies in their plantations than female-headed households meaning that the gender of the farmer influenced organic farming technologies, whereas females are more involved in conventional farming.

Marital Status and Adoption of Organic Banana Farming Technologies

The study revealed that; 75.5% of the farmers adopting organic farming technologies were married, whereas 25.5% were considered single, as presented in *Table 6.*

Table 6: Relationship between the adoption of farming technologies and marital status

Marital Status	Adopters		Non-Adopters	
	Frequency	Per cent	Frequency	Per cent
Single (Never or Ever married)	69	25.5	0	0
Married	201	74.5	87	100
Total	270		87	

Analysis of data revealed that marital status also influences organic farming technologies, where most respondents reported that married people might have sources off arm inputs and shared roles to manage all the activities involved in the organic farming technologies, unlike the widows, singles, and divorced families. A chi-square test was thus run to test whether there were differences in marital status between adopters and non-adopters in relation to the adoption of organic farming technologies, as presented in *Table 7.*

Table 7: Chi-Square test results for the marital status of the farmer.

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	27.560[a]	1	.000
Continuity Correction	25.945	1	.000
Likelihood Ratio	43.619	1	.000
Fisher's Exact Test			
Linear-by-Linear Association	27.483	1	.000
No. of Valid Cases	357		

The chi-square test results yielded a p-value for marital status as p <0.000. This value is below the significance level of 5%, meaning that there were significant differences between adopters and non-adopter farmers in relation to marital status.

Level of Education and Adoption of Organic Banana Farming Technologies

In this study, the adopters were more educated than the non-adopters. Among the adopters,26.3% had never attained any formal education, 37.8 % had

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primary education, 24.1 % secondary education, and 11.9 % had tertiary education. On the other hand, among the non-adopters, 12.6% had never attained any formal education and the rest 87.4 % had attained at least primary education, and none had attained secondary and tertiary level education; it can be observed that education attainment negatively impacts the adoption of organic farming technologies.

Table 8: Relationship between the adoption of farming technologies and level of education

Level of education	Adopters		Non-Adopters	
	Frequency	Per cent	Frequency	Per cent
No Education	71	26.3	11	12.6
Primary Level	102	37.8	76	87.4
Secondary Level	65	24.1	0	0
Tertiary level	32	11.9	0	0
Total	270	100	87	100

A chi-square was thus run to test whether there were differences between adopters and non-adopters in terms of their levels of education and whether those differences significantly affected their responses to farming technologies, as presented in *Table 9.*

Table 9: Chi-Square test results for the level of education of the farmer

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.508[a]	3	.000
Likelihood Ratio	43.764	3	.000
Linear-by-Linear Association	6.825	1	.009
No. of Valid Cases	357		

Chi-square results in *Table 9*gave a significant p value of p <0.000, which means that there were significant differences between adopters and non-adopters in relation to the level of education.

Household Size and Adoption of Organic Banana Farming Technologies

The study considered household size to mean the number of people within a single homestead sharing roles and responsibilities as a single unit. The study revealed that a household that comprised of more members had more chances of engaging in organic farming technologies on the banana plantations compared to those which comprised of few, as presented in *Table 10.*

Table 10: Relationship between the adoption of farming technologies and household size

Household size	Adopters		Non-Adopters	
Members	Frequency	Per cent	Frequency	Per cent
1- 5	24	8.9	0	0
6-10	129	47.8	67	77
11-15	82	30.4	20	23
Above 15	35	13.0	0	0
Total	270	100	87	100

Findings of the study showed that, out of the 357 farmers, 6.7 % had 1-5 members, 54.9% had 6-10 members, 28.5% had 11-15 members, and 9.8% had more than 15 members. Among 270 adopter households, 8.9% had 1-5 members,47.8% had 6-10 members, 30.4% had 11-15 members, and those

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with a membership of more than 15 were 13%. On the other hand, among the eighty-seven non-adopters, none had 1-5 members, 77% had 6-10 members, and 23% had 11-15 members.

Farmers reported the absence of reliable and cheap labour as an impediment to applying organic farming technologies in their banana plantations. A chi-square was thus run to test whether there were differences between adopters and non-adopters in terms of household size in relation to the adoption of organic farming technologies, as presented in *Table 11*.

Table 11: Chi-Square test results for household size.

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.508[a]	3	.000
Likelihood Ratio	43.764	3	.000
Linear-by-Linear Association	6.825	1	.009
No. of Valid Cases	357		

The chi-square test indicated a value of p <0.00; hence there was a positive relationship between household size and adoption of organic farming technologies.

Land Ownership and Adoption of Organic Banana Farming Technologies

The research findings show that, among the adopters, 63.7% farmed on privately owned while 36.3% did carry out farming on rented land. On the other hand, all eighty-seven (100%) of the non-adopters were farming on privately owned or customary land (*Table 12*), implying that land ownership provided security for long time engagement in organic banana farming.

Table 12: Relationship between the adoption of organic farming technologies and land ownership

Land Ownership	Adopters		Non-adopters	
	Frequency	Per cent	Frequency	Per cent
Rented	98	36.3	0	0
Private / Customary	172	63.7	87	100
Total	270	100	87	100

A chi-square test was run to establish whether there was a statistically significant relationship in landownership between adopters and non-adopters, as reflected in *Table13.*

Table 13: Chi-Square test results for land ownership

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.526[a]	1	.000
Continuity Correction	41.723	1	.000
Likelihood Ratio	65.857	1	.000
Fisher's Exact Test			
Linear-by-Linear Association	43.404	1	.000
No of Valid Cases	357		

The chi-square results in *Table 13* yielded a p-value of p <0.000, implying that land ownership had an influence on the adoption of organic farming technologies.

Membership to a Farming Group and Adoption of Organic Banana Farming Technologies

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The uptake of information on organic farming technologies was found to be driven by farmer's belonging to a farmer group, as shown in *Table 14.*

Table 14: Relationship between the adoption of organic farming technologies and membership to a farming group

Member of Association	Adopters		Non-adopters	
	Frequency	Per cent	Frequency	Per cent
Yes	174	64.4	37	42.5
No	96	35.6	50	57.5
Total	270		87	100

A cross-tabulation indicated that among the 270 organic farmers, 64.4% belonged to at least a farming group, while 35.6% did not subscribe to any form of farming group. From the above analysis, it can be concluded that most of the adopters belonged to at least one farmer group. These groups helped the farmers to share knowledge and farming experiences. As such, a chi-square test was run to ascertain whether there were significant differences in adopters and non-- adopters of organic farming technologies in relation to membership to farmer group.

Table 15: Chi-Square test results for membership to a farming group

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.075[a]	1	.000
Continuity Correction	12.184	1	.000
Likelihood Ratio	12.907	1	.000
Fisher's Exact Test			
Linear-by-Linear Association	13.038	1	.000
No of Valid Cases	357		

The chi-square analysis in *Table 15* indicated that there was a significant difference in membership to farmer groups between adopters and non-adopters in the adoption of organic farming techniques at p <0.000.

Agricultural Extension Service Delivery and Adoption of Organic Banana Farming Technologies

The ease of access to information and training services was found to play an important role inthe adoption of organic farming technologies by smallholder banana farmers. The results obtained from the study are summarised in *Table 16.*

Table 16: Relationship between agricultural extension service delivery and adoption of organic farming technologies

Agricultural extension service received	Adopters		Non-Adopters	
	Frequency	Per cent	Frequency	Per cent
Yes	174	64.4	37	42.5
No	96	35.6	50	57.5
Total	270		87	

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Among the 270 organic farmers, 64.4% had ever received training and accessed agricultural extension information, while 35.6% had not received it. On the other hand, 42.5 % of the eighty-seven no adopters had received training, and 57.5 % had not received any training on farming technologies.

A chi-square was run to test the significant differences between adopters and non-adopters of organic farming technologies in relation to access to training and information to farmers.

Table 17: Chi-Square test results for agricultural training

	Value	Df	asymp. sig.(2-sided)
Pearson chi-square	13.075[a]	1	.000
continuity correction	12.184	1	.000
likelihood ratio	12.907	1	.000
fisher's exact test			
linear-by-linear association	13.038	1	.000
No of valid cases	357		

The chi-square test results in *Table 17*revealeda value of p <0.00, implying significant differences between adopters and non-adopters of organic farming technologies in relation to access to training and information to farmers. The number of farmers that accessed both information and training was had a high likelihood to adopt organic farming technologies

Discussion

Organic Farming Technologies Adopted in Kajara County Western Uganda

Mulching was the most dominant practice employed by smallholder banana farmers in Kajara county (43.9%); farmers argued that mulching of bananas plantations was an indigenous practice used in suppressing weed growth, maintaining soil fertility and conserving soil moisture for the shallow rooting banana crop. This is in agreement with studies by (Gold et al., 2006), who emphasised the importance of mulching in supporting infiltration of runoff and protecting the soil from the impact of raindrops hence maintaining moisture in the soil for long periods. This, therefore, confirms the importance of mulching as an organic farming technology vital in the sustainable growth of bananas in Kajara County.

Weed management in Kajara County involved the removal of unwanted plants that compete with the banana plant for nutrients and moisture. These use of weed management technologies in the banana plantations was emphasised by (Bhan and Behera et al.,2014), who noted the importance of mechanical and physical weed control technologies used on organic farms involving tillage to remove existing weed growth at early stages before they grow fruits that form seeds like blackjack and preparing pits when rhizome weeds like galinsoga; turning soil after seeding to kill weeds.

The use of farmyard manure in Kajara County involved the use as a varying mixture of animal (cattle, goat, and sheep) and poultry manure that farmers regarded vital in nurturing soil organisms and essential in maintaining an active soil life. These findings correspond with the study by Vanilarasu and Bal Krishnamurthy (2014), who suggested that organic manures gave better quality and post-harvest life of fruits when compared to inorganic sources of nutrients in bananas.

Pest Management involved early pruning of the dead leaves and fibres so as to destroy the nests for pests like weevils and nematodes and herbicide "concoction" mixture comprising of animal dung, urine, red pepper and ash that would be fermented for two weeks and later applied around the pseudo banana stems. The findings concur with studies by Hennessy and Heanne (2012), who emphasised the use of a combination of biological, cultural, and physical tools as a sustainable approach in the management of pests.

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The argument for the use of cover crops like beans and groundnuts was that they acted as living mulching and when tilled into the soil, help add organic matter and nutrients. The results of this study are consistent with a conclusion by (Wittwer et al., 2017) which demonstrated that cover crop effects on crop yield were highest in the organic system with reduced-tillage (+24%), intermediate in the organic system with tillage (+13%) and in the conventional system with no-tillage (+8%) and lowest in the conventional system with tillage (+2%). Our results indicate that cover crops are essential to maintaining a certain yield level when soil tillage intensity is reduced under conservation agriculture or when production is converted to organic agriculture. Thus, the inclusion of cover crops provides additional opportunities to increase the yield of lower intensity production systems and contribute to ecological intensification.

Drivers of Adoption of Organic Banana Farming Technologies in Kajara County

Older banana farmers were found more likely to adopt organic farming technologies. This is because older groups of farmers were more driven by the need to be more efficient in farming technology and had physical strength and commitment to apply organic farming technologies, unlike children below 18 years of age who are dependents. These findings resonate with studies by Mwangi and Kariuki (2015) that older farmers are assumed to have gained knowledge and experience over time and are better able to evaluate farming technologies information than younger farmers.

Gender coefficient was positively related to the probability of adoption of organic farming. This is particularly true in a traditional African setup, where key decisions in the households are made by men. Also, women have limited control over land and property rights in sub-Saharan Africa. This finding is in consonance with the findings of Akudugu et al. (2012) that women only have rights to use and access land through men, especially in the customary land tenure system. In addition, male-headed households are more likely to get information about innovations and undertake risky businesses than female-headed households.

Results of the study indicated a positive relationship between marital status and the adoption of organic farming technologies. Differences were observed in abilities of married families or single or widowed households whereby the cheap family labour in married people homesteads contributed greatly to adoption. These findings concur with studies by Mrinila et al. (2015), who reported that married farmers work more hours than unmarried ones, working not only in cash but also in food crops.

Regarding land ownership, there were significant differences between the adopters and non-adopters**.** In this study, 72.5 % of the respondents interviewed revealed that they owned land where they practised banana farming. This system of land ownership gave them assurance of continued use of the same land and so they needed to sustain its use by adopting organic farming technologies. These results tally with findings by Dessart et al. (2019), who noted that ownership of farmland increases the assurance of future access to the returns of investment, thus increasing the probability of adopting organic farming technologies.

In terms of the level of education, results in chi-square test analysis revealed no significant differences between adopters and non-adopters with regard to the use of organic farming technologies. These results disagree with a study by (Malaba et al., 2000) that concluded that a household's level of education influenced the level of adoption of farming technologies. This difference in the two studies is because there were more agricultural extension services in Kajara County in which farmers accessed the information irrespective of the education level. In fact, the uneducated looked at banana farming as the only source of income, so they concentrated on it more than the educated had other sources of income from their professions.

The study findings indicated that 59.1% of the smallholder organic banana farmers belonged to at least a farmer's group, while 40.9% were not members of any form of farming group. The findings agree with studies by (Hennessy and Heanue, 2012) which revealed that belonging to farmers' groups or cooperatives had a positive impact and was statistically significant to food production, and that prevalence of poverty is higher among non-members of farming cooperatives or groups.

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The study findings indicated that 59.1% of the smallholder organic banana farmers had accessed information and training on agricultural farming technologies compared to 40.9% who had been exposed to incidental learning or no training about agricultural practices. The information was mainly availed through radio programmes hosted on the Local Radio stations (Radio Ankole and Radio Boona F.M) and through the local newspaper, “Orumuri”. These results correspond to studies by (Gold et al., 2006), who observed that access to information helped in reducing the uncertainty about a given farming technologies’ performance, consequently changing farmer’s assessment from purely subjective to objective over time.

CONCLUSION AND POLICY IMPLICATION

The study revealed that mulching the most highly applied organic farming technologies were followed pest management, weed management, use of farmyard manure and use of crop residue employed by smallholder banana farmers in Kajara County. The study findings also revealed that there are no single organic farming technologies that can singularly account for increased productivity in the banana cropping system. The variations in the applications of farming technologies were attributed to differences in the nature of landscapes. Generally, the rate of adoption of organic farming technologies in Kajara County was low

There is a need for sustained emphasis on training of the farmers at local levels so as to equip farmers with information on the organic farming technologies for sustainable banana farming. Although the access to markets was not analysed in this study, many farmers cited it as a factor influencing the adoption of organic farming technologies; therefore, further studies need to be carried out to ascertain the influence of produce markets and segmentation on the adoption of organic farming technologies. The study did not assess the effectiveness of the different organic farming technologies; more studies are thus necessary to assess the efficiency of these practices in the banana cropping systems so that the most appropriate practices are emphasised in the study area.

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