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Research Article

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Adoption of organic pepper production practices among smallholder farmers in Rwanda- A case study of Bugesera district.

Gaspard Ntabakirabose[1], Felicien Ndaruhutse[2], Charles Kyeyune[3], Yves Theoneste Murindangabo[4], Joshua Etieno Ogweno[5]

[1]*Ministry of Agriculture and Animal Resources, Kigali, Rwanda*
[2]*Department of Agricultural Engineering, Integrated Polytechnic Regional College (IPRC) Huye, Kigali-Rwanda*
[3]*Department of Agriculture and Resources Economic, Jomo Kenyatta University of Agriculture and Technology (JKUAT), Nairobi, Kenya*
[4]*Department of Agroecosystems, University of South Bohemia, Bohemia, Czech Republic*
[5]*Department of Crops, Horticulture and Soil, Egerton University, Nairobi, Kenya*
Corresponding author e-mail: gmutago@gmail.com
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ABSTRACT
Bugesera is among the district located in Eastern Province of Rwanda where drought is a limiting factor for agriculture. Innovation and adoption of new technologies in agriculture is one of the keys that should reduce poverty in that area. The general objective of this study was to assess the level of the adoption of organic peppers production practices among smallholder farmers in Rwanda. A case study of Bugesera district. This study employed a cross-sectional survey design and a multi-stage sampling technique to select a sample of 150 respondents was used. The findings of logit regression analysis indicated that four factors such as education level, land size, farming experience, gender and enhanced soil fertility had positive and significant influence on adoption of organic pepper production practices. The demand for organic products creates new export opportunities. The market returns from organic agriculture can potentially contribute to local food security by increasing family incomes. The findings showed that the most common constraints to adoption of organic pepper production practices were lack of stable irrigation system, lack stable and reliable market, unreliable climate, high cost of inputs, lack of extension services, and inadequate capital respectively. Based on these findings, it was recommended that provision of training and technical advice on organic farming practices through agricultural extension services and developing information networks among farmers is vital, input subsidy, harvest(yield) insurance, financial inclusion (accessing affordable loans) is more crucial for stallholder farmers. Government should made effort in stable and durable irrigation systems, improvement of extension services through field visits and more effort in marketing of cash crops especially vegetables because are more perishable.
Keywords: Adoption**,** Organic Pepper, Production, Smallholder farmers.

INTRODUCTION

It is undoubtable that, for every country in the world, agriculture is an indispensable sector that accelerates economic growth and development (Enu, P. and Attah-Obeng, P, 2013. Likewise, agriculture is the dominant sector and main stay of the worlds' population especially, in developing countries (Bechdol *et al*, 2010. In Africa, better than other economic sectors, a GDP growth of agricultural sector is paramount importance in reducing poverty, rising farm income and invigorating non-farm activities (World Bank., 2008. More particularly, in Sub-Saharan Africa (SSA), smallholder agriculture is an input for poverty reduction and food security (FAO, 2009. Source of foreign exchange and engine of development (Shimelles *et al*, 2009. Income and employment (Olajide, 2011) and rural regeneration (Bosshaq *et al.*, 2012).

In sub-Saharan African (SSA), smallholder-based agriculture is the main source of livelihood, especially in the rural areas, where most of the population live. Livelihood challenges such as poverty and hunger are prevalent among farming and rural households in the region, and they are largely attributed to low agricultural productivity (FAO, 2017).

In Rwanda, agriculture is the main support of the economy and is crucial to the growth of the country and its poverty reduction. The agriculture sector accounts for 39% of gross domestic production, 80% of employment and 63% of foreign exchange earnings (USAID, 2018. The majority of the land found in Rwanda is arable, with favourable conditions for cultivation. The country has

designed and implemented different poverty reduction strategies including land use consolidation, Twigire Muhinzi, and crop insurance. Increasing agricultural production, therefore, is vital for ensuring food security, providing inputs for industrial sector, invigorating export earnings, GDP and then getting better the income and living condition of the people where the revenues generated from the export of Agricultural export products for the FY 2017-2018 indicated an increase of 44.71% (MINAGRI, 2018).

Hot pepper is one of the major vegetable crops produced in Rwanda and the country is one of a few developing countries that have been producing it for export market because of its wide use in Rwanda diet, the hot pepper is an important traditional crop mainly valued for its pungency and color. The crop is also one of the important spices that serve as the source of income particularly for smallholder producers in many parts of eastern province of Rwanda (Clay, D. and Turatsinze.J, 2014).

Hot peppers like most other plants, prefer well drained, moisture holding loam soil (sandy loam) containing some organic matter (Lemma, D. and Edward.P, 1994. A pH of 6.5-7.5 is suitable and the land should be level to 0.01- 0.03% slope to allow adequate drainage and prevent root diseases. It performs well warm climatic conditions with areas that receive 600 – 1,200 mm of rainfall annually which is well distributed throughout the growing period is required. The optimal temperature range is 18 – 30°C. Soil: Adequate water supply is essential. Water stress can cause abscission of fruit and flowers, especially when it occurs during flowering (Matta, F. R. and D. J. Cotter, 1994. Reduces yield through reduced pollination. The extreme case can result in increased risk of diseases. Poorer soil types and water stress are believed to produce lower yields (Haigh *et al*., 1996).

Pepper is a rich source of vitamins A, C, and E (Dipeolu AO, and Akinbode SO, 2008. It is a high value crop (Aliyu, L., 2000) and has economic significance in the world market. It has potentials to generate foreign exchange and can be utilized in confectionary, medicinal, and culinary purpose (Mohammed *et al*, 2016. Pepper production is an important source of foreign exchange and its exportation in Rwanda has been reported to be lucrative (FAOSTAST, 2014.

Various estimates say that up to 40% of food is lost in the postharvest stage. Green chilies/peppers are produced for export mainly in the Nyanza District. Production of all types of chilies and capsicum fruits is small, but has increased from 4,100 tonnes in 2010 to 4,500 tonnes in 2014 (Tabo *et al.,* 2006. FAOSTAT reports that in 2013, 400 hectares were cultivated and 5,400 tons produced in Rwanda, a figure that includes all fresh chilies. In Ethiopia, Oromia, pepper generated an income of 122.80 million Birr for farmers in 2000/01. This value jumped to 509.44 million Birr for smallholder farmers in 2004/05. This indicates that hot pepper serves as one of the important sources of income to smallholder farmers and as exchange earning commodity in the country (Beyene T. and David Phillips, 2007.

The chili sector in Rwanda comprises three main varieties: Birds Eye Chili (BEC), mostly dried and exported; Scotch Bonnet Chili (SB), exported fresh and used locally fresh or processed; and Green Chilies (GB), exported fresh with a small local market (USAID, 2018. It therefore this study focused on the identification of factors influencing farmer's adoption of organic peppers production practices in Rwanda. Aassess the level of awareness and adoption of organic peppers production practices, identify the factors influencing adoption of organic peppers production practices, and determine the constraints of adoption of organic peppers production practices.

In spite of its importance, the hot pepper production system for green and dry pod has stayed as low input and low output with a national average yield of 7.6 t/ha for green pod whereas it was 1.6 t/ha for the dry pod respectively (CSA. ,2006. The decline of hot pepper production is also attributed to poor varieties, poor cultural practices, the prevalence of fungal (blights) and bacterial as well as viral diseases (Fekadu, M. and Dandena, G, 2006).

According to Babatunde *et al* (2010) financial capital appears to be the most limiting factor for farming, so that cash income from off-farm activities can help to expand farm production. Education is the key factor that determines agricultural production in adopting inputs in general and management demanding practices in particular (Uwagboe *et al*., 2012. According to Hema, M., r. Kumar and N.P. Singh. (2007) from the input adoption view point, small land size owners are obliged to adopt inputs and other land management practices to increase agricultural production. The major constraints to adoption were found to be lack of capital, high cost of fertilizer and lack of market for produce (Kudi, 2011.

One of the most well-known practices to recover and maintain the soil productivity is to add organic amendments. Organic manure plays an invaluable role in rectifying land degradation and enhancing productivity thus achieving farm household food security, income and agricultural development (IFDC, 2007; Alimi, 2002. Organic manure can increase soil drainage, soil aeration, water holding capacity and the ability of the soil to hold nutrients. The beneficial effects of organic matter on soil structure can have a greater effect on plant growth than the fertilizer value of some of the organic materials (FAO, 2000).

Organic farming avoids the use of synthetic fertilizers and pesticides and relies on developing biological diversity in the field to disrupt habitats for pest organisms and the purposeful maintenance and replenishment of soil fertility. Organic farming emphasizes the use of renewable natural resources and their recycling (Emsley.J, 2001. It eliminates the use of synthetic pesticides, growth hormones, antibiotics and gene manipulation in the crop production system and this poses a challenge to crop and pest management

specialists to device new tactics for crop and animal protection (Ivbejaro, 1990; Tapondjou *et al.,* 2002).

Organic systems rely on crop rotation, crop residues, animal manures, legumes, green manures, off-farm organic wastes and aspects of biological pest control to maintain soil productivity and tilt, to supply plant nutrient and to control insects, weed and other pests (Lampkin, 1990; Miguel, 1998. Despite these beneficial effects and the vital role in supporting crop production and soil fertility improvement, organic manure is not regularly applied by most farmers, even in areas where aggregate livestock population may permit its use (Adejobi, A.., Kormawa, P. M, 2002). In Sub-Saharan Africa.

Crop rotation is one of the nearest and easily be done agronomic practices that could potentially increase soil fertility and even kill weed and pests. In theory and practice, according to Chiputwa *et al.,* (2011) in Zimbabwe and Chomba (2004) in Zambia, nitrogen fixation crops do maintain soil fertility much better than cereal crops. Thence, rotating legumes after cereals and vice versa improves soil fertility and break weed and pest life that pave the way for increased crop production.

Animal manures, particularly cattle dung, were the main source of nutrients for the maintenance of soil fertility in settled agriculture until the advent of mineral fertilizers (Ofori and R. Santana, 1990. Farmyard manures are responsible to nutrient availability for crop in demand, improve soil physical properties/aggregation and hence improve water retention capacity, infiltration rate and biological activity of soil (Aliyu, 2000. The advantage of farmyard manure application, however, greatly depends, among others, on proper application methods, which increase the value, reduce cost, and effectiveness (Teklu *et al.,* 2004).

Now days, it is widely recognized that quality product and access to fair market is a key element in providing a route out of poverty for small scale producers in developing countries including Rwanda. In Bugesera district area, hot pepper is a major spice and vegetable crop produced by the majority of farmers for export. There is therefore a strong need to help small producers to achieve sustainable production and fair access to pepper markets in order to increase their income and secure their livelihood by providing adaptable and high yielding varieties. In the other hand, poor soil fertility should be a challenge to achievement of food security and rural wellbeing in Sub-Saharan Africa (Sanginga and P. L Woomer, 2009.

Agriculture being the backbone of the Rwanda's economy relies heavily on environmental resources. Therefore, for Rwanda to attain the Millennium Development Goals and realize vision 2030, environmental conservation by way of organic farming should be prioritized. This can only be carried out if there is a clear understanding of the factors that influence adoption of organic farming among farmers in rural Rwanda where intensive farming is carried out. The adoption of organic farming practices and the participation in fair trade certification regimes provides access to global markets for smallholder farmers (ADB, 2012. Organic pepper marketed under fair trade regimes, provides an opportunity to diversify agricultural export markets. This can contribute to increased and a more stable income from agriculture. While certification improves production standards and labeling generates economic and environmental benefits (Waibel and D. zilberman, 2007).

It however, the general objective of this study was to analyse the factors influencing farmer's adoption of organic peppers production practices in Rwanda. A case study of Bugesera districts. Therefore, the specific objectives were to assess the level of awareness, and adoption of organic peppers production practices, to identify the factors influencing adoption of organic peppers production practices, to determine the constraints of adoption of organic peppers production practices.

MATERIALS AND METHODS

Study Area

Bugesera district is one of the seven districts of Eastern Province of Rwanda. The District covers a total surface area of 1337 Km² of which arable land is estimated at 91,930.34 ha. The average size of land cultivated per HH is 0,59ha (NISR, 2014. The district is composed of 15 Sectors namely (Nyamata, Musenyi, Ntarama, Mwogo, Mayange, Juru, Rilima, Gashora, Ruhuha, Mareba, Ngeruka, Kamabuye, Nyarugenge, Rweru and Shyara), 72 Cells and 581 Villages with a total Population of 363,339 people-177,404 males and 185,935 females (NISR, 2012).

The soils of the District are generally sandy with a low quantity of humus and are very permeable. They dry quickly even after a great rain. In summits of some plateaus located in the center and the north of the District, the soils are often made of ochre clay, whereas the sides and the tops of the plateaus are made up of rocks and schist, which contain gravel, lateritic soil and quartz. In Bugesera, two plant formations remarkably dominate the savannahs densely shrubs covering the hills, and the grassy savannahs covering the dry valleys and the trays of the hills (MINITERE, (2003a. The vegetation is composed largely by the acacia trees, euphorbia tricare and the cactuses with intertwined with gramineous and of spiny bushes. One also observes other rare species that are not gigantic but supports the bushes and trailing lianas (NISR, 2014).

Bugesera District hydrographical network is mainly characterized by three rivers, namely Akanyaru, Akagera and Nyabarongo. Besides rivers, there are nine lakes. However, these have little effect on rainfall, but they can be exploited for fishing, tourism, transportation, power generation, agricultural irrigation and farming among others whether taken into consideration. Regardless of these rivers and nine lakes, the district has experienced in drought, which resulted in hunger emigration. Its climate is dry with temperature varying

between 20 and 30°C. The temperature average range is between 26 and 29°C (NISR, 2012).

The main food crops grown in Bugesera are sorghum, maize, groundnuts, cassava, soybean, sweet potatoes, beans, and rice. Arabica coffee is grown for cash but is mainly limited to the northern parts of Bugesera. As agriculture in Bugesera is almost entirely rain-fed, In general, the climatic conditions support two crop seasons in hilly side ecosystem, which provides the greatest proportion of food consumed in Bugesera. A third season is possible for areas where wetlands are under agriculture for the production of rice, maize, beans and vegetables (NISR, 2012).

Sampling Technique and Sample Size

Multi-stage sampling technique was adopted to select sample for this study. The interested farmers were those engaged in organic peppers farming production as a potential business. Therefore, the first stage involved the purposive selection of six (6) sectors out of fifteen (15) in Bugesera district. These sectors are Rweru, Gashora, Rilima, Juru, Mwogo, and Ntarama. A purposive selection method was used to select cells/zones based on high volume of peppers production. The second stage involved random selection of two (2) cells in each sector under which twelves (12) cells were selected. The farmers were proportionally selected from each cell based on the number of pepper farmers found in each cell. However, a total sample size for this study was 150 respondents engaged in peppers farming as business. Data for this study were generated from primary source. Primary data were sourced using a set of structured questionnaires as well as informal oral interview method. The copies of the questionnaires were administered to the selected organic pepper farmers soliciting information on their socio-economic characteristics, reasons for adoption and use of organic practices.

Data Analysis

The functional form of the stochastic frontier production (or cost) model employed for this study is the Cobb-Douglas (C-D) functional form. Descriptive statistics such as frequency and percentage were used to analyze the first and second objectives. While inferential statistics (logit regression) was used to analyze objective three. Both descriptive and regression analysis were performed by use of SPSS and STATA soft wares respectively. The regression model is expressed as:

$Y=a + b_1x_1 + b_2x_2\ldots\ldots\ldots b_{10}x_{10} + e$ (1)

Where Y = adoption of organic peppers production practices (1=adoption, while 0=non adoption)
X1 = Age (years)
X2 = Gender (male or female)
X3 = Family Size (number)
X4 = Educational status (years spent in school)
X5 = Farming experience (years)
X6 = Distance to the market (km)
X7 = off farm-income (ha)
X8 = Extension services (1=yes, 0=no)
X9 = Land size reserved to pepper (ha)
X10 = Access to credit (1=yes, 0=no)
a = Constant (intercept)
e = Error term
b_1-b_{10}= regression parameters estimated

RESULTS AND DISCUSSION

Household Characteristics of Farmers in Bugesera District

The mean age for adopters of organic peppers production practices was about 47 years while that for non-adopters was about 54 years. Age of the household head plays a key role in influencing the decision to adopt one or more different new technologies. Result of two-tailed t-test indicate that age was statistically significant at 5% indicating that non-adopters of organic peppers production practices were more aged than adopters.

Table 1. Description of farm and farmer characteristics in Bugesera district.

Characteristic	Mean		Overall	t-ratio	Sig
	Adopters	Non-adopters			
Age	46.7	53.3	47.45	-1.576	0.054
Household size	6.4	4.9	5.82	5.661	0.000
Land size	0.75	1.66	1.36	0.464	0.003
Experience	8.97	5.74	7.455	0.235	0.071
Extension	3.32	1.29	2.32	7.618	0.000
Training	4.17	2.7 0	3.48	-1.570	0.000
Farm proximity	0.25	1.54	0.89	-4.231	0.000
Off-farm income	158554.07	182869.69	170712.8	0.412	0.053

The mean household size was about 7 members for adopters of organic peppers production practices and about 5 for non-adopters. Result of two-tailed t-test show that household size was statistically significant at 1% revealing that adopters of organic peppers production practices had more household members than non-adopters. This due to the non-adopters are oldest people who stopped to give birth while rather than young people. Large household size positively influences adoption of labour-intensive agricultural technologies since they have the capacity to relax the labour challenges required during the installation of heavy infrastructures used in technological agriculture.

The mean farm size was 0.75 hectares for adopters and 1.66 hectares for non-adopters. Result of t-test show that land size was statistically significant at 1% indicating that non-adopters had larger land sizes than adopters. Small land holding hinder adoption of technologies compared to large land holding. Big portions of land allow farmers to practice different agricultural practices like crops rotation, agroforestry, planting of leguminous crops and integration of animals into farming system.

In case of farming experience, the mean number of years of farming was about 9 for adopters and about six for non-adopters. However, the result of t-test show that experience was insignificant at 10% level to influence

adoption indicating that adopters and non-adopters of organic peppers production practices were in only the difference of three years. Adopters had a mean of 3.32 contacts per year with extension officers while non-adopter had a mean of 1.29 contacts with extension officers. Result of two-tailed t-test show that extension was statistically significant at 1% indicating that adopters of organic peppers production practices had more extension services than the non-adopters. This result was supported by the study of [6] who showed that the number of contacts with extension officers is a proxy measure for access to information and this positively contributes to awareness and subsequent adoption of new technologies.

The mean farm distance from the farmers homestead to the farm for adopters of was 0.25 kilometers while that for non-adopters was 1.54 kilometers. This indicated that non-adopters are far from their farms which many times hinder adoption and protection of grown crops. Result of t-test analysis show that farm proximity was negatively and statistically significant at 1% indicating that non-adopters of organic peppers production practices had their farms located very far from their homestead than the adopters of organic peppers production practices. However, this could be a factor reducing many farmers from adopting new technology. This implies that I km increase from the homestead to their Farm should reduce adoption by 0.9%.

The mean off-farm income was 158554. 07Rwf for adopters and 182869.69Rwf for non-adopters. Result of t-test analysis revealed that off-farm income was significant at 5% indicating that non-adopters of had more off-farm income compared to adopters. This Perhaps should because non-adopters of organic pepper production practice have other resources those adopters in study area. However, the higher the off-farm income, the higher the money can be allocated to agricultural activities especially purchase of agricultural inputs (improved seeds, organic fertilizers and pesticides) and payment of labors.

Socio-Economic and Demographic Characteristics of Pepper Farmers

In this study, the majority 55.3% of the respondents were male as indicted by results in table (2. This implies that male mainly dominates pepper production in study area while this crop is mostly taken as a cash crop that has both national and international market.

The result of this study indicated that majority 53.3% of the pepper farmers are between the ranges of 36-50 years followed by the farmers who are in range between 51-65 years. The last class is that of farmers of 66 years and above actually older with 7.3%. The result therefore revealed that most of the pepper farmers in study area are mature representing more than 80% of all farmers. Thus, labor productivity of pepper farmers is expected to be high due to different good agricultural practice carried out themselves. However, young people ignore this sector as indicated by the results.

The majority of the pepper farmers (57.3%) have household size of 4-7 people followed by the household size of 8 and above members with 28%. Therefore, it has been found that the respondents' large household size is above the recommended average size of five (5) composed of parents and three children per family in Rwanda. This implies that the larger household size, the more chance of getting none hired labor force from outside. These results show that there is significant number of people in a household that provide labor in pepper production, which reduce cost for farm activities in a family.

The result in Table (2) indicated the majority of pepper farmers 47.5% attended primary school followed by illiterate with 22.7%. The lowest and last class is of university people represented by 3.3% of the pepper farmers in the area. This implies high-educated people are not engaged in agriculture sector due mainly to the old mentality and sometimes lack of initial capital for inputs purchase, labor payment and particularly land as main primary factor of production. The results were supported by Uwagboe *et al.,* (2012) indicated that education is the key factor that determines agricultural production in adopting inputs in general and management demanding practices in particular. Educated households farmers have a better access for agricultural information that is pertinent for decision making on what and when to produce; to adopt and use inputs efficiently thereby increase production (Anyanwu, 2009).

The findings in table (2) revealed that majority (58.7%) of the respondents have been farming pepper for around 6-10 years followed by those 26% of 11 years and above in farming peppers. only 15.3% have been in the cultivation of pepper vegetable crop as business for a period less than 5 years. This indicated that farmers in the study area have earned more experience in pepper production. Hence, the adoption of new technology should not be a new item. The result was supported by study conducted by Tapondjou, A. L *et a.,l* (2002) indicated that farmers with more years of farming experience in terms of farm operations handle better, compared to farmers with few years of farming experience.

Level of Farmers' Awareness on Organic Pepper Production Practices in Bugesera District

Result in Table 3 shows that farmers had high level of awareness in appropriate seeds and planting material (96.7%), Crops rotation (88.8%), Planting of agroforestry plants (80.6%), green manuring (63.3%), Incorporation of crop residues (60.7%), and organic pest management (55.3%. This implies that pepper farmers were familiar with different agricultural practices. The results of this study were studded by the study of (Genius, 2013) when they studied awareness of new maize varieties by maize farmers. They further explained that maize farmers found information on improved maize varieties from radio, extension agents, other farmers, village/ward heads and their friends while

explaining that most of the farmers obtained information (awareness) through extension agents.

Table 2. Distribution of Pepper Farmers by the Socio-Economic Characteristics (n=150.

	Frequency	Percentage
Gender		
Male	83	55.3
Female	67	44.7
Age		
Between 21-35	19	12.7
Between 36-50	80	53.3
Between 51-65	40	267
66 and above	11	7.3
Family size		
Between 1-3	22	14.7
Between 4-7	86	57.3
8 and above	42	28
Education level		
Illiterate	34	22.7
Primary	71	47.3
Secondary school	25	16.7
Vocation	15	10
University	5	3.3
Farming experience		
Less than 5 years	23	15.3
Between 6-10	88	58.7
11 and Above	39	26

Majority of the farmers obtained information from extension agents followed by fellow farmers [FAOSTAST, 2014; Fekadu. and Dandena, 2006. Explained that maize farmers who adopted the technologies benefited a lot from increased awareness, yield, and income. In contrast, the results of the study showed that farmers had high level of not aware in Terraces and soil bunds (86%) followed by mulching and intercropping with (76.5%) and (52%) respectively. Appropriate seeds and planting material is one of the most important factors in production, which can lead to high yields and minimum losses. The results show that 96.7% of the households use aappropriate seeds and planting material. This one provides a greater window of an opportunity for replant decisions; minimizes the first yield-limiting barriers such as weeds and pest and diseases.

Crop rotation was practiced by 88.8% of the households. This is because, crop rotations help to reduce pests and diseases in the cropping system as well as controlling weeds by including smothering crop species or green manure cover crops in the rotation. In addition, crop rotations give other benefits by improving soil quality, better distribution of nutrients in the soil and increases biological activity (Litterick *et al.,* 2002. Agroforestry trees plantation was practiced at (80.6%) because it plays an important role in food security as well as environment conservation especially in dry region of Eastern Province. In addition, agroforestry produces organic matter, which serves as fertilizer and saves the farmer from expenses of buying and transporting fertilizer from off-site.

The most common grown agroforestry tree species were *Alnus accuminata.* Integrating tree growing with crop production on the farm helps in solving the problems of wood shortages, stakes for climbing beans, indeterminate tomatoes and environmental degradation. Waste products or surpluses from agroforestry trees are used as fodder for livestock. In terms of services, agroforestry trees provide service as windbreaks and shade. They control both kind of soil erosion and demarcate land when planted along the farm boundaries. Intercropping in study area was found that farmers aware this activity at (48%. It was found to be commonly a leguminous crop like beans or a green manure crop in alternating rows with maize or another cereal crop or vegetable is a common practice in organic farming to diversify production and maximize benefits from the land. In intercropping, special attention must be paid to avoid competition between the crops for light, nutrients and water.

Table 3. Distribution of Pepper Farmers According to the Level of Awareness of Organic Pepper Production Practices.

Organic production practices	Aware		Not aware	
	F	%	F	%
Appropriate seeds and planting material	145	96.7	5	3.3
Crops rotation	133	88.8	17	11.3
Planting of agroforestry plants	121	80.6	29	19.3
Green manuring	95	63.3	55	36.7
Incorporation of crop residues	91	60.7	59	39.3
Organic pest management	83	55.3	67	44.7
Intercropping	72	48	78	52
Mulching	35	23.3	115	76.7
Terraces and soil bunds	21	14	129	86

Mulching was practiced by (23.3%) of the respondents on their farms. Mulching is important practice in crop production since it controls soil erosion, suppresses the growth of weeds and improves soil moisture content during the season of inadequate rainfall. It was practiced at low level compared with other practice because in this region when it is applied it should directly be a source of bad pest particularly mites. For this reason, farmers prefer to not use it if they can use grasses.

Socio-Economic Factors Influencing Adoption of Organic Pepper Production Practices in Bugesera District

The result of logit regression analysis in Table 4 indicates that four factors such as education level, land size, farming experience, gender and enhanced soil fertility had positive and significant influence on adoption of organic pepper production practices. As indicated by table 4 the education level, land size, farming experience are statistically significant at 1% level of probability. This was supported by Thierfelder and Wall (2011) reported that education as a source of knowledge has had resulted in a brain wash for farmers to reject the traditional agricultural system and adopt the

new technique; knowledgeable farmers are keen enough to adopt techniques that control weed, enhance residue management, encourages crop rotation and fertilizer adoption. This was also supported by study of (Bechdol *et al.,* 2010; Komolafe *et al*, 2014) indicated that education was also found to have positive effect on efficiency of pepper farmers. Educated farmers will be able to adopt innovations in production, which may be necessary to improve yield. This result was supported by the study of Ajewole (2010) and Wheeler (2008) respectively showed that more educated farmers with longer years of farm experience are organic adopters.

A study conducted in Nigeria by Okoedo and Onemoleas (2009) on factors affecting the adoption of corn storage technologies, indicated that corn farmers in the study area experienced serious post- harvest losses particularly due to grain rot. Most farmers claimed not to be aware of improved technologies. The main reason for low adoption was lack of awareness of the improved storage methods.

Rao and Rao (2006) indicated that training increases farmers experience in relation to adoption. Through training farmers are able to understand the nature of risks associated with each of the new systems and are willing to face risks associated with the method (Oluoch Farida Achieng, 2014. This indicated theses three factors have more and significant influence on organic pepper adoption in study area. Educated farmers will be able to adopt innovations in production that may be necessary to improve yield. In Ethiopia, farmers that were educated were more technically efficient in pepper production compared to those with no education (Kibret and Abebo, 2019. Increase in the quantity of labor will lead to increase in output of pepper. This may be because pepper production may be labor intensive but over utilization of the resources should be prevented in order not to lead to decline in output (Adeoye e*t al.,* 2014. Young and advanced age, gender and education level within household influenced modem agricultural technology adoption in Nigeria (Akudugu *et at.,* 2012).

In other hand, this should implies that larger the farm size, the higher the adoption of organic pepper production practices in study area. This was supported also by the study of Ajibefun IA, Daramola AG (2003) and Kibret BG, Abebo MT (2019) reported that farm size had bearing on the capacity of farmers to utilize agricultural innovation and new farm practices. They indicated that there was positive and significant relationship between farm size and agricultural innovation utilization (Klieber, 2000). It was also supported by the study of Musara *et al* (2012) found that a larger farm size influences agricultural technology adoption. The higher the farm size, the higher is the probability of adoption of organic black pepper production.

However, the study of Lugandu (2013) indicated that from the input adoption viewpoint, small land size owners are obliged to adopt inputs and other land management practices to increase agricultural production.

This was also supported by Datar and Del Carpio (2009) revealed that stable irrigation and irrigation technologies are important ingredients for accelerating agricultural production. It can be taken as an input to stabilize crop yield and patterns; it is an asset that can be exploited when rainfall is insufficient; it also enhances cropping intensity by letting to produce twice or more per year. However, it is pertinent for production, its adoption and expansion can be influenced by extension services, education (Bawa and Ani, 2014).

According to Dipeolu AO, Akinbode SO (2008) numerous studies of technologies adoption in developing countries have used farmers' socio-demography characteristics such as gender, age, education, household size to explain household adoption behaviors. These studies reported that the rate of new adoption was higher among male-headed households, compared to female-headed households, because of discrimination. Women have less access to farm management practices, external inputs, services, and information due to cultural values.

However, findings in this study show that adoption of organic pepper production practices was negatively influenced by age, marital status, and distance to market. This implies that 1 km increase to the market should reduce adoption of organic pepper production practices by 1%. A shorter distance to market and having access to off-farm income increases organic adoption. Owning livestock is used as an asset indicator in this study (Priyanka Parvathi and Herman Waibel, 2015. This was contrasted by the study of Adebiyi and Okunlola (2013) showed that age can be related with farm experience and as age increases farm experience increases and then input adoption as well as production will increase up to a certain age limit. This implies 1-year increase in farming experience should influence the adoption of organic pepper production practices by 3.6%. This was also supported by IFOAM (2006) indicated that the major goal of organic farming activities is a sustainable production of quality food with little or no effect on the environment. This goal has not been fully achieved by the current agricultural practices, i.e., conventional farming in the study area, hence, the need to encourage organic farming which is capable of providing solutions to the current agricultural problems and help to achieve optimal production of quality food sustainably (IFOAM, 2003. In addition, the adoption of any innovation on organic farming may not be as high as expected, as adoption can vary inversely with age (Ogunyemi, 2005.

Many times, it is farmers with more resources in terms of capital, land and labor that are able to take advantage and adopt new or improved methods and practices (Litterick *et al.,* 2002. They discovered a significant relationship between farm size and adoption of improved technology and stated that there was a positive correlation between farm size and adoption of improved technology (Jamilu *et al*, 2014. Farmers with large farms are more likely to adopt improved storage technology

unlike those with small farm sizes since having larger farms strengthens farmer's capacity to produce more, which makes them interested in preserving their produce from loss (Olusegun *et al.*,2011).

Table 4. Logit Regression Analysis of the Factors Influencing Adoption of Organic pepper production practices

Variables	Coeff.	Std. Error	P> |z|
Age	-0.053	0.462	0.037
Gender	0.125	0.074	0.024
Marital status	-0.414	0.142	0.078
Education level	0.058	0.013	0.005
Land size	0.084	0.029	0.009
Farming experience	3.568	0.532	0.000
Irrigation system	0.2421	0.0520	0.027
Distance to market	-1.005	0.174	0.056
Constant	-3.176	0.822	0.000
Number of observations =150 Prob > chi2 = 0.0000			
Log likelihood = -53.902 Pseudo R2 = 0.7590			

The Effects of Adoption of Organic Peppers Production Practices on Livelihood of Smallholder Farmers in Study Area

Organic agriculture is an integrated production management system, which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity (FAO and WHO. 2007. Organic agriculture follows the principles and logic of a living organism, in which all elements (soil, plant, farm animals, insects, the farmer and local conditions) are closely linked to each other. According to IFOAM (2006) the organic agriculture practices are based on four principles namely principle of health, principle of ecology, principle of fairness, and principle of care.

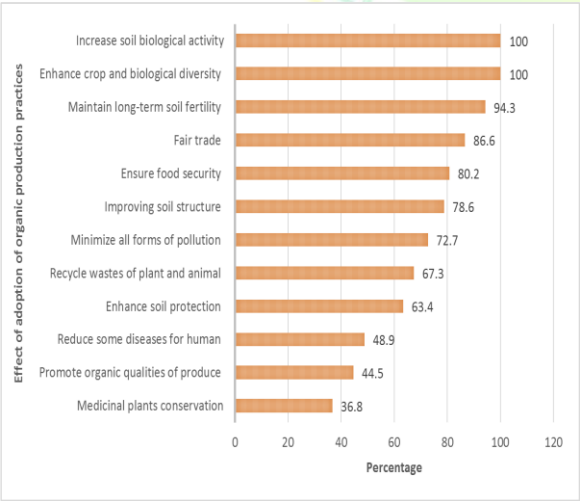

Figure 1. The Effects of Adoption of Organic Peppers Production Practices on Livelihood of Smallholder Farmers

The finding of this study in figure 1 indicated that organic farming practices affected their life through social sustainability, economic sustainability, and market opportunities. The findings revealed that adoption of organic peppers production practices increase soil biological activity, enhance crop and biological diversity (100%), followed by Maintain long-term soil fertility (94.3%), Fair trade (86.6%), Ensure food security (80.2%), Improving soil structure (78.6)%, Minimize all forms of pollution (72.7%), Recycle wastes of plant and animal (67.3%), Enhance soil protection (63.4%), Reduce some diseases for human (48.5%), Promote organic qualities of produce (44.5%), and Medicinal plants conservation (36.8%. This was supported by Chiputwa *et al* (2011) in Zimbabwe and Chomba (2004) in Zambia indicated that in theory and practice, crop rotation is one of the nearest and easily be done agronomic practices that could potentially increase soil fertility and even kill weed and pests, nitrogen fixation crops do maintain soil fertility much better than cereal crops.

It implies that soil biological activity, and biological diversity should be performed through adoption of use of natural pest controls rather than synthetic pesticides, which, since misused, are known to kill beneficial organisms (e.g. natural parasites of pests, bees, earthworms), cause pest resistance, and often pollute water and land.

For the case of recycle wastes of plant and animal, the findings showed that, its effect present (67.3%. Therefore, this should be achieved through recycling the nutrients by using crop residues (straws, stoves and other non-edible parts) both directly as compost and mulch or through livestock as farmyard manure. With this study, farmers of respondents also said organic production practice should sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. However, this should be achieved through avoidance of effective use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects. The reduction of inputs by reuse, recycle and the efficient management of materials and energy will contribute to improve environmental quality and will conserve resources.

Natural and environmental resources that are used for production and consumption should be managed in a socially and ecologically fair way and should be held in trust for future generations. Where fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs. It has been found that organic agriculture contributes to the social well-being by reducing the losses of arable soil, water contamination, biodiversity erosion, greenhouse emissions, food losses, and pesticide poisoning. By using local resources, local knowledge, connecting farmers, consumers and their markets, the economic conditions and the development of rural can be improved. Organic farming appears to generate 30% more employment in rural areas and labor achieves higher returns per unit of labor input. By using local resources better, organic agriculture facilitates smallholders' access to markets and thus income generation.

The findings indicated that the demand for organic products creates new export opportunities. Organic exports are sold at impressive premiums, often at prices higher than the same products produced on non-organic farms. Under the right circumstances, the market returns from organic agriculture can potentially contribute to local food security by increasing family incomes. The findings showed that organic agriculture contributes to the social well-being by reducing the losses of arable soil, water contamination, biodiversity erosion, greenhouse emissions, food losses, and pesticide poisoning. It appears to generate more employment in rural areas and labor achieves higher returns per unit of labor input. This was supported by Mohammed (2015) indicated that the demand for organic products creates new export opportunities since organic exports are sold at impressive premiums, and can potentially contribute to local food security by increasing family incomes. The production and profitability of black pepper is highly influenced by its international price. This makes the revenues from black pepper highly volatile (Hema *et al*., 2007. The adoption of organic farming practices and the participation in fair trade certification regimes provides access to global markets for smallholder farmers (ADB, 2021).

Organic black pepper marketed under fair trade regimes, provides an opportunity to diversify agricultural export markets. This can contribute to increased and a more stable income from agriculture. While certification improves production standards and labelling generates economic and environmental benefits (Waibel and D. zilberman, 2007. Most of the organic and fair-trade impact studies analyze welfare outcomes like household income or consumption expenditures. They find that although organic certification increases per capita income, it does not contribute to poverty reduction among Ethiopian organic and fair-trade certified coffee farmers (Jena *et al*, 2012).

However, most of the organic fair trade impact studies pertain to coffee and find that organic certification increases well-being of smallholders (Bacon, 2005. Some studies like Kleeman and Abudalai (2013) analyze welfare outcomes in terms of return on investment and find that organic farmers have a higher return on investment than conventional pineapple farmers in Ghana. The value of an innovation must be measured with regard to its potential to generate benefits, like increase yields, stabilize incomes or and contribute to sustainable development. The value of the innovation is also a major factor determining its adoption (Aliyu *et al*; Hartwich and Scheidegger, 2010).

Challenges of Adoption of Organic Pepper Production Practices in Study Area

The constraints to adoption of organic pepper production practices are presented in figure 2. This figure indicates that the most common constraints to adoption of organic pepper production practices were lack of stable irrigation system (100%), lack stable and reliable market (98.7%), unreliable (weather) climate (96.1%), high cost of inputs (94.7%), lack of extension services (84.5%), and inadequate capital (83.3%. This finding was supported by the findings of Genius et *al* (2013) indicated that the major constraints to adopt was lack of capital and high cost of inputs. However, Lampkin (1990) found that unavailability of seed was the major constraint of maize production to maize farmers, followed by inadequate fertilizer. It was also supported by Datar and Del Carpio (2009) revealed that stable irrigation and irrigation technologies are important ingredients for accelerating agricultural production. It can be taken as an input to stabilize crop yield and patterns; it is an asset that can be exploited when rainfall is insufficient; it also enhances cropping intensity by letting to produce twice or more per year. However, it is pertinent for production, its adoption and expansion can be influenced by extension services, education, water price, cost of irrigation equipment and farmland size (Genius *et al*, 2013).

Major constraints in pepper production were price fluctuation, activities of intermediaries, and high cost of inputs such as fertilizer, labor, and seeds other problems were pests and diseases infestation in the field (Kleemann and A. Abdulai, 2013. Constraints in onion production include high cost of production input, lack of storage facilities, limited access to improved seeds, pests, and diseases, and lack of effective extension services (Grema and Gashua, 2014).

The results are consistent with Kanyama and Damian (2015) and Mkonda and Xinhua (2016) who reported that unpredictable and unreliable rainfall is a serious problem in Tanzania that decreases crop yields of smallholder farmers.

As reported by Rodríguez and Creamer (2014) pest is a second serious constraint after diseases facing common beans production. Moreover, the study is consistent with Karanja (2016) who reported that most of the legumes are vulnerable to insect pests in the field and in storage. Pod sucking bugs, bean stem fly, bean bruchids, pod borers, aphids and thrips are major legume pests in Tanzania that lead to reduced yields and low-quality grain.

This was supported by MALF (2016) revealed that the price of fertilizers, improved seeds and agrochemicals is too high, which leads to the increase of the production costs that disturbs production and marketing effectiveness of the beans. This shows that the smaller holder farmers incur many costs in producing beans. This constraint is supported that farmers in Tanzania are still forced to pay higher prices for farm inputs even as the government has exempted taxes on fertilizers and pesticides. The study revealed that high prices of agricultural inputs were responsible for the reduction of production and profitability bean producers through reduced area of cultivation.

Unreliable market of common beans was identified as a constraint to the bean farmers in Tanzania. The respondents highlighted it as a challenge and a poor market of beans in the study force the farmers to sell their produces after harvesting by low price (Joshua Julias

Musimu, 2018. It is estimated that only 10 % of the farmers can hardly wait for market prices to go up, 30% wait until the buyer is found while 60% sell immediately after harvest due to immediate family cash demands (Kilimo Trust,2013).

Availability of adequate capital could enable adoption of a technology in the sense that farmers will be able to purchase improved seeds, fertilizer and agro-chemicals, pay for hired labor and purchase or hire modern farm implements and machines. This constraint was also identified Kanyama and Damian (2015) where they stated that lack of access to capital impedes investment in important agricultural technologies such as improved seeds, agricultural chemical and irrigation, whereas these are keys to modernization of agriculture. Smallholder farmers in developing countries are seriously challenging by the price fall of agricultural products immediately after harvest (Abdoulaye and Sanders, 2006).

The study was supported by Julias Musimu (2018) indicated that Inadequate extension services limit awareness of the availability of improved bean varieties and improved production technology currently available at the research stations. Extension agents play vital roles in disseminating new technologies, practices and information on modern farming techniques to help boost farmers' level of production.

Julias Musimu (2018) in his study revealed that respondents responded that fake chemical is among of the constraints in the study area. This is because the effectiveness of agricultural chemicals like insecticides, herbicides and fungicides is too low. Due to inability of agrochemicals of not controlling pests and diseases, farmers end up with getting low yield and poor adoption of innovations.

These findings support that of Okoedo and Onemoleas (2009) which revealed that high costs of storage systems lead to increased rate of non-adoption since farmers, could not afford them. A study on the adoption of new storage technologies carried out by Khanna (2010) in India found out that agricultural productivity remained low in Fata region in India as compared to other settled areas of the province. The reasons included poor extension services and lack of communication between the rural people and extension agents. The study indicated that the benefits of training farmers resulted in improvement in their productivity with use of better storage methods. The results were supported by study of Priyanka Parvathi and Herman Waibel (2015) found that while organic farming is generally considered to be a labor-intensive venture, majority of the farmers adopted some of the techniques using family labor. Safe for tillage practices, the other techniques (fertility, biodiversity, EPM and marketing) could be adopted with the available family labor, as far as the family remained organized and committed to the undertaking. Therefore, some techniques were easier to adopt than others depending on their available labor were. In effect, labor availability would not entirely influence adoption of organic farming techniques.

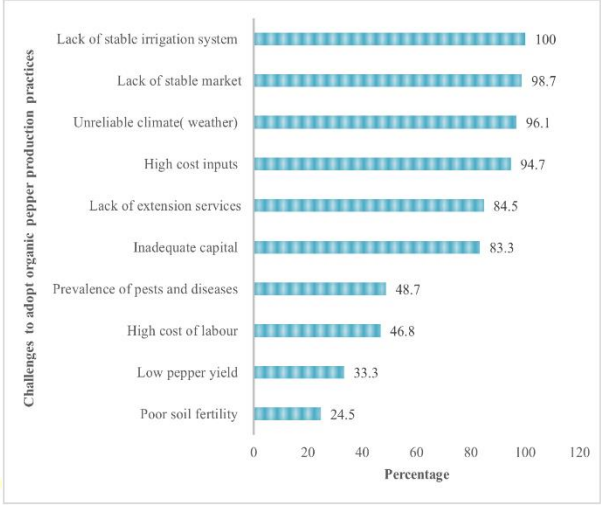

Figure 2. Challenges of Adoption of Organic Pepper Production Practices

CONCLUSION

The general objective of this study was to assess the level of farmer's adoption of organic peppers production practices in Rwanda. A case study of Bugesera Districts. The result of this study indicated that majority of the pepper farmers are between the ranges of 36-50 years followed by the farmers who are in range between 51-65 years. The result of logit regression analysis indicated that four factors such as education level, land size, farming experience, gender and enhanced soil fertility had positive and significant influence on adoption of organic pepper production practices. The findings also showed that organic agriculture contributes to the social well-being by reducing the losses of arable fertile soil, water contamination, biodiversity erosion, greenhouse emissions, food losses, and pesticide poisoning. It appears to generate more employment in rural areas and labor achieves higher returns per unit of labor input. The findings revealed that the most common constraints for the adoption of organic pepper production practices were lack of stable irrigation system, lack stable and reliable market, unreliable (weather) climate, high cost of inputs, lack of extension services, and inadequate capital respectively. Based on these findings, the following recommendations are highly made:

Provision of training and technical advice on organic farming practices through agricultural extension services and developing information networks among farmers is vital. To ensure high return for the produce the county Government come up with farm input subsidy programme and also ensures the inputs are supplied to farmers timely as well as to overcome the problem of agricultural production losses.

As the inadequate capital, high cost of inputs was found to be one of the challenges of adoption of organic pepper production practices. The government should facilities farmers' access to agricultural credit facility's needs, and

subsidies. This will help to eliminate liquidity challenges experienced in the purchase organic manure from agro dealers or from other important sources.

The findings showed that the most common constraints to adoption of organic pepper production practices were lack of stable irrigation system. Therefore, Government should made effort in stable and durable irrigation systems especially drip and sprinkler irrigation system in this region where many lacs are found and altitude is very low compared to other agro-climatic zone of the country. This will reduce farmers to depend their farming business on rain fed agriculture.

Lack of stable and reliable market, lack of extension services were found to be also the challenges for adoption of organic pepper production practices. Therefore, Ministry of Agriculture and Animal Resources through its agencies particularly National Agriculture and Export Development Board should made effort on the improvement of extension services through field visit and more effort in marketing of cash crops especially vegetables because of their high perishability. This will be more important to stabilize and attract farmers in agriculture sector as business rather than doing it as a culture.

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