OPEN ACCESS

Journal of Development and Agricultural Economics

March 2018
ISSN 2006-9774
DOI: 10.5897/JDAE
www.academicjournals.org

academicJournals

Academic Journals

ABOUT JDAE

The Journal of Development and Agricultural Economics (JDAE) (ISSN:2006-9774) is an open access journal that provides rapid publication (monthly) of articles in all areas of the subject such as The determinants of cassava productivity and price under the farmers' collaboration with the emerging cassava processors, Economics of wetland rice production technology in the savannah region, Programming, efficiency and management of tobacco farms, review of the declining role of agriculture for economic diversity etc.

The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published shortly after acceptance. All articles published in JDAE are peer- reviewed.

Contact Us

Editorial Office: jdae@academicjournals.org

Help Desk: helpdesk@academicjournals.org

Website: http://www.academicjournals.org/journal/JDAE

Submit manuscript online http://ms.academicjournals.me/

Editors

Prof. Mammo Muchie
Tshwane University of Technology,
Pretoria, South Africa and
Aalborg University,
Denmark.

Prof. S. Mohan
Indian Institute of Technology Madras
Dept. of Civil Engineering,
IIT Madras, Chennai - 600 036,
India.

Dr. Munir Ahmad
Pakistan Agricultural Research Council (HQ)
Sector G-5/1, Islamabad,
Pakistan.

Dr. Wirat Krasachat
King Mongkut's Institute of Technology Ladkrabang
3 Moo 2, Chalongkrung Rd,
Ladkrabang, Bangkok 10520,
Thailand.

Dr. Morolong Bantu
University of Botswana, Centre for Continuing Education
Department of Extra Mural and Public Education
Private Bag UB 00707
Gaborone, Botswana.

Dr. Siddhartha Sarkar
Faculty, Dinhata College,
250 Pandapara Colony, Jalpaiguri 735101,West Bengal,
India.

Dr. Bamire Adebayo Simeon
Department of Agricultural Economics, Faculty of Agriculture
Obafemi Awolowo University
Nigeria.

Editorial Board

Journal of Development and Agricultural Economics

Table of Contents: Volume 10 Number 3 March, 2018

ARTICLES

academicJournals

Vol. 10(3), pp. 64-70, March 2018
DOI: 10.5897/JDAE2017.0881
Article Number: 1820CDE55981
ISSN 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Review

Production and marketing of rice in Kenya: Challenges and opportunities

Evans A. Atera[1*], Florence N. Onyancha[2] and Eucabeth B. O. Majiwa[3]

[1]Department of Technical Services, Lake Basin Development Authority, Kenya; P. O. Box1516- 40100, Kisumu, Kenya.
[2]Kimira Oluch Smallholders Farmers Improvement Project, P. O. Box 293- 40300, Homabay, Kenya.
[3]Department of Agriculture and Resource Economics, Jomo Kenyatta University of Agriculture and Technology, P. O. Box 62000-00200, Nairobi, Kenya.

Received 26 September, 2017; Accepted 14 November, 2017

Rice farming remains an important concern in Kenya due to its positive impact on increasing household food security, raising farmer's income as well as reducing risks in the years of poor weather conditions. Currently, the demand for rice in Kenya outstrips its production, a gap that is filled through imports. Thus, increasing rice production and productivity in Kenya requires a number of measures to be put in place such as providing improved rice varieties that are attractive to farmers and consumers, and technical support to both public and private sectors which may inform on a wide range of policy issues such as promoting investment, land and water use management, market and pricing information and extension services. In order to integrate, promote and upgrade the existing rice agribusinesses in the country; there is need for the rice entrepreneurs to have easy access to financial services that will provide sustainable affordable funds. The possible factors that constrain the rice sub-sector trading include low production, high competition from cheap rice imports, changing consumer preferences and government policy restrictions. Bearing in mind such limitations, there still exists a significant market opportunity in the sector and with the right support either from government or donor funding, Kenya's rice demand can be met.

Key words: Rice, production, imports, marketing, Kenya.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important agricultural food crops for more than half of the world's population. Globally, about 150 million hectares is estimated to be under rice cultivation with an annual production of 500 million metric tons. The area under rice represents 29% of the total output of grain crops worldwide with Africa accounting for about 10 to 13% (Tsuboi, 2005; Onyango, 2006). Currently, rice is grown in over 75% of the 54 African countries and its territories, with a total population of nearly 800 million people depending on rice for their food and livelihoods (Africa Rice Centre, 2009). Rodenburg and Demont (2009) reported that rice is the fifth most important cereal in terms of acreage and fourth in production in sub-Saharan

*Corresponding author. E-mail: eatera@yahoo.com. Tel: 254-720-824446.

Africa (SSA).

The demand for rice has increased steadily in the recent decades thus, playing a major role in the strategic food security planning policies for several countries. According to FAO (2015), 741.3 million tons of paddy rice was harvested from 164 million hectares in the world in 2014 with China and India accounting for approximately 50%. In SSA, production of rice increased from 8.6 to 21.6 million tons between 1980 and 2006 (FAO, 2007). The increase in rice output is attributed to land expansion, increase in both population and incomes and due to changing of consumer preference in favor of rice in urban centers (Kijima et al., 2006; Balasubramanian et al., 2007; Africa Rice Centre, 2008). Becker and Johnson (2001) reported that nearly 90% of rice in Asia is grown under paddy field conditions; in contrast, approximately 60% of rice in SSA is grown in upland ecosystems.

In Kenya, rice demand exceeds production and the gap between production and consumption is filled through imports to meet the domestic demand at a huge cost. The current rice production is estimated at 150,000 metric tons from about 25,000 hectares of land (Kenya Bureau of Statistics, 2016). The rice output meets only about 20% of the total demand, with rice consumption projected to rise with increasing population and changes in eating habits (Atera et al., 2011). Annual rice consumption is approximated at 550,000 metric tons (Kenya Bureau of Statistics, 2016) and it is increasing at an annual rate of 12% as compared to 4% for wheat and 1% for maize, which is the main staple food (Ministry of Agriculture, 2008). The market requirement of rice is set to increase to 517.5 million ton by 2030 (Ministry of Agriculture, 2010). In order for Kenya to attain self-sufficiency in rice production by 2030, the total domestic rice production must increase at the rate of 9.3% per annum (Ministry of Agriculture, 2008). To enhance rice production and hence boost food security, Kenya's policy makers must understand the impediments that exist across the rice value chain and import process and explore the opportunities that may exist within the value chain that will benefit all the stakeholders

This paper aims at highlighting the constraints that rice agribusinesses/entrepreneurs face within the Kenyan rice value chain which are largely divided into three categories: agro-ecological, technological, and socio-economic. These constraints will provide a deeper understanding of Kenya's rice value chain as well as the myriads of rice marketing channels. This paper will recommend suitable policy remedies that may help boost rice production and marketing in Kenya.

BANKING ON RICE FOR THE FUTURE

History of rice in Kenya

Historically, rice has long been perceived as a cash crop for the rural population where it is grown, however, that perception is changing rapidly with many communities now appreciating the importance of rice as a food crop as well as an important source of income. This change in perception has greatly influenced the balance between production and consumption of rice in many African countries (Olembo et al., 2010). Rice production in Kenya dates back to 1907 when it was introduced by Europeans at the Coast (Onyango, 2014). There are three main value chains found in the Kenyan rice sub-sector: the integrated large farm chain, the highly concentrated chain on the National Irrigation Board (NIB) schemes, and the traditional market value chain of the non-NIB irrigated production and rain-fed producers.

There are several rice cultivars that have been released to farmers for both upland and irrigated conditions. The first dominant rice variety in Kenya is the irrigated aromatic rice Basmati 217. Other traditional irrigated rice cultivars grown by farmers include Sindano, ITA310 and BW196. The Basmati 370 was introduced to farmers as an irrigated aromatic variety in the country in the late 1990s as an improved variety. African Development Bank (ADB) funded a program known as the West Kenya Rain-fed Rice Development project (WKRRDP) to promote upland rice in Kenya. The program was implemented by the Lake Basin Development Authority (LBDA) in the Lake Victoria Basin Region between 1989 and 2000. The WKRRDP program had several components such as provision of extension services and credit to rice farmers, construction of a rice mill, and adaptive research (Lake Basin Development Authority, 1991). Through the collaborative efforts of the Kenya Agricultural and Livestock Research Organization (KALRO) and the Ministry of Agriculture, Livestock and Fisheries, the program released Dourado precoce and IR 2793 varieties to farmers.

The New Rice for African (NERICA) developed by African Rice Center (ARC) is an inter-specific hybridization of *Oryza glaberrima* and *O. sativa*. These cultivars combined the hardiness of the African rice with the productivity of the Asian rice to develop NERICA, which has provided a window of opportunity in SSA to reduce hunger. The NERICA cultivars were released to Kenya by ARC in 2004 for adaptability trials. Among the eighteen NERICA cultivars tested, four (NERICA1, NERICA4, NERICA10 and NERICA11) were found to be suitable and were released to farmers in 2008. The yield of the NERICAs' ranged from 3.5 to 5.0 t/ha. In 2014/2015 crop year Bayer East Africa in conjunction with Lake Basin Development Company (LBDC) and National Irrigation Board (NIB) tested the performance of hybrid rice varieties Arize Tej Gold and Arize 6444 Gold at Bunyala and West Kano irrigation schemes and found them promising in transforming the rice sub-sector (Table 1), since they have high tillering capacity of 20 to 35 tillers per plant, high yields of between 8 and 10 ton per ha and have a milling rate of 60.1%.

Table 1. Potential of hybrid rice varieties in comparison with local variety at Bunyala and Ahero Rice Irrigation Schemes, Kenya.

Variety	Plant height (cm)	Tiller number	Yield (t/ha)	Recovery rate (%)	Total extraction (%)
Arize Tej Gold	129.0	29	8.6	60.1	76.4
Arize 6444 Gold	130.0	28	9.2	61.0	75.0
IR 2793	88.6	21	4.1	60.0	73.0

Source: Bayer East Africa and Lake Basin Development Company (2015).

Table 2. Brands of milled aromatic and non-aromatic rice in the major supermarkets shelves in Kisumu City, Kenya

Milling company and packaging	Brand	Non-Aromatic (Ksh/kg)	Aromatic (Ksh/kg)
Lake Basin Development Authority	Lake Basin	105.00	175.00
Dominion Farms	Prime Harvest	95.00	-
Capwell Industries Ltd.	Cil	-	170.00
Mjengo Limited	Dawat	-	185.00
Capwell Industries Ltd.	Pearl	-	210.00
Capwell Industries Ltd.	Ranee	110.00	190.00
Krish Commodities	Sunrice	-	205.00
Kings Commodities	5 Stars	105.00	-
Argus Limited	Argus Mzuri	105.00	-
Mjengo Limited	224 Pilau	-	155.00
Mwea Millers	R&P Mwea	115.00	165.00
Mwea Rice Mills Ltd.	MRM	-	123.00

Average prices in the four major supermarkets (Nakumatt, Tuskeys, Choppies and Uchumi in Kisumu City, Kenya, means no brand, US$1 = Ksh 100.00).

Recently, new generations of high performing rice cultivars named Advanced Rice Varieties for Africa (ARICA) were launched by ARC. Five ARICA varieties (three lowland and two upland) out yielded the checks which were the NERICAs (IRRI, 2013). The two upland (ARICA 4 and ARICA 5) varieties yielded 15% more than NERICA 4, a favorite cultivar in East Africa, while the three lowland cultivars (ARICA 1, ARICA 2 and ARICA 3) have yield advantage of 30 to 50% over NERICA-L19. The varieties ARICA 4 and ARICA 5 have been released in Uganda, while in Kenya adaptabilities trials are ongoing (Africa Rice Centre, 2013). The issue that ponders in the minds of many researchers is whether the new ARICA cultivars will be the turning point for Africa (Kenya inclusive) towards the green revolution.

Rice production

Rice is produced both under irrigation and upland conditions in Kenya. It is currently the most expensive cereal in the country, retailing at about Ksh.80 to 100 kg^{-1} (US$0.84 to 1.05 kg^{-1}) for non-aromatic and Ksh.150 to 200 kg^{-1} (US$1.58 to 2.11 kg^{-1}) for aromatic type (Table 2). The trend of rice production in Kenya from 1961 to 2013 is as shown in Figure 1. It is noted that between 2008 and 2013, the total rice produced increased by about 7-fold from 21,800 tons to 146,900 tons. At the same time, average on farm rice yields of 4.25 t/ha was achieved under irrigable ecosystem which is within the average range of 3.4 to 5.4 t/ha obtained in SSA. The overall increase in production is largely attributed to the increase of total area under rice cultivation.

Presently, about 78% of the total area under rice cultivation in Kenya is under irrigable ecosystem (Table 3) in national rice schemes that are managed by the National Irrigation Board (NIB). These irrigation schemes include Mwea, Bura, Hola, Perkera, West Kano, Bunyala and Ahero. Small quantities of rice are produced along river valleys especially in smallholder irrigation schemes which include Kore, Alungo, Nyachoda, Wanjare, Anyiko, and Gem-Rae in western Kenya and Kipini, Malindi, Shimoni and Vanga at the coastal region. In the irrigable ecosystems, rice production involves continuous flooding as is typified in the Mwea, Ahero, Bunyala, and West Kano Irrigation Schemes. This system of rice production depends on a continuous supply of water for irrigation and soils with high water holding capacities. Moreover, if there is water scarcity in times of drought it means that the schemes have to receive rationed water thereby reducing productivity.

Rice yield in upland ecosystems in Kenya is about 1 ton/ha (Kijima et al., 2006; Africa Rice Center, 2008). The low yield of rice in upland conditions is due to constraints

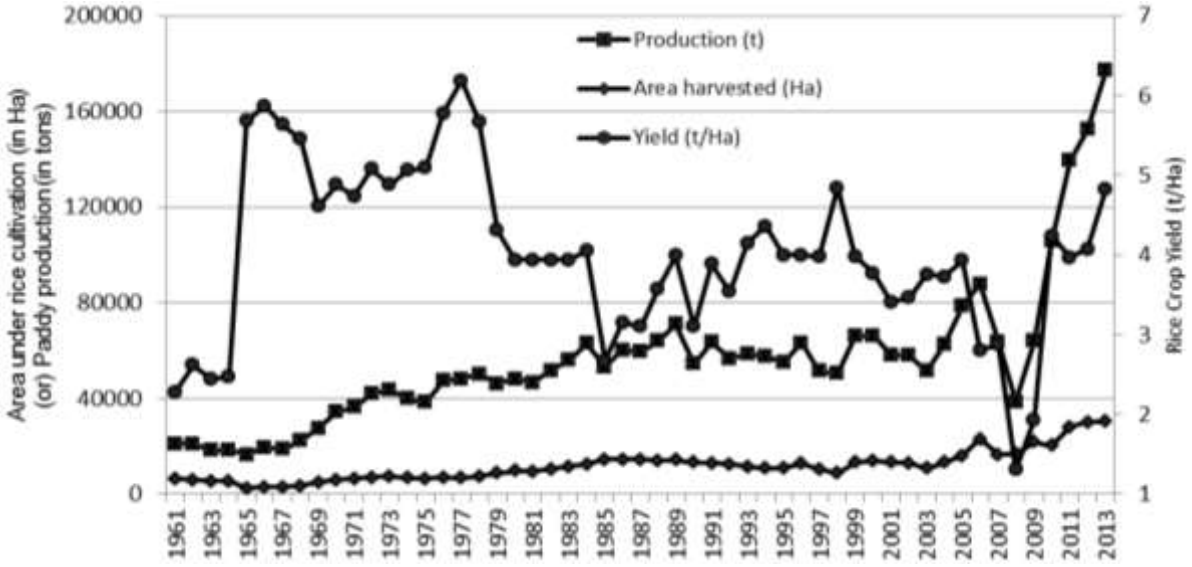


Figure 1. Trends of rice production in Kenya.

Table 3. Production of rice in major irrigation schemes in Kenya.

Scheme	Production (tons)		
	2013	2014	2015
Mwea	64,672	70,416	91,624
Ahero	8,326	7,405	7,942
West Kano	5,165	4,345	4,660
Bunyala	4,278	4,289	4,600
South west Kano	8,262	9,574	10,268
Total	90,703	96,029	119,094

Source: Kenya Bureau of Statistics (2016).

such as nutrient depletion, loss of organic matter and drought. Production of rice is also negatively impacted by pests and disease incidences such as bird damage, rice midge, blast, leaf blight, and the parasitic weed *Striga* (Bruce, 2010). Thus, any future increase in rice production will only come as a result of improved yields, through expanding the area under production and reducing field and storage losses (Orke and Dehne, 2004).

Remedial measures to curb imports

Kenya's dependency ratio on rice imports is very high with nearly 73% of rice consumed in Kenya is being imported at an average cost of US$87.5 million per annum over the past 5 years (Atera et al., 2011). Rice is imported to Kenya from several counties, namely: Pakistan, Vietnam, Thailand, Egypt, and Tanzania (Figure 2), thus causing strenuous pressure on foreign and trade balance. Given that there is over reliance on international market, the domestic rice production has significant implications on food security and poverty reduction. In order to narrow the gap between import and production of rice (Figure 3), the Government of Kenya has put in place several remedial measures. One of these measures is the expansion of the irrigation schemes in the country to increase rice production. For instance, the government has increased the land under rice farming at the Mwea Irrigation Scheme from 24,000 to 48,000 acres. Government has also put in place mechanisms of rehabilitating several schemes in Western Kenya including small holders' schemes and improving their infrastructure. Research on improvement of varieties and provision of farmers' incentives such credit will play a major role in boosting production. Construction of fertilizer plant in Eldoret is another major undertaking of government to reduce the cost of production. Recently, Japan International Cooperation Agency (JICA), in partnership with the Alliance for a Green Revolution in

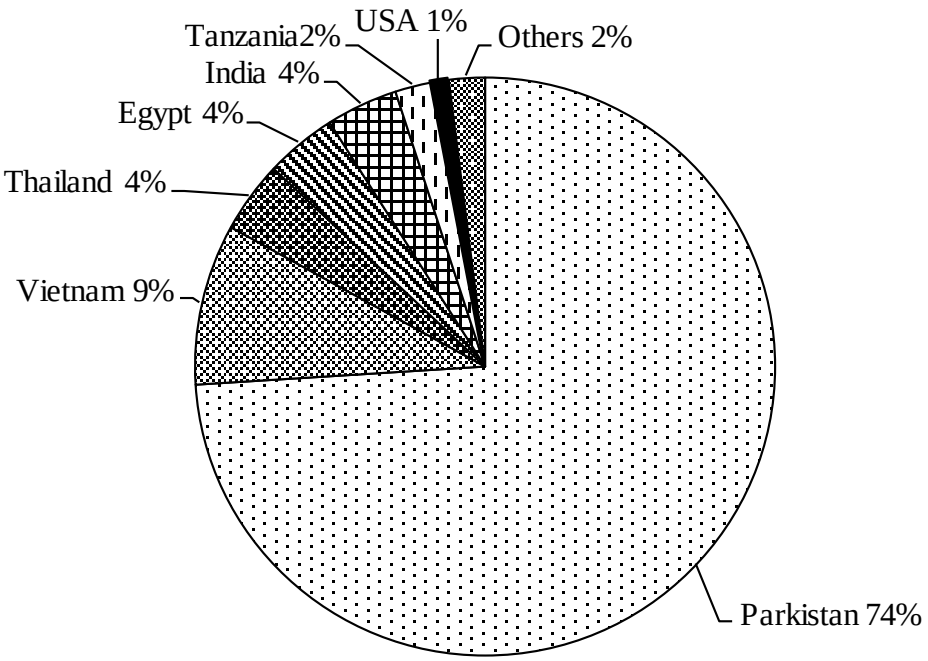


Figure 2. Share of rice imports (%) in Kenya from different countries.

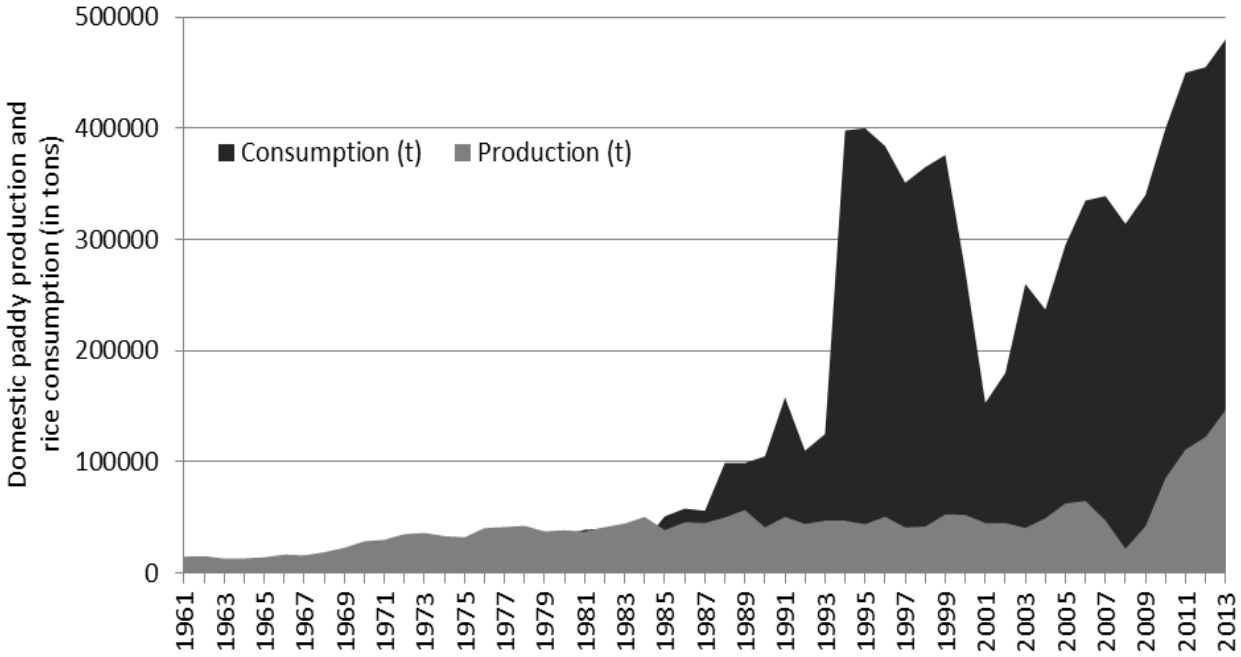


Figure 3. Gaps between domestic rice production (paddy) and consumption in Kenya.

Africa (AGRA) launched an initiative known as “Coalition for African Rice Development” (CARD) which is aimed at doubling rice production in Africa by 2018. This will not only contribute to improvement of food security, but also to rural development and poverty reduction in the region.

DOMESTICATING KENYAN RICE MARKET

Rice marketing channels

Nearly 95% of the rice produced by the farmers in Kenya

is marketed locally. There are several rice traders in the country who are taking advantage of the evolving market opportunities and changes in consumer demand. These traders include the government owned National Cereals and Produce Board (NCPB) which purchase paddy from farmers and process in the state-owned mills. These state-owned mills also purchase paddy from farmers and process the same through their rice mills in Ahero, Mwea and Kibos and supply their milled rice products to supermarkets and local retailers. In addition, there are also numerous small traders, mostly women who sell the commodity in the local market.

There are four major rice mills owned by the government spread across the country with varying milling capacities which include the Lake Basin Development Authority (LBDA), National Irrigation Board (NIB-Mwea), Western Kenya Rice Mills (WKRM), and Tana River Development Authority (TARDA) rice mills. The LBDA rice mill has a milling capacity of 3.5 metric tons/h, NIB-Mwea has a capacity of 3.5 metric tons/h, while WKRM mills have capacity of 3.0 metric tons/h and Tana Delta Rice mill owned by TARDA has milling capacity of 3.0 metric tons/h. In addition, there are several privately-owned mills such as Dominion Farms Mill, Capwell, Nice Rice Millers and other small mills especially in Mwea and western Kenya with throughput of about 2.0 to 2.5 metric tons/h each. It is notable that rice mills have achieved competitive status, although they experience frequent machine breakdown, low investment in modern mills, stiff competition from cheap rice imports and lack of a reliable source of energy for mill operation. The Kenyan Government in collaboration with JICA stepped up this initiative to promote rain-fed rice by providing several rice mills in western Kenya with a throughput of about 1.0 metric ton/h.

Currently, paddy is retailed at Ksh.35 to 40 kg^{-1} (US$0.37 to 0.42 kg^{-1}) of non-aromatic and Ksh.55 to 60 kg^{-1} (US$0.58 to 0.63 kg^{-1}) of aromatic. Market survey on milled rice conducted by the Marketing Department of Lake Basin Development Authority in the supermarkets in Kenya in 2016 revealed that price is driven by the varying availability of cheap Asian imports, tariff regimes, transport costs and distance to markets. It is important to note that paddy prices are high due to low on-farm investment in inputs, seed, and labor and so yields are low by global standards. Currently, production is growing faster than demand, which is based on increases in area under rice instead of gains in productivity and this will slow down the local supply growth and unable to keep pace with the demand.

Challenges in the rice sub-sector

Among the major challenges experienced in the rice value chain, the unfavorable weather conditions and inadequate water for irrigation, acceptable variety, low and declining land productivity, high cost of inputs, poor infrastructure, lack of machinery, transboundary/regional issues, and human and institutional capacities with the rainfed rice system suffering the worst decline in performance.

Among the identified challenges, the most critical one is the lack of development of high yield rice cultivars whose grain quality is not only acceptable to most consumers but also tolerant to local pests in both rainfed and irrigated ecosystems. Additionally, the poor post-harvest practices of farmers of recycling seeds for planting contribute to low quality output. Another major challenge that rice farmers face is high post-harvest losses which account for about 15 to 50% of the market value of production. In terms of milling, many small millers do not have good quality milling equipment, have poor handling and storage facilities, which lead to high levels of broken grains and increased foreign matter in milled rice. In Kenya, there are several small private owned mills producing low and poor-quality rice which is a barrier to competitiveness. This has significantly affected the traders and has been a hindrance in accessing quality paddy in the market and thus a constraint to traders in expanding their activities.

Further, the sector lacks a coherent and comprehensive policy, plan, and program to tackle the many constraints and deficiencies in the rice sub-sector. Thus, policy makers, producers and millers need to identify, brand, and promote high quality locally adapted rice varieties in national, regional, and international markets in order to boost rice productivity. Strengthening research and development through training and provision of adequate funds to conduct research will also help to address some of the aforementioned mentioned challenges. The rainfed rice system needs to be given more serious attention in the process of revitalizing rice production. A coherent and comprehensive policy, plan, and program will thus help in tackling the many constraints and deficiencies in the rice sub-sector.

Opportunities in the rice industry

Despite the challenges Kenya faces in terms of rice productivity, there exists great opportunities to increase rice production and strengthen both household and national food security systems. As already mentioned, the government is trying to increase rice production through land expansion and rehabilitation of the existing schemes to reduce rice imports. In addition, the donor community has increased foreign aid assistance to Kenya to support programs that help reduce poverty and improve on food security. Rice sub-sector has benefited greatly through JICA and FAO to improve and develop underexploited rice producing areas which will substantially increase production as well as improve on food security and farmers' incomes. Through research

the low potential pest susceptible old varieties should be replaced with the new high yielding varieties with promising yield potential. Further, cultivation of hybrid rice should be encouraged by stakeholders through field sites demonstrations and making seed available to farmers.

At the moment in Kenya most farmers, processors and other end users of agricultural mechanization technologies do not use enough technologies for their farming and processing operations to have much impact on national productivity. This therefore makes the Kenyan rice value chain labor intensive and uncompetitive. Most operations in the rice sub-sector are labor-intensive when conducted manually and the end result is low productivity. This low productivity has several causes of which many are related to low use of mechanization. Therefore, there exist an opportunity of promoting mechanization in the rice value chain including: proven willingness by end users across the country to adopt economically beneficial technologies, fabricators who are able to produce low cost equipment at affordable prices, and willingness and capability among fabricators to copy machines that have a proven record of technical and financial success.

CONCLUSION

The policy makers are aware that increasing rice productivity per unit area requires adopting intensive use of land by increasing the cropping intensity which will help in sustaining production so as to meet the increasing demand for rice. Emphasis therefore, should be laid to farmers on the adoption of non-monetary inputs like timely sowing, maintaining optimum plant population, timely irrigation, efficient use of fertilizers, need based plant protection measures, and timely harvesting of the crop. The government should come up with a policy to support industrialization through private firms to drive investment in order to make rice profitable for firms that are investing in true commercial production and processing. In addition, the county governments should have policies that are leading to different enabling environments around the country and differentiated opportunities for expansion of the rice industry across the value chain.

CONFLICTS OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Africa Rice Centre (2009). African Rice Center annual report 2008. Responding to the rice crisis, Cotonou, Benin P 60.

Africa Rice Centre (2013). New generation rice varieties unveiled for Africa. Available at: http://www.cgiar.org/224023/new-generation-rice-varieties-unveiled-for-africa/

Africa Rice Centre (WARDA)/FAO/SAA. (2008). NERICA: The New Rice for Africa – a Compendium. Somado E.A, Guei R.G and Keya S.O (eds.). Cotonou, Benin: Africa Rice Center (WARDA); Rome, Italy: FAO; Tokyo, Japan: Sasakawa Africa Association P. 210. Available at: http://www.africarice.org/publications/nerica-comp/Nerica%20Compedium.pdf

Atera EA, Onyango JC, Azuma T, Asanuma S, Itoh K (2011). Field evaluation of selected NERICA rice cultivars in western Kenya. Afr. J. Agric. Res. 6(1):60-66.

Balasubramanian V, Sie M, Hijmans RJ, Otsuka K (2007). Increasing rice production in sub-Saharan Africa: challenges and opportunities. Adv. Agro. 94:55-133.

Becker M, Johnson DE (2001). Cropping intensity effects on upland rice yield and sustainability in West Africa. Nut. Cycl. Agro. 59:107-117.

Bruce TJA (2010). Tackling the threat to food security caused by crop pests in the new millennium. Food Sec. 2:133-141.

Food and Agriculture Organization (FAO) (2007). International Rice Commission Newsletter. Rome, Italy P 56.

Food and Agriculture Organization (FAO) (2015). Rice Market monitor. Rome, Italy 18:1.

International Rice Research Institute (IRRI) (2013). Rice Today. Africa gets rice varieties with higher yields. Available at: http://africarice.org/publications/ricetoday/Africa%20gets%20rice%20varieties.pdf

Kenya Bureau of Statistics (2016). Economic Survey of Kenya. Nairobi, Kenya pp. 144-165.

Kijima Y, Sserunkuuma D, Otsuka K (2006). How revolutionary is the“NERICA revolution”? Evidence from Uganda. Dev. Econ. 44:252-267.

Lake Basin Development Authority (1991). Annual Report – West Kenya Rain-fed Rice Development project, Kisumu, Kenya.

Ministry of Agriculture (2008). National Rice Development Strategy (2008 – 2018). Agricultural Information Resource Centre, Nairobi, Kenya.

Ministry of Agriculture (2010). Economic Review of Agriculture Central planning and project monitoring unit, Nairobi.

Olembo N, M’mboyi F, Oyugi K (2010). Success Stories in Crop Improvement in Africa. The Case of Rice in Sub-Saharan Africa. African Biotechnology Stakeholders Forum (ABSF). Nairobi, Kenya.

Onyango AO (2014). Exploring Options for Improving Rice Production to Reduce Hunger and Poverty in Kenya. World Environ. 4(4):172-179.

Onyango JC (2006). Rice, a crop for wealth creation: Productivity and prospects in Kenya’s food security. Maseno University, Kisumu, Kenya.

Orke EC, Dehne HW (2004). Safeguarding production –losses in major crops in and role of crop production. Crop Prot. 23:275-285.

Rodenburg J, Demont M (2009). Potential of herbicide-resistant rice technologies for sub-Saharan Africa. AgBioForum 12:313-325.

Tsuboi T (2005). The benefit of NERICA rice in Africa. Paper presented at the WARDA NERICA rice Workshop, Ivory Coast, 8th October, 2005.

academicJournals

Vol. 10(3), pp. 71-78, March 2018
DOI: 10.5897/JDAE2017.0815
Article Number: 5D173BF55989
ISSN 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Full Length Research Paper

Effect of price and exchange rate volatility on Kenya's black tea export demand: A pooled mean group estimation

Winrose Chepng'eno

Department of Agricultural Economics and Resource Management, Moi University, Kenya.

Received 8 February, 2017; Accepted 10 May, 2017

The tea sector plays an important role in the Kenyan economy mainly through employment, contribution to Gross Domestic Product (GDP) and foreign exchange earnings. However, the sector faces a number of risks including but not limited to production, technological, price and market risks, legal and personal risks. Price and exchange rate volatility is one of the main sources of risk in the agribusiness sector. This paper sought to determine if foreign income, exchange rate, relative prices, price and exchange rate volatility have effects on Kenya's black tea export demand. The study used panel data from World Bank and Central Bank of Kenya statistical bulletins for the period 1997 to 2010. Price and exchange volatility cannot be observed directly and were thus computed using Moving Average Standard Deviation (MASD) method. Sixteen major importer countries of Kenya's tea were considered in the study. Im Peseran and Shin (IPS) unit root tests were used for testing the variables for the presence of unit roots. The study employed dynamic heterogeneous panel techniques developed by Peseran and Shin using autoregressive distributed lag (ARDL) model in the error correction form. The empirical model was estimated using pooled mean group (PMG) estimator. The study found that growth in foreign income and changes in price and exchange rate volatility were significant in the long and short run. Proportional changes in relative prices and foreign exchange rate were insignificant in the long run and short run.

Key words: Price volatility, exchange rate volatility, Kenya's black tea exports, autoregressive distributed lag (ARDL) model, pooled mean group (PMG) estimation.

INTRODUCTION

Research has shown that commodity price fluctuations in the era of economic globalization and increased liberalization of commodity markets have seriously affected the weaker economies of the developing world (Byerlee et al., 2006; Ivanic and Martin, 2008).

Economic reforms with the aim of liberalization of domestic markets were adopted by most developing countries in the 1980 and 1990s. The structural

E-mail: winroseck@gmail.com. Tel: +254 724 589 771.

adjustment programs (SAPs) were recommended by World Bank (WB) and were prescribed with the aim of restoring fiscal and current account balance, reducing or eliminating price distortions and facilitating efficient price transmission. The adoption of economic reforms meant that participation of governments, through parastatals in markets would be minimal.

Price volatility is one of the main sources of risk in the agribusiness sector. Exchange rate variability can further affect the transmission of world prices to domestic prices further increasing the risks faced by farmers particularly those producing for the foreign markets.

An understanding of risk as well as its impacts is critical in order to manage the inherent variability of agricultural income through price and yield volatility especially in low income countries. Commodity price volatility and its impact on the economy of low income countries are a critical concern for both economists and policy makers. The impact of commodity price variability can have effects on economies in various ways and can distinguish between *ex ante* effects of volatility and *ex post* effects of extreme output (Dehn et al., 2004).

Theoretical and empirical evidence both indicate that agricultural commodity prices are more volatile than those of manufactured goods in the short run (UNCTAD, 2008). Tea production in many developing countries is dominated by small scale farmers (60% in Kenya and 76% in Sri Lanka) (FAO, 2014) who rely on tea as a major source of income. Further, the economies of these developing countries rely on tea as a major source of income.

Random price variation adversely affects the welfare of both producers and consumers of agricultural products (Gardner and Gardner, 1977). It has been argued that price variability reduces welfare (Zheng et al., 2008) of both producers and consumers by exposing them to uncertainty and risk (Apergis and Rezitis, 2011). Price volatility creates uncertainty at farm level and variability in profit margins and lessens the incentive to invest. The effects are more pronounced in developing countries where opportunities for hedging against price risks are nonexistent.

Tea dependent households and economies are vulnerable to price volatility. Price variability negatively affects household incomes and welfare. Tea producers face dynamic and confusing price signals. Price movements can be viewed simply as indications of a well-functioning market, but even if there are no market distortions, tea producers may not respond in the short term to the price movements. Although, farmers of other crops face similar situations, tea producers face greater constraints on their ability to adjust production levels than farmers who grow annual crops, and do so in an environment with no hedging options, unlike farmers in developed countries. Further, Kenyan tea farmers cannot influence price levels even through deliberate reduction in supply.

Frequent fluctuations in world tea prices also have secondary effects along the tea value chain that implicitly affect tea producers. When faced with variable prices, tea buyers and other players in tea value chain may require large margins in order to minimize exposure to risk and thus reducing farmers' margin even further.

Tea production decisions are made well in advance of product sales, and there generally exists an uncertainty about the price that will be received for products when sold in the market at a future date (OECD, 2009). Stable prices and by extension incomes are critical for planning reasons and that is why many governments in developing countries intervened in pricing of agricultural commodities prior to adoption of market and economic reforms in general.

FAO (2014) acknowledges the role that tea production and export play in food security by covering food import bills in tea producing countries. FAO notes that in 2011, tea export earnings paid for 51% of Kenya's food import bills. Thus, the need for careful monitoring and analysis of international tea trade by policy makers concerned with food security, trade and rural development in Kenya.

Problem statement

In 1980 and 1990s, several governments of sub-Sahara Africa (SSA) adopted economic reforms under the wider context of SAPs following suggestions by World Bank (WB), International Monetary Fund (IMF) and governments of developed countries in line with the Uruguay Round of 1986 to 1994. Among the recommendations were the removal of price controls, trade liberalization and privatization of state-owned enterprises. It was purported that adoption of economic reforms would lead to improved producer prices and enhance trade efficiency (White and Levy, 2001).

Trade liberalization required gradual abolition of state interventions in agricultural markets. Governments were required to open up to international trade by eliminating trade barriers and tariffs in order to improve economic growth and welfare in developing countries (Amikuzuno, 2009). It was postulated that trade liberalization would lead to improved commodity market performance (Mofya-Mukuka and Abdulai, 2013) and improved efficiency by increasing productivity of human talent and physical assets (Akiyama et al., 2003). Increased efficiency is crucial for countries that rely on agriculture (Ankamah-Yeboah, 2012).

International commodity trade is associated with two main sources of risks: volatility in world prices and volatility in exchange rates. This is more pronounced in developing countries because primary commodities form the bulk of exports of these countries.

There are different theoretical views on the impact of price and exchange rate volatility on exports. One of the views is that exchange rate volatility does not have

impact on the volume traded (exports or imports). For example Friedman (1953) and Johnson (1969) base their argument on the neoclassical paradigm and propose that with perfectly flexible markets, any shock arising from changes in the nominal exchange rate will be absorbed through changes in prices or hedging markets and thus the real effective exchange rate and trade volumes will be left unchanged.

According to De Grauwe (1988), a rise in nominal exchange rate fluctuations can either have a positive or a negative effect on the volume on trade depending on the substitution and income effects. He argues that risk-averse parties are likely to decrease export volumes due to the substitution effect while the income effect causes risk-averse agents to increase exports to avoid severe fall in revenues. The increased risk associated with volatility is likely to induce risk-averse agents to direct their resources to less risky economic activities. He further noted that when income effect is greater than the substitution effect, there will be a positive relationship between exchange rate volatility and trade. If substitution effect is greater than income effect, there will be a negative impact on trade.

Another view is that exchange rate volatility depresses trade (Cote, 1994; Hooper and Kohlhagen, 1978; Clark, 1973). Arize et al. (2000) and Hooper and Kohlhagen (1978) argue that higher exchange rate volatility will depress trade volume through a rise in adjustment costs like irreversible investment due to higher uncertainty and risks.

Contrary to the aforementioned proposition, Franke (1991) and Sercu and Vanhulle (1992) propose that exchange rate variability can influence trade volume positively. Exchange rate variability increases risk which creates higher opportunity for higher profits and thus leads to increased international trade.

The mixed theoretical literature has motivated many empirical studies to analyze the effects of exchange rate volatility on exports and the results of these studies, just like the theoretical propositions are mixed. However, most of the studies have focused on developed countries and few have focused on developing countries.

Sun et al. (2002) employed a gravity model within a panel data framework to evaluate the effect of exchange rate volatility on international wheat trade and found that exchange rate volatility had negative effect on world wheat trade. Yuan and Awokuse (2006) investigated the relationship between exchange rate volatility and U.S poultry exports and the results of their study indicated that exchange rate volatility had a negative effect on trade. They also found export volume to be sensitive to foreign income and price changes.

In Kenya, Kiptui (2007) investigated the impact of the real exchange rate on the demand for Kenya's exports. He established long-run relationships for coffee, tea and horticulture but rejected for manufactured export goods. His results suggested that the effects of real effective exchange rate were more likely to be long-run than short-run in nature and there could be a threshold level beyond which exchange rate fluctuations harm exports.

Alam and Ahmed (2012) estimated the export demand for Pakistan within ARDL framework using annual quarterly data from the first quarter of 1982 to the second quarter of 2008. The findings showed that relative price of aggregate exports and real effective exchange rate volatility real exports were significant, both in the long and the short run. Serenis and Tsounis (2014) examined the effect of exchange rate volatility on exports for Croatia and Cyprus using quarterly data for the period 1990Q1-2012Q1. Their results revealed that exchange rate volatility had a positive effect on exports of the two countries. Using monthly data from February 2001 to January 2010, Demirhan and Demirhan (2015) examined the effect of exchange rate stability on Turkish exports. The findings indicated that exchange rate stability had a positive significant on real export volume, both in the short and long run.

Theoretically and empirically, it is not clear whether there is a positive or negative relationship between exchange rate volatility and export demand thus leading to the question: Do price volatility and exchange rate volatility affect Kenya's black tea exports? The study sought to assess the long run relationship and short run dynamics between foreign income, exchange rate, relative prices, price and exchange rate volatility and Kenya's black tea export demand.

METHODOLOGY AND MODEL SPECIFICATION

Econometric model

This study adopted the standard trade model on export demand adopted by Goldstein and Khan (1985) in assessing the long term determinants of exports. According to the standard demand theory (the Marshallian type), the main determinants of demand are relative price and income.

Since the study focuses on the effect of price and exchange rate volatility, the model is further extended to capture price and exchange rate volatility. Consistent with economic literature, the extended model is therefore restated as:

$$EX_{it} = f(Y_{it}, DEP_{it}, WEP_{it}, EXR_{it}\ PV_{it}, ERV_{it}) \quad (1)$$

where EX_{it} is the tea export volume to country *i* at time *t*; Y_{it} is the level of economic activity in export market *i* in period *t*; DEP_{it} is the price of domestic tea exports country *i* at time *t*; WEP_{it} is the world price of tea exports at time *t*; EXR_{it} is the exchange rate between Kenya and importing country *i* at time *t*; ERV_{it} is the exchange rate volatility between Kenya and importing country *i* at time *t* and; PV_{it} is the price volatility between Kenya and importing country *i* at time *t*.

The ARDL specification of equation (1) above is presented as;

Table 1. Variable description and expected sign.

Variable code	Variable name	Description	Expected sign
Dependent variable			
EX_{it}	Kenya's black tea exports	Logarithm of Kenya's black tea exports in kilograms to a specific country in 1997-2010 period	
Independent variable			
Y_{it}	Foreign income	It is measured using the importing country's GDP in US dollars	+
$\frac{DEP}{WEP_{it}}$	Relative export prices	It refers to ratio of the price of Kenya's black tea per kilogram in Nominal USD to the price of black tea per kilogram in Sri Lanka in Nominal USD.	-
EXR_{it}	Exchange rate	Nominal Exchange rate between importing country and Kenya	-
PV_{it}	Price volatility	Price volatility was calculated using GARCH model (Equation 3).	+ /-
ERV_{it}	Exchange rate volatility	Exchange rate volatility was calculated using GARCH model (Equation 3).	+ / -

$$\Delta \ln EX_{it} = c_0 + c_1 t + \alpha_1 \ln EX_{it-1} + \alpha_2 \ln Y_{it-1} + \alpha_3 \ln \left[\frac{DEP}{WEP}\right]_{it-1} + \alpha_4 \ln EXR_{it-1} +$$
$$+ \alpha_5 \ln ERV_{it-1} + \alpha_6 \ln PV_{it-1} +$$
$$\sum_{j=1}^{p} \beta_j \Delta \ln EX_{it-j} +$$
$$\sum_{j=0}^{q} \gamma_j \Delta \ln Y_{it-j} + \sum_{j=0}^{r} \delta_j \Delta \ln \left[\frac{DEP}{WEP}\right]_{it-j} + \sum_{j=0}^{s} \pi_j \Delta \ln EXR_{it-j} +$$
$$\sum_{j=0}^{t} \tau_j \Delta \ln ERV_{it-j} + \sum_{j=0}^{v} \eta_j \Delta \ln PV_{it-j} + \mu_i + \omega_{it} \qquad \forall i \leq N$$

and

$1 \leq t \leq T$: T=14

and

N=16 (2)

where Δ is the first difference; c_0 and c_1 t are drift and trend variables; $\alpha_1, \alpha_2, \alpha_3 \alpha_4, \alpha_5$ and α_6 are long term multipliers, while $\beta_j, \gamma_j, \delta_j, \pi_j, \tau_j$ and η_j are short term coefficients; *p, q, r, s, t* and *v* are optimum lags periods. The rest of the variables are defined in Equation 1.

Data

The study used annual panel data set to estimate the export demand for Kenya's black tea. The panel comprised of 16 countries and 14 years and thus, the number of observations was 224. Volume of black tea exports, GDP values, real exchange rates, foreign and domestic prices of black tea were obtained from http://wits.worldbank.org and UNCOMTRADE, statistics division. Data on real exchange rate of the Kenyan shilling against relevant currencies were also obtained from the Central Bank of Kenya (CBK) statistical bulletins.

Exchange rate volatility and price volatility cannot be observed directly and thus, were computed using generalized autoregressive conditional heteroscedasticity (GARCH) model. The GARCH model was estimated as follows:

$$\sigma^2 = \gamma_0 + \sum_{i=1}^{r} \emptyset_i \mu_{t-i}^2 + \sum_{i=1}^{s} \delta_i \sigma_{t-i}^2 \qquad (3)$$

where σ^2 is the conditional variance, γ_0 is constant, $\emptyset_i$ and δ_i are the parameters to be estimated, *r* refers to the number of autoregressive lags (ARCH terms), while *s* is the number of moving averages lags (GARCH terms) specified, and μ is the error term.

A summary of the description and the expected sign of each of the variables used in assessing export demand for Kenya's black tea are presented in Table 1.

Data analysis

Data was first tested for unit roots using Im Peseran and Shin (IPS) unit roots tests. The second step after testing for unit roots was to test for panel cointegration. The study employed PMG method by Pesaran et al. (1999) due to the following merits. Unlike Westerlund (2007), the test is consistent even if there is a mixture of *I(0)* and *I(1).* It is concise in the sense that, it estimates the functional Error Correction Model (ECM) and tests for cointegration at the same time. Pesaran et al. (1999) model for cointegration utilizes pooled mean group (PMG) estimator which provides for heterogeneity as it allows short run adjustment to differ across individuals (countries).

In the presence of cointegration in panel data frameworks, the next step requires one to estimate both the long run and the short run models. There are two estimation methods commonly used when dealing with dynamic panel data models. The first consists of

Table 2. IPS panel unit roots test.

Variable		Test statistic	Critical value ($\alpha = 0.05$)	Conclusion
$ln\, EX_{it}$	Level	-3.868	-1.870	Stationary at level *I(0)*
$ln\, Y_{it}$	Level	6.429	-1.870	Non-stationary
	1st Difference	-4.327	-1.870	Stationary *I(1)*
$ln\, EXR_{it}$	Level	0.000	-1.870	Non –stationary
	1st Difference	-4.450	-1.870	Stationary at level *I(1)*
$ln\left[\frac{DEP}{WEP}\right]_{it}$	Level	-4.632	-1.870	Stationary at level *I(0)*
$ln\, PV_{it-1}$	Level	-9.181	-1.870	Stationary at level *I(0)*
$ln\, ERV_{it-1}$	Level	-3.847	-1.870	Stationary at level *I(0)*

The null hypothesis is that all panels contain unit roots that is each series in the panel is integrated of order one.

averaging separate estimates for each group in the panel. According to Pesaran and Smith (1995), the mean group (MG) estimator yields consistent estimates of the parameter averages. It allows the parameters to be freely independent across groups and does not consider potential homogeneity between groups.

The second method is the pooled method which includes the random-effects, fixed effects and Generalized Method of Moments (GMM) models. These models force the parameters to be identical across groups, but the intercept can vary between groups. GMM estimations of dynamic panels could lead to inconsistent and misleading long-term coefficients, a possible problem that is exacerbated when the period is broad (Pesaran et al., 1999). The PMG involves both pooling and averaging and thus is an intermediate estimator.

Three different regression scenarios were considered; the first regression was unconstrained country equation yielding MG estimator, the second is ARDL-ECM with equal long run coefficient and different short run coefficients yielding PMG estimator, and dynamic fixed effects (DFE) which assumes homogeneity in both short and long run coefficients (except the constant term). PMG estimation method also allows one to estimate both long run and short run coefficients simultaneously from the underlying ARDL model. Further, endogeneity problems encountered in Engle and Granger (1987) approach are avoided by autoregressive distributed lag approach (Islam et al., 2014).

The MG estimator requires one to estimate a separate regression for each country and calculate the coefficients as unweighted means of the estimated coefficients for the individual countries (Islam et al., 2014; Persyn and Westerlund, 2008). Unlike PMG, there are no restrictions on the coefficients under this method. Rather, all coefficients are allowed to vary both in the short run and in the long run. The method, however, requires large time (T) and cross-section (N) components.

The DFE estimator, just like PMG restricts the coefficient of the cointegrating vector to be equal across countries in the long run. Further, it restricts the speed of adjustment and short run coefficient to be equal (Islam et al., 2014). The method is subject to simultaneous equation bias due to endogeneity between error term and the lagged dependent variable.

The next step was model selection. Firstly, the appropriate numbers of lags were to be estimated to find the most parsimonious model. Secondly, the three models allow estimation of both short run and long run models simultaneously. Hausman test was used to test whether there were significant differences among the three estimators. If the null hypothesis is not rejected, it implies there is no significant difference and PMG estimator is efficient and adopted for analysis (Peseran et al., 1999). If null is rejected, it means either DFE or MG are appropriate estimators. Five percent level of significance was used for significance test.

RESULTS AND DISCUSSION

The results of panel unit roots tests are presented in Table 2.

Existence of both *I(0)* and *I(1)* shows that test for cointegration is necessary to establish existence of long term relationship between the variables of interest.

Three dynamic panel regression models: PMG, MG and DFE were estimated and the results presented in Table 3. ARDL (1,1,1,1,1) was chosen because attempts to add lags led to non-convergence of the model due to overparametization a common problem with PMG, MG and DFE models (Samargandi et al., 2013). Hausman test was used to determine the most efficient and consistent estimator among the three models. Hausman test between PMG and MG had a score of 0.21 with a corresponding p-value of 0.9990. Hausman test between PMG and DFE had a score of 0.33 with a corresponding p-value of 0.9971. In both cases, the null hypothesis that there were no systematic differences between the estimators was not rejected at 1% significance level. Therefore, PMG is more efficient estimator than MG and DFE. Failure to reject the null hypothesis also indicates that the long run estimates were homogenous; hence, PMG is consistent and most efficient.

Cointegration results are discussed in Table 3. The error correction coefficient was -0.860. The results show that error correction coefficient was significant and less than -2. The significance of ECT in the model implies that both long run and short run models can be estimated.

Table 3. Pooled mean group versus mean group and dynamic fixed effect estimators.

Dependent variable: $ln\ EX_{it}$	Pooled Mean Group (PMG) Estimator		Mean Group (MG) Estimator		(DFE) Estimator	
Long run						
	Coefficient	**P-Value**	**Coefficient**	**P-Value**	**Coefficient**	**P-Value**
$ln\ Y_{i\ t-1}$	0.684*** (0.078)	0.000	2.00 (1.502)	0.183	-0.024 (0.035)	0.504
$ln\ \left[\frac{DEP}{WEP}\right]_{it-1}$	0.251 (0.158)	0.112	0.183 (0.618)	0.768	-0.816*** (0.288)	0.005
$ln\ PV_{it-1}$	0.111 (0.057)	0.051	0.229 (0.188)	0.222	0.167 (0.161)	0.297
$ln\ ERV_{it-1}$	0.081*** (0.016)	0.000	-0.316 (0.233)	0.174	-0.012 (0.040)	0.774
$ln\ EXR_{it-1}$	0.094 (0.165)	0.568	257.51 (253.46)	0.310	0.301 (0.347)	0.384
Short run						
$\Delta\ Y$	3.0776 (1.5760)	0.051	1.093 (2.3385)	0.640	-0.014 (0.0348)	0.584
$\Delta\ ln\left[\frac{DEP}{WEP}\right]$	0.06167 (0.0896)	0.491	-0.0556 (0.4487)	0.901	-0.291 (0.1663)	0.081
$\Delta\ ln\ PV$	0.1365*** (0.0292)	0.000	0.241 (0.1566)	0.122	0.135** (0.068)	0.047
$\Delta\ ln\ ERV$	0.1193** (0.0473)	0.012	-0.118 (0.1535)	0.443	0.040 (0.0282)	0.153
$\Delta\ ln\ EXR$	-9.287 (12.092)	0.442	113.31 (111.26)	0.308	-1.97*** (0.380)	0.000
Speed of convergence						
Error correction	-0.859*** (0.135)	0.000	-1.285*** (0.105)	0.000	-0.683*** (0.060)	0.000
Intercept						
Constant	-0.871*** (0.291)	0.003	-196.134 (173.97)	0.250	4.456*** (0.476)	0.000
Diagnostics						
Log Likelihood 95.166						
Number of observations (NT) = 224			Number of panels N=16		Number of years (T) = 14	
Hausman test: PMG versus MG			Chi^2 =0.21		P-value= 0.999	
PMG versus DFE			Chi^2 =0.33		P-value= 0.9971	

*** and ** indicates significance at 1 and 5% respectively. Standard errors are in the parentheses.

In the long run, the results show that the foreign income (proxied by of GDP) had a positive elasticity of 0.68 which was significant at 1 per cent. Exchange volatility had a positive coefficient of 0.081 and was significant at 1% level. Proportional changes in relative prices, foreign exchange rate and price volatility had positive coefficients. However, the coefficients were not significant in the long run.

The significance of foreign income and exchange rate volatility variables justified the estimation of an error correction model can be estimated to capture the short-run dynamics of Kenya's black tea exports.

In the short run, the results show that price volatility and exchange rate volatility were significant at 1 and 5% level, respectively. Proportional changes in relative prices, foreign income and foreign exchange rate were insignificant in the short run.

The results show that foreign income was significant in the long run but insignificant in the short run. Price volatility had significant positive effect in the short run. On the other hand, exchange rate variability had significant positive effects both in the short-run and in the long run even though the effects are more in the short run than in the long run. In the long run exchange rate may tend towards equilibrium, hence, the reason for less effect in the long run. Positive significant results between Kenya's tea exports and price volatility and real exchange rate volatility in the short run shows that their volatilities increases the demand for exports in the world market and vice versa. This could be attributed to increase in these volatilities induce uncertainty and that may lead to increased demand for Kenya's black tea exports.

The PMG model also gives the speed of convergence of Kenya's tea exports to changes in identified explanatory variables. The results show that the speed of convergence coefficient of -0.859 was significant at one percent. First, these results confirm the existence of cointegration relationship between Kenya's tea exports and at least one of the explanatory variables. The negative sign implies that Kenya's tea export adjust towards long run equilibrium path. The results show that the speed of convergence of Kenya's tea exports to long run equilibrium after a shock is approximately 85.9% per year. This means that following a shock, 85.9% of the deviations (away from long run equilibrium) are corrected within one period (one year).

Conclusions

The results show that in the long run, two variables; foreign income (GDP as proxy), and exchange rate volatility were statistically significant. The foreign income variable had a positive and statistically significant effect on Kenya's tea exports. The study findings suggest that there is a positive relationship between foreign income and Kenya tea exports. The study therefore concludes that an increase in foreign income results in an increase in Kenyan tea exports. This means that Kenya should target countries with high GDPs and/or economic expansion in order to gain more from its black tea exports. Though FAO predictions indicate that in the near future Kenya is likely to continue being the largest exporter of black tea in world market, policy measures should be put in place to enhance its competitiveness in the world market.

In line with Serenis and Tsounis (2014) and Demirhan and Demirhan (2015), the study found a positive relationship between exchange rate volatility and exports. This is contrary to studies that point to a negative relationship between exports and exchange rate volatility such as Sun et al. (2002). Though the study found that exchange rate volatility had a positive and a statistically significant effect on the export demand function of Kenya's tea exports both in the long and short run, the effect was felt more in the short run than in the long run. The significance of exchange rate risk variable suggests that it has significant positive long run effect on real exports of Kenya's black tea. Based on the results, the study concluded that exchange rate volatility aids Kenya's tea exports in the long run. This implies that exchange rate variability is not a serious problem for the Kenyan tea sector. However, it would be vital for policy makers to take into account the existence and degree of exchange rate volatility and predict the likely impact of exchange rate volatility for each tea importing country when implementing policies for Kenya's black tea export demand.

Price volatility was significant in the short run. The study concluded that there is a positive and significant relationship between Kenyan tea exports and price volatility in the short run. Policy makers should be able to forecast the likely impact of price volatility on each tea importing country while pursuing policies to improve demand for Kenyan tea in the world market.

The speed of convergence coefficient was found to be highly significant with the expected negative sign further confirming a stable long run relationship. Thus, the study concludes that Kenyan tea exports adjust towards long run equilibrium path after a shock. This implies that strategies that can help tea exporters cope in the short run should be put in place since in the long run Kenyan tea exports revert to long run equilibrium.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Akiyama T, Baffes J, Larson DF, Varangis P (2003). Common commodity reform in Africa: Some recent experience. World Bank Research Working Paper No. 2995.

Amikuzuno J (2009). Spatial price transmission and market integration in agricultural markets after liberalization in Ghana: Evidence from

fresh tomato markets. Unpublished PhD Thesis, Georg-August University Goettingen, Germany.
Ankamah-Yeboah I (2012). Spatial price transmission in the regional maize markets in Ghana. MPRA Paper No. 49720.
Apergis N, Rezetis A (2011). Food price volatility and macroeconomic factors: Evidence from GARCH and GARCH-X estimates. J. Agric. Appl. Econ. 43(1):95-110.
Arize AC, Osang T, Slottje JD (2000). Exchange rate volatility and foreign trade: Evidence from Thirteen LDCs. J. Bus. Econ. Stat. 18:10-17.
Byerlee D, Jayne T, Myers R (2006). Managing food price risks and instability in a liberalizing market environment: Overview and policy options. Food Policy 31:275-287.
Clark PB (1973). Uncertainty, exchange risk, and the level of international trade. Western Econ. J. 6:302-313.
Cote A (1994). Exchange rate volatility and trade. Bank of Canada Working Paper Number 94.
De Grauwe P (1988). Exchange rate variability and the slowdown in growth of international trade. ZMF Staff Paper 35:63-84.
Dehn J, Gilbert CL, Varangis P (2004). Commodity price variability, in B. Pinto ed., Volatility and its consequences for crises and growth: A Handbook For Practitioners, Washington DC, World Bank.
Engle RF, Granger CWJ (1987). Co-integration and error correction: Representation estimation and testing. Econometrica 55:251-276.
FAO (2014). Contribution of tea production and exports to food security, rural development and smallholder welfare in selected producing countries. Committee on commodity problems. Food and Agriculture Organization of the United Nations, Rome, Italy.
Franke G (1991). Exchange rate volatility and international trading strategy. J. Int. Money Fin. 10:292-307.
Friedman M (1953). The case for flexible exchange rates. In Essays in Positive Economics, Chicago: University of Chicago Press. pp. 157-203.
Gardner BL, Gardner BD (1977). Discussion on Firch, Baker and Lins. Am. J. Agric. Econ. 59(1):185-191.
Goldstein M, Khan MS (1985). Income and price effects in foreign trade. In R.W. Jones and P.B. Kenen (Eds). Handbook Int. Econ. 2:1041-1105.
Hausman JA (1978). Specification tests on econometrics. Econometrica 46:6.
Hooper P, Kohlhagen S (1978). The effect of exchange rate uncertainty on the prices and volume of international trade. J. Int. Econ. 8:483-511.
Im KS, Pesaran MH, Shin Y (1995). Testing for unit roots in heterogeneous panels. Working Paper, Department of Applied Economics, University of Cambridge.
Islam SM, Kazi M, Sohag K (2014). CO_2 emission and agricultural productivity in South East Asian region: A pooled mean estimation approach. January to June 2014. Sci. J. COMSATS- Sc. Vis. 20:1.
Ivanic M, Martin W (2008). Implications of higher global food prices for poverty in low income countries. World Bank Policy Research Working Paper No. 4594. Washington, DC: World Bank.
Johnson H (1969). The case of flexible exchange rates. Federal Reserve Bank St. Louis Mon. Rev. 51(6):12-24.
Kiptui M (2007). Does the exchange rate matter for Kenya's exports? A bounds testing approach. Prepared for presentation at the African Econometric Society Conference, Cape Town, July 4-2007.
Kiptui M (2008). Does exchange rate volatility harm imports? Evidence from Kenya's tea and horticultural exports. Prepared for presentation at the CSAE Conference at Oxford University, 16-18 March 2008.
Mofya-Mukuka R, Abdulai A (2013). Effects of policy reforms on price transmission in coffee markets: Evidence from Zambia and Tanzania. Indaba Agricultural Policy Research Institute (IAPRI) Working Paper 79.
Organization for Economic Co-operation Development (OECD) (2009). Managing risk in agriculture: A holistic approach. Paris, OECD.
Pesaran MH, Shin Y (1995). An autoregressive distributed lag modelling approach to cointegration analysis. DAE Working Paper No. 9514, Department of Applied Economics, University of Cambridge.
Pesaran MH, Shin Y, Smith RJ (1999). Bounds testing approaches to the analysis of long run relationships. Cambridge Working Papers in Economics, 9907, Faculty of Economics, University of Cambridge.
Samargandi N, Fidrmuc J, Ghosh S (2013). Financial development and economic growth in an oil-rich economy: The case of Saudi Arabia. Working Paper Number 13-12, Department of Economics and Finance, Brunel University, London.
Sercu P, Vanhulle C (1992). Exchange rate volatility, international trade, and the value of exporting firms. J. Bank. Fin. 16:155-182.
Sun C, Kim M, Koo W, Cho G, Jin H (2002). The effect of exchange rate volatility on wheat trade worldwide. Agribus. Appl. Econ. Report No. 488.
UNCTAD (2008). Commodity price hikes and instability. Chapter 2, Trade and Development Report. UNCTAD.
Westerlund J (2007). Testing for error correction in panel data. Oxford Bull. Econ. Stat. 69(6):709-748.
White H, Levy J (2001). Economic reforms and economic performance: Evidence from 20 developing countries. Eur. J. Econ. Res. 2(13):120-143.
Yuan Y, Awokuse TO (2006). Exchange rate volatility and US poultry exports: Evidence from panel data. Agribusiness: Int. J. 22:233-245
Zheng Y, Kinnucan HW, Thompson H (2008). News and volatility of food prices. Appl. Econ. 40:1629-1635.

academicJournals

Vol. 10(3), pp. 79-86, March 2018
DOI: 10.5897/JDAE2016.0747
Article Number: 4EDDAD755993
ISSN 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Full Length Research Paper

Senior academic background, R&D intensity and productivity: Based on the data of listed companies in the agricultural sector

Shu Yehong and He Yucheng*

School of Economics and Management, Huazhong Agriculture University, Wuhan 400370, China.

Received 15 June, 2016; Accepted 15 November, 2016

Agricultural companies (2011-2013) were chosen as the samples of this study. Financial report data were used to analyze the disciplines of the executives, their strength mean, research and development (R&D) strength and productivity. The results of the empirical research showed that companies with technology executives will significantly have increased R&D intensity; but companies with management executives would have reduced R&D intensity; while both executives would have increased R&D intensity. Hiring management executives would have significant impact, but technical executives have no significant impact. Agricultural companies' R&D intensity and corporate productivity have a significant negative correlation, because R&D transformation takes longer time. It is believed that reasonable arrangements of senior management structure, a modest increase in business R&D intensity, vertical integration strategy for improving productivity and competitiveness of core formation are necessary.

Key words: Knowledge-based executives, agricultural companies, R&D intensity, productivity.

INTRODUCTION

With the current agricultural development faced by small enterprises, the extensive mode of development, aging workforce, poor organization, poor health service system and other outstanding issues, the state made it clear at the policy level to build intensive, professional, organizational, and social operating system to speed up China's agricultural modernization process. Throughout the process of agricultural modernization in Europe, America and other developed countries in the last centuries, the effective supply of agricultural enterprises has made farmers to increase employment; the construction of modern agriculture plays an important role. The Ministry of Agriculture shows that as at the end of 2012, our agricultural enterprises were nearly 110,000, with annual sales income of more than 5.7 trillion yuan; agricultural products provided the total market supply; 1/3 cities supply more than two thirds of agricultural exports, accounting for over 80% of total exports. Presumably, within "five-second", the total number of enterprises will reach 150,000, their sales will reach hundreds of billions; there will be an annual output value of over $10 billion, which would lead to clusters of enterprises.

*Corresponding author. E-mail: 1789236634@qq.com.

Scientific and technological innovation is a breakthrough resource, but environmental constraints will hinder sustainable and stable development of agricultural base support. The development of leading enterprises is inseparable from scientific research and innovation in agricultural science and technology innovation capacity. The Ministry of Agriculture supports the promotion of agricultural science and technology enterprises to develop innovative ideas; it clearly supports the hosting of enterprises, commitment to agricultural science and technology projects, the establishment of a high level of research and development (R&D) institutions, the establishment of science and technology, promotion of scientific and technological talents, rational allocation of resources, etc. A number of guiding opinions help to improve the capability of independent innovation of agricultural enterprises, agricultural science and technology to solve the problem of out touch with production and management. As modern production factor is the most important human capital (particularly senior management), it is bound to become the decisive force to accelerate the construction of modern agriculture, starting by ensuring national food security, effective supply of agricultural products and other important long-term roles. However, China's leading academics on agricultural research and development investment and different disciplines of executives lag behind in this area. Most of the R&D investment and productivity research are still limited to advanced manufacturing, computer software industries, research on agricultural research and development investment, and the transformation rate is very limited. From the overall small-scale agricultural enterprises, their R&D investment cannot truly improve their productivity. This is an important reason for the lack of R&D investment, which leads directly to lack of research. But in the stock exchange generally, the industries are leading, mainly in large-scale production, corporate governance structure, appropriate R&D investment, high scientific and technological achievements conversion rate. China's capital markets are maturing in the background; the securities regulatory agency responsible for disclosing the information of the listed companies have stringent financial report for corporate human capital, R&D investment, and productivity, and the reliability of the data obtained is greatly improved. In January 1, 2013 the companies provided guidelines for information disclosure content and format. This paper studies the disciplines of the senior management listed in agricultural sector, R&D intensity of internal relations to provide business productivity between micro-data at the industry level.

LITERATURE REVIEW

Faced with an increasingly competitive external environment, improving total factor productivity has been the subject of managers, shareholders and other stakeholders. Foreign scholars doing a large number of empirical studies have shown that the continuous enhancement of R&D investment (total R&D) and R&D intensity (R&D and total revenue ratio) can significantly increase productivity (Hall and Mairesse, 1995; Jefferson et al., 2006). However, domestic scholars' conclusion about the relationship between independent R&D investment, productivity and intensity in literature is controversial. Some scholars believe that independent research and development, technology transfer, foreign investment in R&D are total factor productivities, which have a significant role in promoting and improving business performances (Wu, 2008; Feng and Chen, 2013). Further study found that it is only when the R&D intensity is moderate, that is when a range of business productivity can have the greatest role in promoting the intensity; if it is too high or low it will offset this mechanism (Maode et al., 2013). But another part of the researchers found that, at this stage of internal R&D, increasing productivity has a significant negative effect; it will not only fail to encourage enterprises to improve competitiveness, but will reduce productivity (Li, 2010). In the agricultural enterprises there is a significant positive correlation between more R&D investment and the risk of bankruptcy (Huangjie et al., 2014).

Existing research suggests that employees enhancing human capital can significantly enhance the absorption of existing technologies and applications. This results in the motivation to create new technologies that increase investment in research and development to produce the direct cause (Raffaello and Paolo, 2009; Xia, 2010). As a business decision-making and senior management personnel (including directors, supervisors and other senior executives), their behavioral characteristics influence the company's future growth and development. Educated executives at the industry level encouraging technological innovation (Subrahmanya, 2005), and formal and technical knowledge for grasping of technological innovation achievements conversion rates are positively correlated (Marvel and Lumpkin, 2007); thus human capital is the driving innovation and transformation determinant (Winne and Sels, 2010). Chinese scholars use incentives given to executives to expand research. The question is, 'is short-term or long-term equity incentive compensation positively correlated with R&D investment, and do state-owned and high-tech enterprises have more significant impact (Wang and Chai, 2012; Yu and Wang, 2014). The researchers also found that technical executives involved in R&D investment have a significant positive effect, but R&D investment due to the technical background of executives has certain inhibition (Yu and Wang, 2014).

This work empirically demonstrates a significant impact of business R&D intensity or total factor productivity, but this work uses a large sample of data in all sectors; it focuses on industrial manufacturing, information

technology services, traditional animal husbandry and fishery. There were no traditional agriculture and its related upstream and downstream industries (including agricultural and sideline products processing, food and beverage manufacturing, etc.) as research subjects in the literature on agriculture sector, which is clearly inconsistent with the connotation and extension of modern agricultural enterprises. The current literature in the study of individual executives states the impact of R&D investment. Failure to function in all types of executives is classified, but executives of the different functions of class technology, management and other R&D investment are clearly different. In the existing literature, modern agro-industries' micro data used to study the characteristics of different professional executives of R&D investment, and the impact of R&D intensity on the enterprises' total factor productivity can be used for further expansion.

STUDY DESIGN

Data sources

Animal husbandry and fishery sample of enterprises listed in Shanghai and Shenzhen main board, agro-food processing industry, food industry, alcoholic beverages and refined tea manufacturing limited to R&D investment are disclosed in the Commission after the promulgation of "Annual Report Guidelines" (revised 2012), taking into account the report of current year. But, the information available may be that of previous year. So this study selects the time zone of 2011-2013. These enterprises' annual financial report was downloaded from the Shanghai and Shenzhen Stock Exchange official website, and chose to disclose the amount of R&D investment; it accounted for the operating income ratio, the formation of 244 3-year panel data as samples and data sources of 2011, 37; 2012, 100; and 2013, 137.

The model specification and variable selection

The empirical analysis consists of three parts: one, examining the relationship between knowledge-based executives and corporate R&D investment; two, measuring the production efficiency, and three, studying the impact of the manipulated variable R&D investment and productivity relations.

Relationship between knowledge-based executives and corporate R&D investment

This paper investigates the impact of knowledge-based executives on R&D strength. Usually companies will employ technical, management, legal and other three professors with doctoral degrees or titles as senior management. This article does not consider the legal executives as having impact on R&D intensity. Depending on the technology employed, management executives are divided into four categories: two categories are only in the management class; the other two are both in technical and managerial class, so as to establish a model for the academic disciplines of research and development executives:

$$R\&D = \beta_0 + \beta_1 TE + \beta_2 ME + \beta_3 BE + \Phi\delta \quad (1)$$

R&D is the ratio of R&D investment and business current revenue. TE, ME, and BE, respectively are technology class, management class, and both technical and managerial class and business executives are the dummy variables; the variable reference is neither technology class, management class, nor business executives. β1, β2, and β3 are the corresponding variable parameter estimates. Φ is the control variable, δ is the vector of parameter estimates. Note that, it is only when the value of the confidence interval is not 0, that is when the parameter estimates would have meaning.

As shown earlier, the executives' education experience and their mastery of technology will make them request for additional R&D investment, so technology is expected to help improve the executives' R&D investment. According to smiling curve theory, value-added business activities take place in more R&D and marketing of these two links; while the lowest increases in the manufacture of intermediate links. When companies only involve in the daily management of production and business class executives, the paper industry is expected to increase the payment chain end marketing, research and development which will reduce the strength of the enterprise. When the technology and management executives participate in the production and operating activities, it would have impact on the intensity of R&D investment.

In order to accurately estimate the impact of R&D, the executives' disciplines strength must also control other factors that may affect R&D strength. According to the relevant theory and literature search, this article selected control variables including economic disparities, firm size, debt ratio, ownership concentration, and regions.

(1) Enterprise scale: Expansion of business scale enables one to face the broader market, therefore, is expected to positively affect R&D intensity scale enterprises. Herein, the size of the enterprises' total assets is based on the value of the natural logarithm.
(2) Asset-liability ratio: Ratio of total liabilities to total corporate assets is the asset-liability ratio; this paper argues that only companies in the debt ratio will increase the low level of R&D investment, so there is expected negative impact of corporate assets and liabilities on the R&D strength.
(3) Ownership concentration: When most equity firms are sometimes occupied by minority shareholders, the company's future operations are likely to be under minority shareholder control. If the R&D strength under minority shareholders is uncertain, the proposed model under the largest shareholder will be more than 50% of the reference variable, making the holding ratio less than or equal to 50% dummies.
(4) Regional economic disparities: The status of unbalanced regional economic development projections in the eastern part of the total economy is significantly stronger than that of the northeast, central and western regions. In this paper, corporates were registered in the eastern provinces or municipalities as a reference variable, while those registered in other parts were set as dummies.

Production efficiency calculation model

On the second phase, it is assumed that each sample has its own stochastic frontier production function, using data envelopment analysis (DEA) to estimate the productivity of all samples; while inputs and outputs are clearly defined.

In other industries, there are not only main inputs of capital and labor but also modern agribusiness production factor. The special nature of the agricultural production of raw materials, seeds, fertilizers, pesticides and others occupies a higher proportion of the factors of production if all the refinement of indicators could lead to multicollinearity problems, in order to reflect as accurately as possible the enterprises' input elements. This paper selected indicators of capital investment, labor, and other inputs. Among them, capital investment and net fixed assets in the financial

Table 1. Main variables descriptive statistics.

Variable	Minimum	Maximum	Average	Standard deviation
Company size	10.03	15.53	12.4366	0.97710
Asset-liability ratio	0.0298	0.8213	0.368078	0.1872155
Concentration of ownership	0.00	1.00	0.2377	0.42655
Regional economic differences	0.00	1.00	0.5000	0.50103
Industry Attributes	0.00	1.00	0.7377	0.44079
Per capita assets	-0.63	9.94	4.7140	1.40659
Nature of shares	1.00	3.00	0.5451	0.71580
Operating income	82003499.07	7.32E10	4.6952E9	9.59019E9
Net fixed assets	20440444.48	1.04E10	1.1988E9	1.90215E9
Employees	136.00	76957.00	6234.5164	13381.92594
Operating costs	38807307.09	6.93E10	3.2792E9	7.77764E9
Management fees	10922651.55	2.83E9	2.5079E8	4.57346E8

statements should be reflected; accurate labor inputs should be measured. Considering it is difficult to obtain, at the end of the year the company's financial report discloses registered number of employees, other inputs with main business income, total amount of administrative expenses of the enterprise and output indicators for the year's total income (million). Some scholars identified the output indicators of total income, and other scholars believe that net profit is more appropriate, taking into account factors that affect operating income. Income taxes are not considered in this paper; output indicators are recognized as gross revenue.

R&D investment and productivity in relation to adjusting the variables introduced

R&D investment and R&D funding affect business productivity, but the magnitude and direction of influence is not uniform. The relationship between the two may be affected by the operating conditions of internal and external business environment; so to explore the precise relationship between them, one must consider the impact of other variables, and these factors are used to adjust variables in the model. From the results of previous studies, this paper selected the following as adjustment variables: firm size, industry, property, capital per worker, and the nature of shares.

(1) Enterprise scale: Expansion of the scale will always lead to "economies of scale" effect. When the agricultural industry has a strong competitive impact on firm size, R&D investment and productivity will not be inverted U-shape. Therefore, this article shows the relationship between firm size and productivity of R&D is positive; the value is firm size Total assets (million) based on the value of natural logarithm.
(2) Industry attributes: Agriculture, forestry, animal husbandry and fishery enterprises are primary products producers, while manufacturing firms are primary processors of products; the downstream industry chain enterprises need stronger R&D. Therefore, animal husbandry and fishery enterprises are assigned 0 in the model, while manufacturing enterprises are 1 in the entry model.
(3) Capital per worker: When each worker has a modest capital, there would be a positive relationship between per capita capital investment and R&D productivity; otherwise, it will be counter-regulatory relationship. The value of capital per period, its total assets (million) and the ratio of the number of employees registered are natural logarithm.
(4) Nature of shares: Expected shares of the different nature of the regulation of companies' R&D investment and productivity are different. This article analyzes the largest shareholders of state-owned property, shares of natural persons, and mixed shares assigned 2, 3 in the entry model.

Descriptive statistics and correlation test

The dependent variables used in the empirical study were descriptive statistics, as shown in Table 1.

In Table 1, from China's listed companies in the agricultural industry, their average asset-liability ratio is not high, indicating that most of the companies' capital structure is more reasonable. Their property industry average was 0.74. This indicates that the mean of most of the companies listed in the agricultural industry chain downstream is 2.55. This shows that majority of the equity of the enterprise is not owned by the state; a large gap between the number of employees shows there is a big difference between the size of the companies. In addition, Pearson's correlation test was used to calculate the control variable, manipulated variable; the absolute value of the correlation coefficient for the amount of output variables within each group was less than 0.5. This indicates there was no serious multicollinearity between variables.

EMPIRICAL RESULTS AND DISCUSSION

Relations executives' disciplines and R&D intensity

This work uses Stata13.0 fitting software development and business executives' disciplines model, and the model of the firm size, debt ratio, ownership concentration, regional differences as control variables in the model. The result is shown in Table 2.

Overall, only technology executives can significantly promote the increase in R&D intensity, while the role of the management executives showed that more companies had reduced R&D intensity. When business executives in both of these groups have positive effect greater than the negative effects of technology executives, management executives will have increased R&D strength. In addition, the results of the control variables in the model estimation, asset-liability ratio,

Table 2. Model estimation results of R&D and executive discipline background.

Variable	Coefficient	Standard error	t value	Significance level
Constant term	4.448	3.117	1.427	0.155
TE	1.988	0.962	2.067	0.040**
ME	-0.572	0.781	-0.732	0.465
BE	0.362	0.779	0.464	0.643
Company size	-0.135	0.261	-0.518	0.605
Assets and liabilities	-3.169	1.330	-2.384	0.018**
Equity	-0.704	0.577	-1.221	0.223
Regional economic disparities	0.792	0.483	1.638	0.103
Observations			244	
R^2			0.102	
Adjusted R^2			0.075	
Durbin-Watson			2.091	

Table 3. Different types of enterprises productivity descriptive statistics.

Type of business enterprise	Productivity numbers	Mean	Standard deviation	Standard error	Minimum	Maximum
I	31	0.5733	0.1954	0.0351	0.27	1.00
II	29	0.5514	0.1475	0.0274	0.348	0.891
III	97	0.6400	0.1986	0.0201	0.238	1.00
IV	87	0.6543	0.1811	0.0194	0.262	1.00
Total	244	0.6261	0.1892	0.0121	0.238	1.00

Table 4. Different types of business productivity homogeneity of variance test.

Levene Statistic	df1	df2	Significant
1.689	3	240	0.170

regional differences in line with theoretical expectations show that the lower the debt ratio, the greater the economic activity in the more developed regions. The scale of business results does not meet the expectations theory; the larger the enterprise the smaller would be the R&D intensity. Results of ownership concentration of R&D intensity show negative effect.

Calculation of production efficiency and productivity of enterprises of different types of variance test

The first stage of the Stata command of DEA analysis estimates the productivity of each sample; then for different types of enterprises' productivity analysis of variance was used to compare the mean equality. Table 3 shows the different types of enterprises' productivity descriptive statistics; Tables 4 and 5 show the productivity homogeneity of variance test results and the results of multiple comparisons. Class I did not represent neither the technology nor the management executives, class II represents only technology executives, class III represents only the management executives, and class IV represents both classes.

In Table 3, the vast majority of knowledge-based companies are hiring senior management personnel, in line with the overall trend of modern business development. Management executives employ modern business more than technology-based business executives, indicating agricultural enterprises pay more attention to marketing. In addition, the maximum value of enterprises' productivity is 1.00 and the minimum value is 0.238, indicating that there is a big difference in the management efficiency of enterprises.

Table 4 shows the homogeneity of variance test results (a significant value 0.170>0.05), indicating that the data set has four homogeneous variance; therefore, they are omitted from the results in Table 5 based on the

Table 5. Different types of business productivity for multiple comparisons.

Type of business	Type of business	Standard error	Mean difference	Significant	95% Confidence interval	
					Upper	Limit
I	II	0.0218	0.0482	0.651	-0.0731	0.1168
	III	-0.0667	0.0385	0.085	-0.1425	0.0091
	IV	-0.0809	0.0390	0.039**	-0.1579	-0.0040
II	I	-0.0218	0.0482	0.651	-0.1168	0.0731
	III	-0.0885	0.0395	0.026**	-0.1664	-0.0107
	IV	-0.1028	0.0400	0.011**	-0.1817	-0.0239
III	I	0.0667	0.0385	0.085	-0.0091	0.1425
	II	0.0885	0.0395	0.026**	0.0107	0.1664
	IV	-0.0142	0.0275	0.605	-0.0685	0.0400
IV	I	0.0809	0.0390	0.039**	0.0040	0.1579
	II	0.1028	0.0400	0.011**	0.0239	0.1817
	IV	0.0142	0.0275	0.605	-0.0400	0.0685

heterogeneity of variance multiple comparisons. Table 5 shows that there is 5% significance level of differences between constituency I and IV (0.039), II and III (0.026), II and IV (0.011), indicating that appointing senior management for enterprises' productivity impact is significant.

The role of moderator in R&D investment and productivity

This stage was added in R&D investment, firm size and productivity of the enterprises based on the research, industry, per capita assets, shares for manipulated variable nature using stata13.0 business productivity software to fit the model. The model summary was obtained and the best fit model coefficients are shown in Tables 6 and 7; wherein a variable represents the product of 2× industry R&D intensity, another variable represents the product of 3× per capita assets of R&D intensity, while another one represents the product of 4× R&D strength.

All the variables are shown using Durbin-Watson statistic of 1.737; therefore, the assumption that there is no serial correlation between the variables cannot be rejected. Estimates show that R&D investment and business productivity have a significant negative correlation, indicating agricultural enterprises' R&D investment in the current period was not successful; industry and corporate productivity have a significant positive correlation; if there is advancement in the downstream industry chain, business productivity will increase. The industry is the moderator and also significantly affects the development of the relationship between investment and enterprises' productivity. Finally, the per capita share of assets and properties as the moderator of the relationship between R&D and productivity is also in line with theoretical expectations; the higher the per capita amount of the assets, the higher the degree of privatization of its shares as a moderator.

CONCLUSION AND IMPLICATION

This work defines the connotation of agricultural listed companies based on the integration of modern agriculture, including animal husbandry and fishery analysis followed by four broad categories of three years' 244 samples of knowledgeable senior management incumbency, and the use of financial reporting data on the study executives, firm R&D intensity, impact of R&D intensity on the enterprise productivity. The following conclusions are given: There is (1) technology executives will significantly increase R&D intensity, management executives will reduce R&D intensity; when the two types of executives exist, the positive effect is greater than the negative effects; (2) there is a big difference between the current Chinese agricultural listed companies market efficiency; most knowledge-based executives were hired; hiring of management executives for business productivity is significantly positive, hiring technology executives is not statistically significant; (3) the agricultural industry companies and business R&D intensity productivity have a significant negative correlation, probably because research into productivity requires more than a year's cycle, but has not been reflected in this issue. At the same time as the moderator of the industry, per capita assets, and share properties can be adjusted in the relationship between the two.

Table 6. Summarizes the model.

Model	R	R^2	Adjusted R^2	estimate standard errors	Durbin-Watson
1	0.439[a]	0.193	0.186	0.1707	-
2	0.493[b]	0.243	0.233	0.1657	-
3	0.530[c]	0.281	0.268	0.1618	-
4	0.530[d]	0.281	0.266	0.1621	-
5	0.531[e]	0.282	0.264	0.1623	-
6	0.532[f]	0.283	0.261	0.1626	-
7	0.533[g]	0.285	0.260	0.1627	1.737

[a]Predictors: (Constant), scale, research and development. [b]Predictors: (Constant), the scale of development, industry. [c]Predictors: (Constant), the scale of development, industry, product 2. [d]Predictors: (Constant), the scale of development, industry, the product of 2 per capita assets. [e]Predictors: (Constant), the scale of development, industry, the product of 2 per capita assets, product 3. [f]Predictors: (Constant), the scale of development, industry, the product of 2 per capita assets, product 3, the nature of the shares. [g]Predictors: (Constant), the scale of development, industry, the product of 2 per capita assets, product 3, shares the nature of the product 4.

Table 7. Added to adjust the variable model R & D investment and productivity.

Variable	Coefficient	Standard error	t value	Significance level
Constant term	-0.359	0.206	-1.743	0.083
R & D intensity	-0.009	0.042	-0.211	0.833
Company size	0.074	0.013	5.576	0.000***
Property industry	0.166	0.032	5.135	0.000***
Product2	-0.035	0.012	-2.909	0.004***
Per capita assets	0.007	0.011	0.612	0.541
Product3	-0.001	0.004	-0.310	0.757
Nature of shares	-0.020	0.024	-0.811	0.418
Product4	0.008	0.009	0.828	0.409

The following conclusions are given: First, there is reasonable arrangement of senior management structure, and technical or management executives are unevenly distributed; the executives' synergy can promote enterprise productivity. Secondly, there is a modest increase in business R&D intensity; increased R&D intensity is bound to improve productivity in the current or short-term effects due to the conversion period. This would not be immediately apparent. If the business current R&D intensity is too high, it may affect other aspects of normal business activities. Finally, to increase the implementation of the corporate strategy of vertical integration at the end of the industrial chain enterprises will have more operating profit than its front-end business; if companies can produce, process, market, import and export trade of agricultural products at reduced prices, it would help improve productivity and form core competitiveness.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENT

Supported by Project of National Natural Science Foundation (71573098 & 71173085); Social Science Foundation for The Excellent Youths of Huazhong Agricultural University; the Fundamental Research Funds for the Central Universities (Program No.52902-0900202876).

REFERENCES

Feng Z, Chen W (2013). Source technology innovation and R & D total factor productivity growth. Sci. Manage. Empir. Res. Chin. Reg. LMEs. 03:33-41.

Hall BH, Mairesse J (1995). Exploring the relationship between R & D and productivity in French manufacturing firms. J. Economet. 65(1):263-293.

Huangjie Li, Tang Pei, Jiang Zhanhua (2014). Tax incentives under the agricultural R & D investment, risk and return. Empir. Stud. Based Chin. Agric. Listed Comp. Agric. Econ. 02:120-128.

Jefferson GH, Bai HM, Guan XJ, Yu XY (2006). R & D performance in Chinese industry. Econ. Innov. New Technol. 15(4):345-366.

Li B (2010). Hampering the development of domestic TFP. J. Sci. Res. 07:1035-1042, 1059. http://www.cqvip.com/qk/93202x/201007/34576412.html

Maode F, Li J, Peng F, Luo ZQ (2013). R & D investment and enterprise

TFP - Based on PSM and GPS testing. J. Fin. Econ. 04:134-144.
Marvel M, Lumpkin G (2007). Technology Entrepreneurs' Human Capital and Its Effects on Innovation Radicalness. Entrep. Theory Pract. 31:6.
Raffaello B, Paolo P (2009). Determinants of Long-run Regional Productivity with Geographical Spillovers: The Role of R & D, Human Capital and Public Infrastructure. Reg. Sci. Urban Econ. 39(2):187-199.
Subrahmanya MHB (2005). Technological innovations in Indian small enterprises: dimensions, intensity and implications. Int. J. Technol. Manage. 30(1-2):188-204.
Wang Y, Chai XK (2012). Research R & D investment, Executive Ownership and Firm Performance - Empirical Evidence from the private high-tech listed companies. J. Zhongnan Univ. Graduate 05:113-119.
Winne DS, Sels L (2010). Interrelationships between Human Capital, HRM and Innovation in Belgian Start-ups Aiming at an Innovation Strategy. Int. J. Hum. Resour. Manage. 9:21.
Wu YB (2008). Independent research and development, technology transfer and Productivity - Empirical Research on Chinese industrial areas. Econ. Res. 08:51-64.
Xia L (2010). Division how human capital and R & D Total Factor Productivity - Empirical Analysis Based on China's large and medium industrial enterprises. Number Tech. Econ. 04:78-94. (http://www.cqvip.com/qk/89856x/2012005/90786790504849504853485055.html)
Yu SL, Wang Y (2014). Vine executives technical background and research and development investment Correlation. Econ. Manage. Res. 05:14-22.

academicJournals

Vol. 10(3), pp. 87-98, March 2018
DOI: 10.5897/JDAE2017.0877
Article Number: A46A80C55996
ISSN 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Full Length Research Paper

Does gender matter in effective management of plant disease epidemics? Insights from a survey among rural banana farming households in Uganda

Enoch Mutebi Kikulwe[1*], Stanslus Okurut[2], Susan Ajambo[1], Eisabetta Gotor[3], Reuben Tendo Ssali[3], Jerome Kubiriba[4] and Eldad Karamura[1]

[1]Bioversity International/ CGIAR Research Program on Roots, Tubers and Bananas (RTB), P. O. Box 24384, Kampala, Uganda.
[2]Department of Agribusiness and natural Resource Economics, Makerere University, P. O. BOX 7062, Kampala, Uganda.
[3]Bioversity International/CGIAR Research Program on Roots, Tubers, and Bananas, Via dei Tre Denari, 472/a 00054 Maccarese, Rome, Italy.
[4]National Agricultural Research Laboratories of the National Agricultural Research Organization (NARO), P. O. Box 7065, Kampala, Uganda.

Received 15 September, 2017; Accepted 30 November, 2017

Crop diseases significantly suppress plant yields and in extreme cases wipe out entire crop species threatening food security and eroding rural livelihoods. It is therefore critical to estimate the extent to which shocks like disease epidemics can affect food availability and the capacity of smallholder farmers to mitigate and reverse the effects of such shocks. This study utilizes sex-disaggregated data from 341 households in Uganda to analyze: first, gender and access to agricultural resources and their control; second, whether men and women in the targeted banana-farming communities share similar perceptions toward the effectiveness of the banana Xanthomonas wilt (BXW) control technologies and their respective information dissemination pathways; third, whether gender and farmer perceptions influence on farm adoption of BXW management practices. Lastly, it determines the impact of adoption of BXW control practices on food security. Results show that whereas most household assets are jointly owned, men have more individual ownership, control, and decision-making on income from household assets than women. Perceptions on effectiveness of BXW control practices and communication channels also differed between men and women. Men rated cutting down of infected plants to be more effective than women, but tissue culture, removal of male buds and disinfecting of farm tools were perceived to be equally effective by both men and women. In addition, apart from newspapers which were more effective in delivering BXW information to men, we found no differences in the effectiveness of other BXW information sources. More importantly, the study finds both gender and farmer perceptions on BXW control to significantly affect adoption of BXW control practices and household food security. For better and sustainable management of plant epidemics in Uganda, it is therefore critical that existing gender-based and underlying perception constraints are addressed.

Key words: Gender-based constraints, food security, perceptions, technology adoption, Xanthomonas wilt.

INTRODUCTION

Crop pests and diseases are some of the major causes of global food production losses. Actual losses are

estimated between 10 and 35.6% of total crop production (Oeke and Dehne, 2004; Strange and Scott, 2005; Bentley et al., 2009). In Africa, for example, the arrival and spread of banana Xanthomonas wilt (BXW) and the recent outbreak of the fall army worm (Spodoptera frugiperda) have caused significant yield losses, and in some instances have wiped out entire plantations, eroding livelihoods and rendering regions and countries' food insecure (Karamura et al., 1998; Chakraborty and Newton, 2011; FAO, 2017). Reducing these losses therefore offers a first line of defense against food and nutrition insecurity, especially in sub Saharan Africa where crop production systems are highly vulnerable to pests and diseases.

Banana is the main staple crop in Uganda; it is an important source of income and provides 17% of the daily caloric needs in the country (Fiedler et al., 2013). However, crop production has been greatly constrained by the outbreak and spread of BXW caused by Xanthomonas campestris pv. Musacearum since 2001 when the disease was first reported in the country (Tushemereirwe et al., 2000). Unlike other diseases that establish gradually, BXW establishes and spreads rapidly over a large area in a short time, killing plants and causing considerable yield and production losses. Currently, all banana cultivars in Uganda are susceptible to BXW (Tripathi and Tripathi, 2009; Blomme et al., 2017). Crop losses from BXW are very high. Literature estimates potential losses in Uganda at 17% (Kalyebara et al., 2006), 52% (Karamura et al., 2010), 65% (Mwangi and Nakato, 2009), and 71.4% (Ainembabazi et al., 2015).

The only disease management strategy for crop protection against BXW in Uganda is the use of one or a combination of cultural BXW control practices. Cultural practices including; removal of the male buds, destruction and disposal of infected plants, disinfecting tools used in the plantation and use of clean planting materials have been identified and promoted as a good first step for preventing BXW related crop losses (Ssekiwoko et al., 2006; Karamura et al., 2008; Mwangi and Nakato, 2009), and have been found to completely prevent the spread of BXW if implemented correctly (Karamura et al., 2008). On-farm adoption of these practices however remains low (Bagamba et al., 2006; Kagezi et al., 2006; Tinzaara et al., 2013).

Bagamba et al. (2006) reports that adoption rates of cultural BXW control practices is low even in areas where households are fully aware of their benefits. It is therefore instructive to understand the reasons for this low adoption. In this paper, we substantiate that gender and perceptions are among the main factors that greatly constrain the adoption of cultural BXW control practices in Ugandan. Surprisingly, this has not been studied before.

An earlier study by Jogo et al. (2013) evaluated the factors that affect farm level adoption of cultural practices for BXW control in Uganda. The study however, only examined inter-household socio-economic factors affecting adoption of BXW control practices. The study did not investigate how intra-household factors, like gender and perceptions influence adoption of BXW control practices. To address this gap, the current study examines how gender-and perceptions affect management of BXW in Uganda. We also further examine if control of BXW has an effect on household food security.

Gender effects on agricultural productivity and technology adoption has been extensively studied (Udry, 1995; Lubwama, 1999; Doss and Morris, 2000; Doss, 2001; Peterman et al., 2011; Ragasa, 2012; Ndiritu et al., 2012; Croppenstedt et al., 2013; Kilic et al., 2013; Mukasa and Salami, 2015; Murage et al., 2015; Ali et al., 2016; Mudege et al., 2017).

Gender has also been explored in emerging frontiers like climate change adaptation (Mehar et al., 2016). However, how gender affects management of plant epidemics like BXW has not been studied. In addition, most existing gender studies use sex of the household head or sex of the respondent to define gender. Okali (2011) and Peterman et al. (2011) argue that this is methodologically flawed as it oversimplifies the diversity of crop farming systems in Africa where men and women within the same household cultivate and own crops either independently or jointly. In addition, such analysis reinforces cultural constructs of gender roles as opposed to actual roles. To overcome this challenge, the current study only examined male headed households (referred to as dual households) and stratified sample observations by sex of the farmer other than sex of household head. On the other hand, evidence on how perceptions affect agricultural technology adoption is mixed. Adesina and Baidu-Forson (1995), Adrian et al. (2005) and Joshi and Pandey (2005) found perceptions to positively influence technology adoption.

Conversely, Murage et al. (2015) found perceptions to have no significant effect on technology adoption. Information on farmers' perceptions has been found to be important in shaping technology dissemination efforts and enhancing technology adoption. Meijer et al. (2014) argue that whereas most adoption studies tend to emphasize the role of extrinsic factors like the characteristics of the adopter, intrinsic factors like knowledge, perceptions and attitudes of a potential

*Corresponding author. E-mail: e.kikulwe@cgiar.org.

adopter towards the technology have been given less attention yet they greatly influence technology adoption decisions. In the current study, we estimate how farmer preferences affect adoption of BXW control practices. We hypothesize that male and female farmers have heterogeneous preferences towards BXW control practices and these preferences in turn affect their likelihood of adopting of the practices.

METHODOLOGY

Data and data collection

Using a multi stage sampling procedure following Torres (1960), FAO (1989) and Gallego (2015), data for this study was collected from 321 randomly selected respondents in 18 banana-growing districts in eastern, central and western Uganda using face-to-face interviews and structured questionnaires between November and December 2015.

First, 18 districts were purposively selected based on banana production to obtain a geographically representative sample for the banana growing population in Uganda. Within each district, the two biggest banana-producing sub Counties were purposively selected. At Sub County, one parish was randomly selected, and in each of the selected parishes, one village or community was randomly selected.

Thereafter, approximately 18 banana farmers were randomly selected per village to participate in the study from a listing of banana farmers provided by local community leaders. The study collected information on access, control and ownership of resources; perceptions on effectiveness of BXW control practices and their information dissemination pathways; adoption and use of BXW control practices and household socioeconomic characteristics.

Field observations were used to validate the data collected. Although data was collected from 321 households (including both male-and female-headed households), only 227 observations were used in analyzing perceptions on access, control and ownership of household resources, effectiveness of BXW practices and for determining factors affecting adoption of BXW control practices. This is, only 227 households were male-headed, and the current study uses male-headed (dual) households to examine intra-household gender dynamics, perceptions and management of BXW.

For each male-headed household, one respondent (either a male or a female farmer) was interviewed. However, in the regression of determinants on food security, all the 321 observations were included. This is because the information used in constructing the household food insecurity access scale (HFIAS), a dependent variable in the regression was for the entire household and was not disaggregated by gender.

Data analysis

Data were analyzed by a combination of descriptive statistics (with t-tests and chi-square tests) and nonlinear econometric methods in STATA version 14 (StataCorp, 2015). T tests and chi-square tests were used to analyze how perceptions on access to resources, effectiveness of BXW control methods and effectiveness of BXW information channels differs between men and women within the same household. However, because farmers can simultaneously and sequentially adopt more than one practice, we used a multivariate Probit model as used by Mittal and Mehar (2015) to determine the factors that influence adoption of the four BXW control practices (that is, cutting down of infected plants, removal of male buds, disinfecting of farm tools and use of tissue culture).

Cappellari and Jenkins (2003) argue that where farmers simultaneously adopt more than one technology, estimation of independent technologies ignores the trade-offs and complementarity across the different technologies and may lead to biased estimates. As such, they suggest the use of a multivariate Probit model using simulated maximum likelihood. The multivariate probit model is used in circumstances where technologies are interdependent and might be adopted simultaneously or sequentially. The theoretical multivariate probit model is specified in equation (1) below:

$$Y_{im}^{*} = \beta_m' X_{im} + \varepsilon_{im} \quad (1)$$

Where;

Y_{im}^{*} = a vector of latent dependent variables
Y_{im} = a vector of observed dependent variables (the four BXW control practices in our case)
X_{im} = a vector of explanatory variables
β_m' = coefficients of the explanatory variables
m = 1, 2, 3, m
Y_{im} = 1 if $Y_{im}^{*} > 0$ and 0 if otherwise (0 = non-adoption, 1 = adoption)
ε_{im}, m = 1, …, M are error terms distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix V, where V has values of 1 on the leading diagonal and correlations $\rho_{kj} = \rho_{jk}$ as off-diagonal elements.

Positive correlation between practices indicates synergies while negative correlation indicates trade-offs (Kassie et al., 2009). We hypothesize that since extrinsic and intrinsic factors enhance adoption of BXW control, they have a resultant effect on food security. As such, this study extrapolates and explores the effects of relationship between the factors that affect technology adoption and food security at household level using a Tobit model as suggested by Tobin (1958). The standard Tobit model is shown in Equation 2 below:

$$y_i^{*} = \beta X_i + \varepsilon_i$$
$$y_i = y_i^{*} \quad \text{if } y_i > 0$$
$$y_i = 0 \quad \text{if } y_i \leq 0 \quad (2)$$

where:
y_i^{*} is the latent dependent variable, y_i is the observed dependent variable, X_i is a vector of the independent variables, β is the vector of coefficients, and the ε_i is assumed to be independently normally distributed: $\varepsilon_i \sim N(0, \sigma^2)$ (and therefore $y_i \sim N(\beta X_i, \sigma^2)$). The observed 0s on the dependent variable could mean either "true" 0 or censored data. For the model to fit, some of the observations must be censored, or y_i would always equal y_i^{*} and the true model would then be a linear regression not a Tobit.

Dependent and independent variables used in econometric analysis

In the multivariate probit (MVP) model, the outcome variables of interest were the farmer adoption decisions for each of the four cultural BXW control practices (that is, cutting down of infected plants, disinfecting of farm tools, use of tissue culture and removal of male buds). For all the four practices, adoption was estimated as binary decision where a farmer could either adopt (this was coded as 1) or not adopt a practice (this was coded 0).

To estimate the effect of BXW control on food security, the outcome variable in the Tobit model was the household food insecurity access scale (HFIAS) index following Coates et al. (2007) and Castell et al. (2015) that is, whether the condition in the

Table 1. Explanatory variables used in the regression models.

Variable	Type	Model	Mean	S.D
Household size	C	Both	6.850	2.866
Sex of the household head (0 = Male, 1=Female)	D	F	0.270	-
Responding farmer (0 = Husband, 1=Wife)	D	A	0.304	-
Age of Household Head	C	F	49.380	18.312
At least secondary education (0 = No, 1 =Yes)	D	Both	0.441	-
Banana Acreage (acres)	C	Both	1.170	1.487
BXW Trainings (0 = No, 1 =Yes)	D	Both	0.358	-
Annual expenditure on farm inputs (USD)	C	Both	85.763	162.903
Production objective (0= commercial, 1 = Subsistence)	D	Both	0.361	-
Resorts to purchasing Banana (0 = No, 1 =Yes)	D	Both	0.379	-
Efficiency of cutting down infected plants (0=No, 1 = Yes)	D	Both	0.449	-
Efficiency of removal of male buds (0=No, 1 = Yes)	D	Both	0.291	-
Efficiency of disinfecting tools (0=No, 1 = Yes)	D	Both	0.291	-
Efficiency of tissue culture (0=No, 1 = Yes)	D	Both	0.163	-

Type refers to type of variable used: D = dummy variables and C = continuous variables; Model refers to the model in which the variable was used; F = Food security; A = Adoption of BXW control practices.

question happened at all in the past four weeks (yes or no). If the respondent answers "yes" to an occurrence question, a frequency of occurrence question is asked to determine whether the condition happened rarely (once or twice), this is coded as 1, sometimes (three to ten times), this is coded as 2 or often (more than ten times), this is coded as 3 in the last four weeks. This is done for all the nine food security-related questions. To generate the HFIAS, all codes for each of the nine frequencies of occurrence questions were summed. However, before summing the frequency of occurrence codes, all frequency of occurrence codes where the answer to the corresponding occurrence question was "no" (that is, if Q1=0 then Q1a=0, if Q2=0 then Q2a =0, etc.) were recoded as 0. From this, the maximum HFIAS score possible is 27 for an extremely food insecure household and the minimum score possible is 0 for an extremely food secure household.

The explanatory variables used in the two regression models and their means are shown in Table 1, and their *apriori* expectations are discussed herein. Kasirye (2009) and Jogo et al. (2013) found household size to have a significant positive effect on agricultural technology adoption, while Kidane et al. (2005), Mannaf and Uddin (2012), Negash and Alemu, (2013), and Ndobo and Sekhampu (2013) found household size to have a negative effect on household food security. Evidence also suggests that men are more likely to adopt technologies than women (Morris and Doss, 1999; Doss and Morris, 2001; Uaiene, 2011; Tanellari et al., 2013; Hailu et al., 2014; Murage et al., 2015).

Female headed households are more likely to be food insecure than male headed households (Musemwa et al., 2013; Zakari et al., 2014). However, Silvestri et al. (2016) found gender to have no significant explanatory power on food security. Age of the household head was found to have a negative effect of food security in Bangladesh (Mannaf and Uddin, 2012) compared to South Africa where age had a positive effect (Ndobo and Sekhampu, 2013). Elsewhere, in Ethiopia, age was found to have no significant effect on food security (Negash and Alemu, 2013).

Morris and Doss (1999), Hojo (2002) and Uaiene (2011) found education and training to be positively correlated with technology adoption, while Tanellari et al. (2013) found education to negatively affect uptake of improved groundnut technologies in Uganda. Access to education and training has been reported to enhance food security (Kidane et al., 2005; Musemwa et al., 2013). Farm size has also been found to either influence technology adoption positively (Morris and Doss, 1999; Murage et al., 2015) or negatively (Ogada et al., 2014). The reported effects of farm size on food security are however positive (Kidane et al., 2005; Husseinl and Janekarnkij, 2013; Negash and Alemu, 2013).

Another factor that has been identified to have a positive effect on technology adoption in literature is access to extension advise (Morris and Doss, 1999; Uaiene, 2011; Tanellari et al., 2013; Hailu et al., 2014), which also positively affects food security (Husseinl and Janekarnkij, 2013; Negash and Alemu, 2013). Whereas a recent study by Murage et al. (2015) found perceptions on technology effectiveness to have no effect on adoption of climate smart push and pull technology in East Africa, a number of earlier studies found a positive relationship between perceptions and technology adoption (Adesina and Baidu-Forson, 1995; Adrian et al., 2005; Joshi and Pandey, 2005). We also explore how the production objective and the relative importance of banana in the household diet (proxied by the household resorting to the buying of bananas after their plots are affected by BXW) affect the control of BXW and food security.

RESULTS AND DISCUSSION

Gender differences in ownership, control and decision making on household assets

Overall, apart from land, which is mostly owned by men, we found out that men and women within the household jointly own most household assets. However, results show that men have more individual ownership of household assets than women. Women own between 4.00 and 30.54% of household assets individually, while men own between 37.57 and 46.00% of the assets. The study findings are similar to other studies (Deere and Doss, 2009; Doss et al., 2013; Johnson et al., 2016),

Table 2. Differences in ownership, control and decision making on household assets by men and women.

Variable	Land	Cereals	Bananas	Roots and tubers	Cash crops	Cattle	Sheep/goats	Poultry
Ownership – Who makes claims on the asset? (%)								
Women	30.45	10.16	8.67	7.51	4.43	4.00	7.14	16.67
Men	40.45	41.71	40.31	37.57	43.67	46.00	40.18	40.48
Joint	29.09	48.13	51.02	54.91	51.9	50.00	52.68	42.86
Gender gap	10.00	31.55	31.64	30.06	39.24	42.00	33.04	23.81
Control – Decision to purchase/use or sell asset (%)								
Woman	4.52	8.47	8.63	8.72	5.06	4.00	7.96	11.81
Man	44.34	36.51	34.01	30.81	35.44	34.00	25.66	29.13
Joint	51.13	55.03	57.36	60.47	59.49	62.00	66.37	59.06
Gender gap	39.82	28.04	25.38	22.09	30.38	30.00	17.70	17.32
Decision on use of income from asset (%)								
Woman	5.00	8.47	9.18	7.60	6.92	4.00	7.96	13.60
Man	40.45	34.92	34.69	30.99	33.33	34.00	27.43	28.80
Joint	54.55	56.61	56.12	61.40	59.75	62.00	64.60	57.60
Gender gap	35.45	26.45	25.51	23.39	26.38	30.00	19.47	15.20

which also found men to have more individual ownership of household assets. The gender asset gap (difference between men and women individual asset ownership) was highest in cattle (42.00%) and lowest in land (10.00%). The land gender gap is partly because culturally land belongs mostly to men and the tendency of men to own most of the high value productive assets within the households. The study findings are consistent with Deere et al. (2010) who found a large gender gap in asset ownership in Nicaragua. Similarly, a large gender gap is observed in the control of assets and the decisions on the use of income from household assets (Table 2). Asset ownership was stratified by farmer sex in the study. Results show significant perception differences between men and women concerning ownership of roots and tubers, cash crops, cattle and sheep/goats. For example, women consider themselves individual owners of 14% roots and tubers. Men, on the other hand, consider women to own 4% of roots and tubers individually. It is apparent that women either over report their ownership of these crops or that men under report women ownership. Similarly, for cattle, men under report women ownership and inflate their ownership. On the other hand, women deflate men's ownership of cattle and inflate their ownership. It is therefore evident that whereas both women and men agree that most household assets are owned either jointly or by men, there exists no consensus on the exact proportions of these assets owned by men and women individually. The study results are similar to that of Twyman et al. (2015) who found gendered intrahousehold perception differences in asset ownership and agricultural decision making in Ecuador.

Furthermore, similar perception differences are observed in the control of assets and the decisions on the use of income from household assets (Table 3)

Gender issues and adoption of BXW control practices

The current study also investigated the effects of gender on the adoption of BXW control practices. Overall, adoption was higher in men owned plots than women owned plots. Specifically, adoption of tissue culture was significantly higher in men owned than women owned plots. This maybe because men have more access to physical and financial resources and as such they can afford to buy tissue culture bananas, which are relatively expensive. This is in line with earlier studies that found men to be more likely to adopt agricultural technologies (Morris and Doss, 1999; Doss and Morris, 2001; Uaiene, 2011; Tanellari et al., 2013; Hailu et al., 2014; Murage et al., 2015). On the other hand, we found that actual implementation of BXW control practices is mostly done by women even on men owned plots (Table 4). This maybe because women are more involved in the day-to-day management of banana plantations.

Effectiveness of BXW control practices

Overall, both men and women ranked cutting down of infected plants as the most effective BXW control practice (45%) followed by removal of male buds and disinfection

Table 3. Differences in ownership, control and decision-making on household assets as reported by men and women.

Variable	Ownership		Control		Decision on income	
	Men	Women	Men	Women	Men	Women
Land						
Female	32.24	26.47	2.61	8.82	3.29	8.82
Male	37.50	47.06	47.71	36.76	43.42	33.82
Both	30.26	26.47	49.67	54.41	53.29	57.35
N	152	68	153	68	152	68
Chi2	1.80 (0.404)		5.49 (0.064)		4.09 (0.129)	
Cereals						
Female	7.14	16.39	4.76	15.87	5.56	14.29
Male	43.65	37.70	38.89	31.75	36.51	31.75
Both	49.21	45.90	56.35	52.38	57.94	53.97
N	126	61	126	63	126	63
Chi2	3.90 (0.142)		6.83 (0.033)		4.17 (0.124)	
Bananas						
Female	6.02	14.29	4.51	17.19	4.55	18.75
Male	43.61	33.33	37.59	26.56	38.64	26.56
Both	50.38	52.38	57.89	56.25	56.82	54.69
N	133	63	133	64	132	64
Chi2	4.25 (0.104)		9.61 (0.008)		11.31 (0.03)1	
Roots and tubers						
Female	4.27	14.29	4.35	17.54	4.35	14.29
Male	40.17	32.14	33.04	26.32	33.04	26.79
Both	55.56	53.75	62.61	56.14	62.61	58.93
N	117	56	115	57	115	56
Chi2	5.72 (0.057)		8.43 (0.015)		5.45 (0.066)	
Cash crops						
Female	1.85	10.00	1.87	11.76	4.63	11.76
Male	45.37	40.00	40.19	25.49	37.04	25.49
Both	52.78	50.00	57.94	62.75	58.33	62.75
N	108	50	107	51	108	51
Chi2	5.39 (0.067)		8.91 (0.012)		4.04 (0.132)	
Cattle						
Female	1.54	8.57	1.54	8.57	1.54	8.57
Male	49.23	40.00	38.46	25.71	36.92	28.57
Both	49.23	51.43	60.00	65.71	61.54	62.86
N	65	35	65	35	3.28	0.193
Chi2	3.25 (0.196)		4.02 (0.134)		3.28 (0.193)	
Sheep/Goats						
Female	2.63	16.67	3.90	16.67	6.49	11.11
Male	40.79	38.89	28.57	19.44	28.57	25.00
Both	56.58	44.44	67.53	63.89	64.94	63.89
N	77	36	77	36	77	36
Chi2	7.94 (0.047)		5.86 (0.053)		0.77 (0.679)	

Table 3. Contd.

Poultry						
Female	12.79	25.00	5.81	24.39	8.24	25.00
Male	41.86	37.50	33.72	19.51	32.94	20.00
Both	45.35	37.50	60.47	56.10	58.82	55.00
N	88	40	87	41	86	40
Chi2	3.91 (0.271)		10.64 (0.014)		7.77 (0.051)	

Note: Values in parentheses are p-values.

Table 4. Gender issues and BXW control.

Variable	**Land ownership**				**Action taker**			
Control strategy	**Men**	**Women**	**Both**	**Sig**	**Men**	**Women**	**Both**	**Sig**
Cutting down infected plants	41.06 (62)	30.46(46)	28.48(43)	-	30.46 (46)	42.38 (64)	27.15 (41)	***
Removing of male buds	40.00(46)	28.70(33)	31.30(36)	-	31.30 (36)	39.13 (45)	29.57 (34)	-
Disinfecting tools	35.42 (34)	31.25(30)	33.33 (32)	-	30.21 (29)	38.54 (37)	31.25 (30)	-
Tissue culture	42.86(18)	33.33(14)	23.81 (10)	*	28.57 (12)	42.86 (18)	28.57 (12)	-

Note: Numbers in parentheses represent the number of respondents. *** And * are significant differences at 1% and 10% levels, respectively. - denotes not significantly different at less than 10% level.

Table 5. Gendered differences on the effectiveness of BXW control practices (n=227).

BXW control practice	**Pooled (%)**	**Men (%)**	**Women (%)**	**Chi^2**
Cutting down of infected plants	44.93	50.63	31.88	6.82***
Removing of male Buds	29.07	29.11	28.99	0.00
Disinfecting tools	31.65	23.19	29.07	1.67
Use of tissue culture	16.03	17.09	14.49	0.24

Note: *** denotes significant differences at 1% level.

of tools (29%), use of tissue culture had the least rank (16%). The study findings are similar with Blomme et al. (2014) and Blomme et al. (2017) who reported that removal of infected plants (referred to single diseased stem removal) in a systematic manner is more effective at reducing BXW incidences, but should be expended together with the use of clean garden tools and male bud removal. Apart from cutting infected plants which men ranked to be more effective, farmer self-reported effectiveness of other BXW control practices did not differ between men and women as shown in Table 5. Table 6 shows differences in self-reported effectiveness of BXW control practices stratified by farmer socioeconomic characteristics. Results show that farmer sex (male=1), access to BXW trainings, farm income (proxied by expenditure on farm inputs), farm commercialization and banana importance in family diets (proxied by farmers resorting to buying of bananas during disease incidence) to be positively correlated with the effectiveness of BXW control strategies. Training enhance better application of practices and make them more effective. Similarly, commercial farmers and men may have more resources (labor and money) to effectively implement BXW control. In addition, farmers whose livelihoods depend mostly on bananas may attach more resources (time and money) to BXW control for increased resilience because they have less diversified livelihood options.

Effectiveness of BXW information channels

Understanding and pursuing the most efficient communication pathway is very important in increasing farmer access to relevant BXW control information, and can enhance adoption of BXW control. The current study investigated the effectiveness of the various sources of information on BXW. Overall, results show that both men and women reported radio as the most effective source of BXW information. Furthermore, extension agents, famer groups and non-governmental organizations were the

Table 6. Effectiveness of BXW control practices by farmer socio economic characteristics (n=227).

Variable	Cutting infected plants		Removal of male buds		Disinfecting tools		Use of tissue culture	
	Effective	Other reasons	Effective	Other reasons	Effective	Other reasons	Effective	Other reasons
Household size	7.17	6.59	7.06	6.76	6.98	6.80	7.08	6.81
Responding farmer (1=Wife)	0.22	0.38***	0.30	0.30	0.24	0.33	0.27	0.31
Secondary education	0.46	0.42	0.50	0.42	0.47	0.43	0.35	0.46
Banana acreage	1.25	1.11	1.33	1.10	1.28	1.13	1.38	1.13
BXW trainings	0.51	0.23***	0.56	0.28***	0.59	0.26***	0.57	0.32***
Expenditure on farm inputs	126.11	52.84***	127.45	68.67**	142.22	62.62***	151.92	72.88***
Subsistence-oriented farmer	0.30	0.41	0.24	0.41**	0.27	0.40*	0.11	0.41***
Resorts to purchasing banana	0.45	0.32**	0.41	0.37	0.41	0.37	0.38	0.38

Note: ***, **, * denote significant differences at 1, 5, and 10% levels, respectively.

second, third and fourth most effective information channels, respectively. Televisions and newspapers on the other hand are the least effective sources of information. The study findings are similar to Bagamba et al. (2006) which found radio to be the main source of information on BXW in Uganda. The effectiveness of radio may be because most households have access to a radio, and the fact that there is a variety of radio stations in the country with agricultural-related programs broadcasting in a variety of local languages. Therefore, this makes it easy for farmers in rural communities to access BXW information. Conversely, the penetration level of newspapers in rural farming communities is low and very few households own televisions. This may explain the ineffectiveness of these information channels. In this study, we also examined how the effectiveness of the information channels differs between men and women. Results show a significant difference in the effectiveness of newspapers between men and women (15.57% for men vs. 5.56% for women). This is presumably because men have more access to and control over resources and can afford to buy newspapers. It could also be that men are more educated (Table 7).

Factors that influence adoption of cultural BXW control practices

The multivariate regression model we used in this study analysis was significant at 1% with a Wald chi square value of 167.33 and a log likelihood value of -286.59. This means the study model significantly explains the factors that affect farmer control of BXW. From results in Table 8, the coefficients of explanatory variables and their significance levels vary across the four different practices. Similarly, the likelihood ratio test of correlation amongst the equations in the model was significant. This justifies our choice of MVP regression. Study results unexpectedly found household size to have a negative effect on adoption of the use of tissue culture. This is contrary to findings by Jogo et al. (2013) and Kasirye (2009). This could be because tissue culture is more capital intensive than labor-intensive technology. Large families tend to have less disposable income, and may thus find it difficult to purchase tissue culture plants. On the other hand, men were more likely to cut infected plants. This is similar to earlier findings that suggest men are more likely to adopt agricultural technologies (Morris and Doss, 1999; Doss and Morris, 2001; Uaiene, 2011; Tanellari et al., 2013; Hailu et al., 2014; Murage et al., 2015). Higher technology adoption by men could be because men have more ownership, control and decision making on bananas. It is therefore important that affirmative women empowerment efforts be adopted to enhance their adoption of BXW control practices. However, results show that actual cutting down infected plants is done mostly by women even on male owned plots (Table 4), it is also essential that men are targeted and challenged to participate more in field implementation of BXW control practices. Furthermore, results showed that farmers who had accessed trainings were more likely to adopt all the four BXW control practices. This finding corroborates earlier studies (Morris and Doss, 1999; Uaiene, 2011; Tanellari et al., 2013; Hailu et al., 2014). This is because training equips

Table 7. Effectiveness of BXW information sources (%).

Information channel	Pooled	Men	Women	Significance
Radio	79.28 (176)	81.88 (113)	75.00 (63)	-
Newspaper	11.86 (23)	15.57 (19)	5.56 (4)	**
Mobile phone	7.25 (14)	5.13 (6)	10.53 (8)	-
Television	5.15 (10)	5.88 (7)	4.00 (3)	-
Posters	11.70 (22)	11.50 (13)	12.0 (9)	-
Farmers/Social groups	28.14 (56)	28.00 (35)	28.38 (21)	-
Extension agents	37.75 (77)	36.22 (46)	40.26 (31)	-
Seed Stockists	10.77 (21)	10.83 (13)	10.67 (8)	-
NGOs	24.76 (51)	26.92 (35)	21.05 (16)	-

Note: Numbers in parentheses represent the number of respondents. ** denotes significant differences at 5% level. - denotes not significantly different at less than 10% level.

Table 8. Factors influencing adoption of BXW control measures using a multivariate regression.

Independent variables	Cutting infected plants	Removal of male buds	Disinfecting tools	Use of tissue culture
Household size	-0.042 (0.036)	0.000 (0.032)	-0.005 (0.040)	-0.116** (0.052)
Responding farmer (0 = Husband, 1=Wife)	-0.333* (0.199)	0.034 (0.198)	-0.220 (0.237)	0.113 (0.242)
At least secondary education (0 = No, 1 =Yes)	0.263 (0.187)	-0.105 (0.195)	0.404* (0.225)	0.182 (0.255)
Banana acreage	0.051 (0.062)	-0.040(0.079)	0.093 (0.075)	0.050 (0.080)
BXW Trainings (0 = No, 1 =Yes)	0.453** (0.201)	0.817***(0.191)	0.903*** (0.226)	0.297 (0.253)
Annual Expenditure on farm inputs (USD)	0.001 (0.001)	0.002***(0.001)	0.001 (0.001)	0.000 (0.001)
Production objective (0=commercial,1= Subsistence)	-0.110 (0.200)	-0.145(0.190)	-0.026 (0.242)	0.034 (0.249)
Resorts to purchasing banana (0 = No, 1 =Yes)	0.727*** (0.189)	0.420**(0.182)	0.181 (0.226)	0.782*** (0.235)
Efficiency of practice (0=No, 1 = Yes)	0.605*** (0.179)	0.827***(0.174)	1.712*** (0.223)	1.648*** (0.257)
Constant	-0.685** (0.293)	-1.247***(0.298)	-1.921*** (0.379)	-1.388*** (0.383)

Number of observations =226
Wald chi2 (36) = 167.33
Log likelihood = -286.593
Prob > chi2 = 0.0000
Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2(6) = 166.825 Prob > chi2 = 0.0000
Notes: Values in parentheses are standard errors, ***, **, and * denote significant at 1, 5 and 10% levels , respectively.

farmers with the necessary technical skills needed to implement the practices. In addition, annual expenditure on farm inputs (a proxy for wealth) is positively associated with removal of male buds (de-budding), suggesting that wealthier farmers are more likely to control BXW in their fields by removing male buds (the main source of infection by insects). Results also show access to extension advice to have a positive effect on disinfecting of tools. Similar to access to BXW trainings, this could be extension access equips farmers with the necessary technical skills needed to implement the practices and enables farmers to appreciate its net benefits. Farmers who coped to the outbreak of BXW by purchasing bananas were more likely to adopt removal of male buds, disinfecting of farm tools and use of tissue culture. Resorting to purchasing bananas is an indicator that bananas make a significant contribution to daily food requirements of a household. For such households controlling BXW is very essential for their livelihoods; this may explain why resorting to purchasing bananas influences the adoption of BXW control practices. Findings also show that perceptions on effectiveness of practices have a positive effect on adoption of all the BXW control practices. This finding is similar to earlier studies (Adesina and Baidu-Forson, 1995; Joshi and Pandey, 2005; Adrian, 2005) which also find perceptions to have a significant effect on adoption of agricultural technologies. This is because farmers usually adopt technologies if they anticipate the technologies to have positive benefits.

Food security and adoption of BXW control practices

The study results show that farmers that perceive removal of male bud and disinfecting of farm tools to be beneficial to be more food secure (Table 9). This maybe because as seen in Table 8 and hypothesized in section 2, farmers who perceive technologies to be beneficial are more likely to adopt BXW control practices which ensures

Table 9. Determinants of food insecurity among banana growing households using a Tobit regression.

Variable	Coefficients	Standard errors
Efficiency of cutting down infected plants	1.302	1.219
Efficiency of de-budding	-2.353*	1.356
Efficiency of disinfecting farm tools	-2.669*	1.372
Efficiency of tissue culture	2.005	1.601
Household size	0.177	0.173
Sex of household head	3.327*	1.252
Age of household head	-0.038	0.030
Secondary education	-2.581**	1.134
Banana acreage	-0.434	0.357
Received training	0.770	1.074
Annual expenditure on farm inputs (USD)	-0.005	0.004
Production objective (0= commercial, 1 = Subsistence)	3.797***	1.023
Resorts to purchasing Banana (0 = No, 1 =Yes)	1.090	0.986
Constant	2.983	2.162

Observations = 335
LR chi2(13) = 46.50
Prob > chi2 = 0.0000
Log likelihood = -804.86951
134 left-censored observations, 201 uncensored observations
***, **, and * significant at 1%, 5% and 10% levels of significance.

more household food production resulting into more food security. Farmers with at least secondary education were also found to be more food secure. This is in line with findings by Kidane et al. (2005) and Musemwa et al. (2013) who also found education to have a positive effect on food security. This may also be because farmers with at least secondary education adopt BXW control practices more than those who do not attain that level of education or it may be because such farmers have more access to off-farm income. Similar to findings by Musemwa et al. (2013) and Zakari et al. (2014), the study results also show female-headed and subsistence households to be less food secure. This maybe because female-headed and subsistence farmers have limited resource endowments to enable them cope with shocks like BXW outbreaks or it may be because these households are less likely to adopt BXW control practices that can help reduce crop-related production losses with direct effects on food production and food availability.

Conclusion

The study found gender and farmer perceptions to have a significant effect on adoption of BXW control practices. Women are less likely to adopt BXW control practices compared to men. Similarly, farmers who perceive BXW practices to be beneficial are more likely to adopt them. Women may be less likely to adopt because they have limited access, ownership and decision-making powers on household resources. Farmer perceptions reflect farmer-anticipated benefits from technology adoption. The more the anticipated benefits the more likely farmers are to control BXW, which in turn ensures increased food production and food security. These findings suggest that addressing gender-based constraints and improving farmer perceptions are critical and essential for scaling up and scaling out BXW control and management. It is important then that women empowerment (through increase in ownership/access, use and decision making on key household assets) is an inherent component of all BXW management efforts and programs. In addition, technologies should be more affordable and accessible to women, and gendered preferences should be considered in technology design. Conversely, BXW communication and training programs should inherently address farmer biases on BXW technologies and explicitly document and disseminate the economic, production, social and resilience benefits of technology adoption.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

The research was supported by the CGIAR Research Program (CRP) Roots Tubers and Bananas (RTB). We thank all the project partners and enumerators who participated in the execution of this work.

REFERENCES

Adesina AA, Baidu-Forson J (1995). Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. Agric. Econ. 13(1):1-9.

Adrian AM, Norwood SH, Mask PL (2005). Producers' perceptions and attitudes toward precision agriculture technologies. Comput. Electr. Agric. 48(3):256-271.

Ainembabazi JH, Tripathi L, Rusike J, Abdoulaye T (2015). Ex-Ante Economic Impact Assessment of Genetically Modified Banana Resistant to Xanthomonas Wilt in the Great Lakes Region of Africa. PLoS ONE 10(9):e0138998.

Ali D, Bowen D, Deininger K, Duponchel M, Bank TW (2016). Investigating the Gender Gap in Agricultural Productivity : Evidence from Uganda. World Dev. 87:152-170.

Bagamba F, Kikulwe E, Tushemereirwe WK, Ngambaki D, Muhangi J, Kagezi CH, Ragama PE, Eden-Green S (2006). Awareness of Banana Bacterial Wilt in Uganda. Afr. Crop Sci. J. 14(2):157-164.

Blomme G, Dita M, Jacobsen KS, Vicente LP, Molina A, Ocimati W, Poussier S, Grant M (2017). Bacterial Diseases of Bananas and Enset: Current State of Knowledge and Integrated Approaches Toward Sustainable Management. Front Plant Sci. 8:1-25.

Blomme G, Jacobsen K, Ocimati W, Beed F, Ntamwira J, Sivirihauma C, Ssekiwoko F, Nakato V, Kubiriba J, Tripathi L, Tinzaara W, Mbolela F, Lutete L, Karamura E (2014). Fine-tuning banana Xanthomonas wilt control options over the past decade in East and Central Africa. Eur. J. Plant Pathol. 139(2):271-287.

Cappellari L, Jenkins SP (2003). Multivariate probit regression using simulated maximum likelihood. Stata J. 3:278-294.

Chakraborty S, Newton AC (2011). Climate change, plant diseases and food security: an overview. Plant Pathol. 60(1):2-14.

Coates J, Swindale A, Bilinsky P (2007). Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide. Food and Nutrition Technical Assistance Project, Academy for Educational Development, (August). Version 3. http://www.fao.org/fileadmin/user_upload/eufao-fsi4dm/doc-training/hfias.pdf

Croppenstedt A, Goldstein M, Rosas N (2013). Gender and Agriculture: Inefficiencies, Inefficiencies, Segregation, and Low Productivity Traps. World Bank Res. Observ. 28(1):79-109.

Deere CD, Doss CR (2009). Gender and the Distribution of Wealth in Developing Countries. Personal assets from a global perspective. P 1. https://doi.org/10.1093/acprof:oso/9780199548880.003.0017

Deere CD, Gina A, Twyman J (2010). Poverty , Headship , and Gender Inequality in Asset Ownership in Latin America tecnologías y a los activos productivos y financieros (No. 296). Gender, Development, and Globalization Program.

Doss CR (2001). Designing Agricultural Technology for African Women Farmers : Lessons from 25 Years of Experience. World Dev. 29(12):2075-2092.

Doss CR, Kovarik C, Peterman A, Quisumbing AR, van den Bold M (2013). Gender Inequalities in Ownership and Control of Land in Africa: Myths Versus Reality. IFPRI Discussion Paper 01308. https://doi.org/10.2139/ssrn.2373241

Doss CR, Morris ML (2001). How does gender affect the adoption of agricultural innovations?: The case of improved maize technology in Ghana. Agric. Econ. (United Kingdom) 25(1):27-39.

FAO (1989). Sampling Methods for agricultural Surveys (FAO Statistical Development Series No. 3). Rome: Food and Agriculture Organization of the United Nations.

FAO (2017). FAO advisory note on the fall army worm (FAW) in Africa. http://www.fao.org/3/a-bs914e.pdf

Gallego J (2015). Area Sampling Frames for Agricultural and Environmental Statistics. EUR 27595 EN, doi:10.2788/88253 http://publications.jrc.ec.europa.eu/repository/bitstream/JRC98806/lb-na-27595-en-n.pdf

Hailu BK, Abrha BK, Weldegiorgis KA (2014). Adoption and impact of agricultural technologies on farm income : Evidence from southern tigray, Northern Ethiopia. Int. J. Food Agric. Econ. 2(4):91-106.

Hojo M (2002). Farmer Education and Technology Adoption: The Choice of Education Measures. Paper Presented at the Fall Meeting of the Japan Economic Association at Hiroshima University on 13–14 October 2002, (October 2002).

Hussein W, Janekarnkij P (2013). Determinants of Rural Housbhold Food Security in Jigiiga District of Ethiopia. Kasetsart J. Soc. Sci. 34:171-180.

Jogo W, Karamura E, Tinzaara W, Kubiriba J, Rietveld A (2013). Determinants of Farm-Level Adoption of Cultural Practices for Banana Xanthomonas Wilt Control in Uganda. J. Agric. Sci. 5(7):70-81.

Johnson NL, Kovarik C, Meinzen-Dick R, Njuki J, Quisumbing A (2016). Gender, Assets, and Agricultural Development: Lessons from Eight Projects. World Dev. 83:295-311.

Joshi G, Pandey S (2005). Effects of farmers' perceptions on the adoption of modern rice varieties in Nepal. Conf. Int. Agric. Res. Dev. pp. 1-4.

Kagezi CH, Kangire A, Tushemereirwe WK, Bagamba F, Kikulwe EM, Muhangi J, Gold CS, Ragama P (2006). Banana Bacterial Wilt Incidence in Uganda. Afr. Crop Sci. J. 14(2):83-91.

Karamura E, Frison E, Karamura D, Sharrock S (1998). Banana Production Systems in Eastern and Southern Africa. In: Picq, C, Foure, E and Frison EA (eds.). Bananas and Food Security. International Symposium, Cameroon, 10-14 November 1998 pp. 401-412.

Karamura EB, Turyagyenda FL, Tinzaara W, Blomme G, Molina A, Markham R (2008). Xanthomonas Wilt of Bananas in East and Central Africa. Diagnostic and Management Guide. Bioversity International, Uganda. http://banana-networks.org/barnesa/files/2012/11/Diagnostic-and-Management-guide-to-BXW.pdf

Karamura E, Kayobyo G, Tushemereirwe W, Benin, S, Blomme, G, Green, SE, Markham R (2010). Assessing the impacts of banana bacterial wilt disease on banana (Musa spp.) productivity and livelihoods of Ugandan farm households. Acta Hort. 879:749–756.

Kasirye I (2009). Constraints to Agricultural Technology Adoption in Uganda: Evidence from the 2005/06-2009/10 Uganda National Panel Survey. Economic Policy Research Centre, Makerere University, Uganda pp. 90-107.

Kidane H, Alemu ZG, Kundhlande G (2005). Causes of household food insecurity in koredegaga peasant association, oromiya zone, Ethiopia. Agrekon 44(4):543-560.

Kilic T, Palacios-lopez A, Goldstein M (2013). Caught in a Productivity Trap A Distributional Perspective on Gender Differences in Malawian Agriculture. World Bank Policy Research Working Paper 6381.

Lubwama FB (1999). Socio-economic and gender issues affecting the adoption of conservation tillage practices. *In*: Kaumbutho P G and Simalenga T E (eds). Conservation Tillage with Animal Traction. A Resource Book of the Animal Traction Network for Eastern and Southern Africa (ATNESA) P. 173. https://pdfs.semanticscholar.org/27b8/6afc8c3669f5e4afa448bb376946714bea3b.pdf

Mannaf M, Uddin MT (2012). Socioeconomic factors influencing food security status of maize growing households in selected areas of bogra district. Bangladesh J. Agric. Econs. 2:177-187.

Mehar M, Mittal S, Prasad N (2016). Farmers coping strategies for climate shock: Is it differentiated by gender? J. Rural Stud. 44:123-131.

Meijer SS, Catacutan D, Ajayi OC, Sileshi GW, Nieuwenhuis M (2014). The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. Int. J. Agric. Sustain. 13(1):40-54.

Mittal S, Mehar M (2015). Socio-economic Factors Affecting Adoption of Modern Information and Communication Technology by Farmers in India: Analysis Using Multivariate Probit Model. J. Agric. Educ. Ext. 22(2):199-212.

Morris ML, Doss CR (1999). How does gender affect the adoption of agricultural innovations ? The case of improved maize technology in Ghana. Presented as a Selected Paper at the Annual Meeting, American Agricultural Economics Association (AAEA), Nashville, Tennessee, August 8-11, 1999 Copyright.

Mudege NN, Mdege N, Abidin PE, Bhatasara S (2017). The role of gender norms in access to agricultural training in Chikwawa and Phalombe, Malawi. Gender Place Culture 24(12):1689-1710.

Mukasa AN, Salami AO (2015). Gender productivity differentials among

smallholder farmers in Africa : A cross-country comparison. African Development Working Papers Series P 231.
Murage AW, Pittchar JO, Midega CAO, Onyango CO, Khan ZR (2015). Gender speci fi c perceptions and adoption of the climate-smart push e pull technology in eastern Africa. Crop Prot. 76:83-91.
Musemwa L, Zhou L, Ndhleve S, Aghdasi F (2013). Factors affecting household access to enough food in the Eastern Cape Province of South Africa. J. Dev. Agric. Econ. 5:84-91.
Mwangi M, Nakato V (2009). Key factors responsible for the xanthomonas wilt epidemic on banana in East and Central Africa. Acta Hortic. 828:395-404.
Ndiritu SW, Kassie M, Shiferaw B (2012). Adoption of Agricultural Technologies in Kenya: How Does Gender Matter? This version: October 2011. Paper Presented at the 28th International Conference of Agricultural Economists in The Global Bio-Economy Rafain Convection Centre - Foz Do Iguacu, Brazil between August 18 - 24, 2012, (October), 1–27.
Ndobo F, Sekhampu TJ (2013). Determinants of Vulnerability to Food Insecurity in a South African Township : A Gender Analysis. Mediterr. J. Soc. Sci. 4(14):311-318.
Negash T, Alemu S (2013). Determinants and Coping Strategies of Household Food Insecurity in Rural Areas of Tigray: The Case of Rural Adwa Woreda. Ethiop. J. Agric. Sci. 23:1-3.
Ogada MJ, Mwabu G, Muchai D (2014). Farm technology adoption in Kenya : A simultaneous estimation of inorganic fertilizer and improved maize variety adoption decisions. Agric. Food Econ. 2:12.
Ragasa C (2012). Gender and Institutional Dimensions of Agricultural Technology Adoption : A Review of Literature and Synthesis of 35 Case Studies. Selected Poster Prepared for Presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz Do Iguaçu, Brazil 18-24 August, 2012.
Castell SG, Rodrigo PC, la Cruz NJ, Bartrina AJ (2015). Household food insecurity access scale (HFIAS). Nutr. Hosp. 31(3):272-278.
Ssekiwoko F, Taligoola HK, Tushemereirwe WK (2006). Xanthomonas campestris pv musacearum Host Range in Uganda. Afr. Crop Sci. J. 14(2):111-120.
StataCorp (2015). Stata Statistical Software: Release 14. College Station, TX: StataCorp LP.
Tanellari E, Kostandini G, Bonabana J (2013). Gender Impacts on Adoption of New Technologies: Evidence from Uganda. Afr. J. Agric. Resour. Econ. 9(4):2-5. Retrieved from http://ageconsearch.umn.edu/bitstream/143204/2/Gender Impacts on Adoption of New Technologies.pdf
Tobin J (1958). Estimation of Relationships for Limited Dependent Variables James Tobin. Econometrica 26(1):24-36.
Torres B (1960). Development of multistage designs for statistical surveys in the Philippines. Digital Repository, Iowa State University. http://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=3623&context=rtd
Twyman J, Useche P, Deere CD (2015). Gendered Perceptions of Land Ownership and Agricultural Decision-making in Ecuador : Who Are the Farm Managers ? Land Econ. 91(3):479-500.
Uaiene R (2011). Determinants of Agricultural Technology Adoption in Mozambique. IPaper Presented at “Dialogue on Promoting Agricultural Growth in Mozambique” 21 July 2011 Hotel VIP, Maputo.
Udry C (1995). Gender differentials in farm productivity : Implications for household efficiency and agricultural policy, 20(5):407-423.
Zakari S, Ying L, Song B (2014). Factors Influencing Household Food Security in West Africa: The Case of Southern Niger. Sustainability 6:1191-1202.

academicJournals

Vol. 10(3), pp. 99-109, March 2018
DOI: 10.5897/JDAE2017.0888
Article Number: C94417C56185
ISSN 2006-9774

http://www.academicjournals.org/JDAE

Journal of Development and Agricultural Economics

Full Length Research Paper

Factors affecting market supply of honey in Chena district, Kaffa zone, Southern Ethiopia

Kassa Tarekegn[1*], Jema Haji[2] and Bosena Tegegne[2]

[1]Southern Agricultural Research Institute, Socio-Economics Research Division, P. O. Box 101, Bonga, Ethiopia.
[2]School of Agricultural Economics and Agribusiness, Haramaya University, P. O. Box 138, Dire Dawa, Ethiopia.

Received 8 October, 2017; Accepted 16 November, 2017

Despite high volume of honey production in Chena district of southern Ethiopia, the market supply of honey is low as compared to its potential due to some socioeconomic, demographic, production, market and institution related factors. This study was initiated to identify factors affecting volume of honey marketed. Data from 154 sample honey producers was collected and analyzed using multiple linear regression model with the aid of STAT version 13. The regression model result reveals that beekeeping experience, hive types used, number of beehives owned, number of extension contact and cooperative membership positively and significantly affected honey market supply while distance from nearest market significantly and negatively affected it. To enhance volume supplied with appropriate market outlet choices which in turn increase producers income generated from honey, all concerned bodies need to focus on promoting farmer-to-farmer knowledge sharing with experienced households, capacity building through training on improved honey production, increasing access to improved beehives, improving poor road facility, strengthening financial capacity of existing and establishment of additional beekeepers cooperatives.

Key words: Honey, market supply, multiple linear regression.

INTRODUCTION

Beekeeping is considered to be an income-generating activity that fits well with the concept of small-scale agricultural development in Ethiopia (MoA and ILRI, 2013). It is also eco-friendly and does not compete for scarce land resources, and provides off-farm employment and income generating opportunity (Workneh, 2011). To support rural economy, agricultural production system should be supported by other income generating activities such as beekeeping. So agriculture together with beekeeping activities could be operated side by side (Desalgne, 2011).

Southwestern part of Ethiopia has great potential for

*Corresponding author. E-mail: kassatar12@gmail.com.

beekeeping activities; due to the presence of dense natural forest with different species of flora and fauna which are used as pollen and nectar source for bees and suitable environmental conditions for bee colony and the production of honey (Yoshimasa, 2014). Kaffa zone is highly suitable for beekeeping and large volume of honey is produced annually in Southwest part of the country (Nuru, 2007). However, sparsely populated rural areas, and poor infrastructural facility are physical barriers to accessing markets; lack of negotiating skills, lack of collective organizations and lack of market information are impediments to market access (Kassa et al., 2017a).

Chena district is believed to have diversified types of vegetation and cultivated crops and expected to be one of the areas that have considerable potential for beekeeping activities and honey production in Kaffa zone (Awraris et al., 2012). However, honey production is very traditional which is practiced mainly by hanging traditional hives on tall trees in the dense forest far from human settlement areas. According to Kassa et al. (2017b) beekeepers produce honey using traditional methods and sell their honey products at the local market. Though the honey production is traditional, currently due to some interventions by government and non-government organizations, the beekeepers in the district are using improved beehives in some extent that boost volume of honey produced. As a result, the district becomes high honey producer in the zone (KZLFD, 2016).

Despite high honey production, the market supply of honey is low as compared to its potentiality due to some socioeconomic, demographic, production, market and institution related factors. According to Kassa (2017), honey producers in the study area faced marketing problem due to remoteness of some kebeles, low farm-gate prices and long market chain which results to low level of market participation.

A number of studies identified factors influencing volume of honey supplied to the market in Ethiopia. Past empirical studies by Assefa (2009), Getachew (2009), Betselot (2012) and Samuel (2014) attempted to identify factors affecting volume of honey supplied to market at household level in different part of Ethiopia. However, there were no comprehensive earlier studies which investigated the factors affecting volume of honey supplied in Kaffa zone of Southren Ethiopia where there is large number of beekeepers. Most of the research on apiculture on southwestern part has largely focused on biophysical aspects such as yield enhancement, production practices and bee disease like that of Awraris et al. (2015); Awraris et al. (2012), Gallmann and Thomas (2012) and Nuru (2007) on honey bee disease.

Improved marketing facility and information access enables farmers to plan their production in line with market demand, to decide how much they sell, which market to sell their produce to and negotiate on a more even footing with traders (CIAT, 2004). Even though honey is economically and socially important, determinants of volume of supply to market have not yet been studied and analyzed for the target study area, where great potential of honey production exists. Therefore, this study was conducted to identify factors affecting honey market supply in Chena district, Kaffa zone.

METHODOLOGY

Description of the study area

The study was conducted at Chena district, Kaffa zone of Southern Ethiopia. The district was purposely chosen out of 11 districts in the zone because of its high honey production potential, which accounts for about 24% of the total honey production in Kaffa zone (KZLFD, 2016).

The district is found within the southwestern plateau of Ethiopia which is 510 and 785 km far from Addis Ababa and Hawassa, respectively. The area is located at 07º18'48''N Latitude and 036º16'25'' E Longitude and at altitude of 2020 m.a.s.l. The district is bordered on the south by the Bench Majji zone, on the west by Bita, on the north by Gewata, on the northeast by Gimbo and on the east by Decha districts (Kifle et al., 2015). According to CWFEDO (2016), Chena district comprises of 42 kebeles (Kebele is the lowest administrative unit under Ethiopian condition) and with a total population of 158,449, of whom 78,150 are men and 80,299 women; 11,629 or 7.34% of its population are urban dwellers. The district agro ecology is 15% high land, 80% midland and 5% lowland and the district has a minimum temperature of 16°C and maximum temperature of 28°C, has average rainfall of 1356 mm. The total area of Chena district is estimated to be 901.92 km^2 that endowed with natural tropical rain forests with suitable climates that favour high honeybee population density and forest beekeeping is widely practiced (Nuru, 2007) (Figure 1).

Sampling procedure and sample size

A multi-stage sampling technique was employed for this study. At the first stage, out of 39 rural kebeles in the district, three kebeles were selected randomly because all of the rural kebeles are honey producers. At the second stage, total households that produce honey during 2015/2016 from the three randomly selected kebeles were identified and stratified. Finally, based on the list of honey producers from the sampled kebeles, the intended sample size was selected by employing probability proportional to size. Accordingly, a total of 154 honey producers were sampled randomly. For this study, sample size was determined from out of 7752 honey producers in the district based on the formula given by Yamane (1967) at 8% level of precision:

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

Where, n = the sample size, N = is total size of the honey

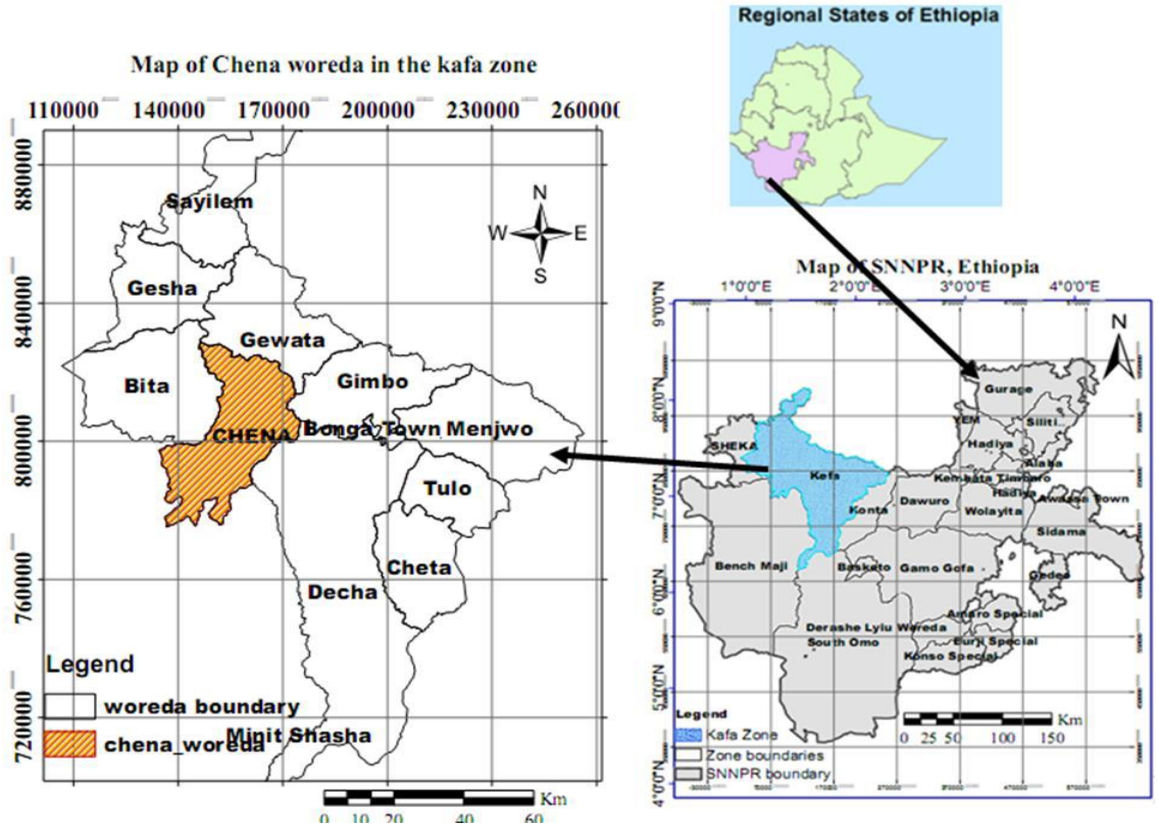


Figure 1. Map of the study area.

Table 1. Sample distribution of honey producers in selected kebeles.

S/N	Kebeles	Total number of honey producers	Number of sampled producers
1	Dinbra-woshi	396	55
2	Wareta	332	46
3	Wanabola	379	53
	Total	1107	154

Source: Own computation 2016.

producers (7752), e= is the level of precision (8%).

From 154 selected households, 35.7% were from Dinbra-Woshi, 29.9% were from Wareta kebele and the remaining 34.4% were selected from Wanabola Keble (Table 1).

Data types, sources and methods of data collection

Both primary and secondary data were used for this study. Primary data were collected using semi-structured questionnaire for honey producers. Primary data collected from beekeepers focused on factors affecting volume of honey supplied; demographic and socioeconomic characteristics of the households. Enumerators who are working in the district rural kebles as development agents was selected to collect data. Before data collection the enumerators were trained on the techniques of data collection and the questionnaire was pre-tested on ten households to evaluate the appropriateness of the design, clarity and interpretation of the questions, relevance of the questions and time taken for an interview. Hence, appropriate modifications were made on the questionnaire prior to conducting the survey.

In addition to the questionnaire, focus group discussion and key informants' interview were employed using checklists to obtain additional supporting information for the study. Secondary data were collected from different published and unpublished sources, government institutions and websites.

Table 2. Summary of hypothesized variables that determine the volume of honey supplied.

Variable	Description	Type	Expected sign
Dependent Variables			
Y	Volume of honey supplied in Kg	Continuous	
Independent Variables			
SHH	Sex of the household head	Dummy,1=male,0=female	+
HhSz	Household size in number of individuals	Continuous	-
EDLH	Education level of the household head in number of class attended	Continuous	+
DNM	Distance to nearest market in Km	Continuous	-
CRED	Credit received in 1000	Continuous	+
EXTCON	Frequency of extension contact per year	Continuous	+
NBHO	Number of beehives owned in number	Continuous	+
INCOME	Annually income excluding income from beekeeping in ETB	Continuous	+
BKEXP	Beekeeping experience in number of year	Continuous	+
TBH	Type of beehive used	Catagorical,0=traditional 1=both 2=improved	+
COOPM	Cooperative membership	Dummy,1=yes 0=no	+

Methods of data analysis

Descriptive statistics such as percentages, frequencies, mean and standard deviation were used to analyze the characteristics of the sampled honey producer households. While for analysis of the factors influencing honey market supply multiple linear regression was used.

Econometric model for volume of honey market supply

Different models can be employed to analyze the determinants of market supply. The commonly used ones are multiple linear regression, Tobit and Heckman's sample selection models. If some households may not prefer to participate in a particular market in favor of another, while others may be excluded by market conditions Tobit or Heckman models are used to analyze market supply. By using Tobit model, the market supply can be analyzed by clustering the respondents' into supplier and non-suppliers. If censored regression is applied, the model estimates are biased because of there is no clustering honey producers as all of households supply their product to market (Wooldridge, 2010).
Like Tobit model, sample selection model (Heckman) was used in some cases when sample selection biased occurred in addition to clustering of respondents. The first stage of the Heckman model a 'participation equation', used to construct a selectivity term known as the 'inverse Mills ratio' which is added to the second stage 'outcome' equation that explains factors affecting volume of product marketed and estimated by using ordinary least square (Wooldridge, 2010). However, in the study area all honey producers participate in the market by supplying their produce and therefore there is no clustering of honey producers in honey market participant and non-participant. Thus, for this study, multiple linear regression model was used to identify determinants of honey marketed supply.

Model specification

Multiple linear regression (OLS) model for supply function is specified as:

$$Y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \beta_5 x_{5i} + \beta_6 x_{6i} + \beta_7 x_{7i} + \beta_8 x_{8i} + \beta_9 x_{9i} + \beta_{10} x_{10i} + \beta_{11} x_{11i} + u \quad (2)$$

Where, y_i= quantity of honey supplied to the market by household head I; x_{1i}=sex of household head I; x_{2i}=size of households in household head I; x_{3i} =beekeeping experience of household head I; x_{4i} =types of bee hives used by household head I; x_{5i}= number of beehives owned by household head I; x_{6i} =frequency of extension contact of household head I; x_{7i} =education level of household head I; x_{8i} =total income excluding income beekeeping activities of household head I; x_{9i} =amount of credit received by household head i and; x_{10i} =cooperative membership of household head I; x_{11i}=distance from nearest market for household head i.

In matrix form, the supply function can be specified as:

$$Y = X\beta + u \quad (3)$$

Where, Y = the volume of honey supplied to the market in kg; β = a vector of estimated coefficient of the explanatory variables; X = a vector of explanatory variables , u = a disturbance term.

The potential explanatory variables expected to have influence on dependent variable are explained as shown in Table 2.

RESULTS AND DISCUSSION

Socio-economic characteristics of the sampled honey producers

From the descriptive statistics result in Table 3, about 78.6% of the sample households were male headed while 21.4% were female headed households. Regarding household size, the mean household size of the total

Table 3. Summary of the socioeconomic characteristics of sampled honey producers.

Continues variables	Observations	Mean	Std. Dev.
Level of education	154	5.40	2.63
Household size	154	6.15	2.53
Income of households in 1000 ETB	154	14.52	4.16
Years of experience in beekeeping	154	12.97	7.95
Credit received in 1000 ETB	83(User)	1.398	0.497
Number of hives owned currently	154	19.25	7.02
Distance to nearest honey market	154	2.65	1.05
Frequency of extension contact per year	154	12.34	3.95
Dummy and categorical variables	**Responses**	**Frequency**	**Percentage**
Sex	Female	31	20.13
	Male	123	79.87
Type of beehives used	Traditional	75	48.7
	Improved	36	23.38
	Both	43	27.92
Cooperative membership	No	34	22.08
	Yes	120	77.92

sample households was 6.15 with the standard deviation of 2.55. Concerning their literacy level, the mean educational level of sample respondents was grade 5.4. This implies that majority of the beekeeping households are literate though they are with low educational level.

The beekeepers of the study area practice various livelihood strategies and income generating activities mainly crop production in addition to animal husbandry, honey production, petty trade and daily labor. For the total sampled households, the average annual income generated from selling of crops, livestock and non/off-farm activity (pension, petty trade and remittance) was 14,520 ETB per year. The average years of beekeeping experience for the sampled households was about 13 years. With regard to the respondents' number of beehive possession (traditional and/or improved), the average holding was about 12 hives per household with minimum of 6 and maximum of 49. The type of hive used is one of the important factors which determine productivity of bees. Therefore, it is important to discuss different hive types that are used by sampled beekeepers in the district. According to the survey result, about 48.7% of the respondents were using only traditional types of hives and keeping bees in the forest by hanging the hive on long trees in dense forests; about 23.9% were using only improved beehives. While, the rest 27.4% of sample beekeepers were using both traditional and improved beehives (chefeka (top bar hive made from cheap and locally available non-timber hive), Kenya top bar and zendar) in the district.

Table 3 depicts that out of the total honey producing sampled households, about 94.16% reported that they had access to extension service in 2015/2016 production season with average number of extension contact per year of 12.34. The extension service providers for honey production in the study area were livestock and fishery office experts, DAs, NGOs and research institutions. Regarding credit service, the mean credit received was 1397.72 ETB from informal sources (friends, relatives or village money lenders). Even if credit services enhance the productivity of farmers, there is lack of attention to access and availability of credit from formal institution. The survey result indicates that majority (77.92%) of the respondents were members of beekeepers' cooperatives while the rest (22.08%) of them were not members. Finally, the average distance needed for sampled honey producer's to reach to nearest market place was 2.65 km.

Factors affecting market supply of honey

Honey is produced mainly for market and is one of the most important cash commodities for Chena district farmers. Analysis of determinants of household level honey supply was found to be important to identify factors constraining honey market supply. From the survey result, the variation in volume of honey supplied at households' level was found to be high and logarithmic

Table 4. OLS estimate of determinants market supply volume of honey (ln).

Variables	Coefficients	Standard errors
Sex of household head	0.049	0.038
Level of education	0.009	0.008
Household size	-0.051	0.039
Total income	0.086	0.073
Beekeeping experience	0.039***	0.007
Hive type(traditional and improved)	0.153**	0.069
Hive type(improved)	0.332***	0.048
Number of hives	0.135***	0.043
Distance from market	-0.052***	0.018
Amount of credit received	0.0132	0.009
Frequency of extension contact	0.033*	0.019
Cooperative membership	0.284***	0.050
Constant	0.93***	0.125
Number of observations		154
F(12, 141)		58.130
Prob > F		0.000***
R-squared		0.832
Adjusted R-squared		0.818
Predicted value, volume supplied (ln)		125.21(4.83)

Dependent variable is volume of honey marketed (in natural logarithm).***, **and * Significant at 1%, 5% and 10 probability level, respectively.
Source: Own computation from survey result, 2016.

transformation was implemented to reduce the variation (Appendix Figure 2). Interpretation of OLS estimates is possible if and only if the basic assumptions of multiple linear regression model are satisfied. Thus, after regression of OLS model existence of multicolliniarity between the hypothesized explanatory variables, heteroscedasticity, omitted variable and normality problems were checked.

Accordingly, the test for multicollinearity in Appendix Table 1 suggests that there is no serious problem of multicollinearity among explanatory variables since the mean VIF value was less than 2 (Gujarati, 2004). The omitted variable bias test with Ramsey RESET test (F (3, 138) = 1.03; prob > F= 0.3831) shows absence of omitted variable in the model indicating that the model has no problem of omitted variable bias (Appendix Table 2). Heteroscedasticity test was performed using Breusch-pagan/Cook-Weisberg (chi^2 (1) = 0.07; prob > chi^2 = 0.7923); suggests that the errors are of the same variance (Appendix Table 3). Thus, the null hypothesis that the errors have constant variance is accepted. In addition, normal probability plot for residuals shows error terms are normally distributed as the normal probability plot for residuals approaches to normality line (Appendix Figure 1). The fitness of the model (Adjusted R^2) was 0.82 that passed the tests and indicating about 82% of the variation in volume of honey supplied to the market by households was explained by the variables included in this model.

Among the hypothesized eleven variables included in the regression model, six variables were found to be significantly affected the market supply of honey at household level. These are experience in beekeeping, frequency of extension contact, number of beehives owned, type of beehives used, cooperative membership and distance to the nearest market (Table 4).

Beekeeping experience (EXPBK)

The model result showed that beekeeping experience of households significantly and positively affected quantity of honey sold at 1% significance level. Thus, the result implied that, as beekeepers experience increase by one year the quantity of honey supplied to market increased by 3.89%, keeping others factors constant. This means that the beekeepers with more experience in honey production and marketing have higher ability to produce

honey in turn sell more than less experience because they have more knowledge in bee management and marketing network. This is in line with finding of Samuel (2014), and Betselot (2012) who illustrated as beekeepers experience increased the volume of honey supplied to the market increased.

Type of beehive used (TBH)

This is a categorical variable that affects positively decision to sell how much of the honey produced. The model result shows that using both improved and traditional beehives affected quantity of honey supplied significantly and positively at 5% level of significance. While using only improved beehive affected volume of honey marketed positively at 1% level of significance.

Thus, as compared to those households who use traditional beehives, the volume of honey supplied to market increase by 15.3% for those households who used both traditional and improved beehives and 29.5% for those households who used improved beehives. This implies that honey producers possessing improved beehives produce better volume of honey than those who use the traditional one. Hence, the more they produce the more they tend to supply to the market. Betselot (2012) confirmed that improved beehives allow honey bee colony management and use of a higher-level technology with larger colonies and can give higher yield and quality of honey thus in turn increase market supply.

The number of beehives owned (NBHO)

t is proxy variable for quantity of honey produced and positively influence the volume of honey supplied to market at 1% significance level. This indicates that producer with more number of beehives can harvest more volume of honey and not only having of better marketable surplus but will able to sell more. The model result indicated that as the number of hives used increased by one, the volume of honey marketed increased by 1.35 percent. Kerealem et al. (2009) confirmed that the use of large number of hives directly related with the amount supplied to the market and return earned by beekeeper. This result is also in line with finding of Getachew (2009).

Frequency of extension contact (EXTCONT)

It was positively and significantly related to the volume of honey supplied to the market at 10% significance level. The positive and significant effect was mostly due to the reality that beekeepers who frequently contact extension worker concerning beekeeping particularly about modern honey production, harvesting and handling methods contributed to increase the amount of honey supplied to market. The model result predicts that increase in number of extension contacts per year by one in relation honey production, increases the amount of honey marketed by 3.25%. This suggests that frequent extension contact avails information regarding improved technology which improves production that in turn affects the marketed surplus. The result is consistent with earlier results of Getachawu (2009), Betselot (2012) and Samuel (2014).

Distance from the nearest markets (DNM)

It affected the volume of honey supplied to market negatively and significantly. The model result indicated that, keeping other variables constant, as the distance of the farmers' residence from the nearest market increases by one kilometer, the volume of honey supplied decreased by 10%. This may be due to the fact that as the farmers reside far from the nearest market the transport cost for selling their output would be high. This implies that as the distance from the nearest market increases, transport costs and loss due to handling increase and this may discourages producers from selling high volumes of honey. The result is consistent with the findings of Biruk (2015) and Efa et al. (2016).

Cooperative membership (COOPM)

It influence positively and significantly the volume of honey marketed at 1% level of significance. As compared to those households who are not member of cooperative, for those household who are members of cooperative, the volume of honey marketed increased by 58.4%. Being a member of producer group motivates farmers to supply more by giving technical advice, input and up to date information provision to members (Adeoti et al., 2014). Study by Shewaye (2015) also confirmed that being membership of cooperative could have better access to market information, inputs, technical advice and access to credit facilities which grid towards increments of output that in turn increase volume of supply to market.

CONCLUSION AND RECOMMENDATIONS

The result of the multiple linear regression model indicated that beekeeping experience, beehive types used, number of beehives owned, frequency of extension

contact and cooperative membership determined the quantity of honey supplied to the market positively and significantly. Moreover, distance to nearest market affected the quantity of honey supplied to market negatively and significantly.

Producer with more number of beehives can harvest more volume of honey with better marketed surplus. Nevertheless, simply increasing number of beehives cannot be an option to increase honey market supply since volume of honey harvested from traditional beehive is low. Hence, increasing number of improved beehives to increase volume of honey per hive is better alternative to increase market supply. So, there is a need for intervention to increase number of beehives owned by increasing access to improved beehives and access to credit services. In line with this, bringing beekeepers under more extension contact in the existing technology at hand and improving technical knowhow of beekeepers on using best practices of the experienced beekeepers as a point of reference can help beekeepers to increase their level of honey market supply.

Finally, cooperatives motivate producers to supply more by giving technical advice, input and up to date information to members which grid towards increments of output that in turn increase volume of honey supply and improve bargaining power of producers in time of selling their produce. Hence, strengthening of the existing honey cooperatives by building financial capacity and creating linkage with processors, motivating non-members to become members of cooperatives and establishment of additional honey cooperatives is suggested. Furthermore, the concerned bodies need to intervene in improving poor road facility and poor transport accessibility to supply their product and establishing honey collection points across rural areas will assist beekeepers for faster delivery of honey.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENT

The authors would like to thank the sampled households and experts of Chena district livestock and fishery office. The financial support of Southern Agricultural Research Institute is gratefully acknowledged.

REFERENCES

Adeoti AI, Issack B, Oluwatayo S, Raheem O (2014). Determinants of market participation among maize producers in Oyo state, Nigeria. Brit. J. Econ. Manage. Trade 4(7):1115-1127.

Assefa A (2009). Market chain analysis of honey production in Atsbi Wemberta district, Eastern zone of Tigray region, Ethiopia. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Awraris G, Amenay A, Hailemariam G, Nuru A, Dejen A, Zerihun T, Asrat T (2015). Comparative analysis of colony performance and profitability of different beehive types in Southwest Ethiopia. Glob. J. Anim. Sci. Res. 3(1):178-185.

Awraris G, Yemisrach G, Dejen A, Nuru A, Gebeyehu G, Workneh A (2012). Honey production systems in Kafa, Sheka and Bench-Maji zones of Ethiopia. J. Agric. Ext. Rural Dev. 4(19):528-541.

Betselot M (2012). Honey value chain analysis with especial emphasis to Ada'a district, East Shoa zone of Ethiopia. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Biruk J (2015). Value Chain Analysis of Bee Honey and Credit Market Participation of Bee Keepers: The Case of Damot Gale District, Southern Ethiopia. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Centro International de Agricultural Tropical (CIAT) (2004). Increasing the Competitiveness of Market Chains of Smallholder's Producers. Manual, 3: Territorial Approach to Rural Agro Enterprise Development Project. http://www.fsnnetwork.org/sites/default/files/manual_3_market_chain_competitiveness.pdf

Chena District Finance and Economic Development Office (CWFEDO) (2016). Physical and Socio-economic Profile of the District. https://www.2merkato.com/tenders/companies/view/3385/page:2

Desalgne P (2011). Ethiopian honey: Accessing international markets with inclusive business and sector development. SNV, Ethiopia. Available at: http://www.snv.org/public/cms/sites/default/files/explore/download/7._soc_ethiopia_honey.pdf [accessed on 12 July 2016]

Efa G, Degye G, Tinsae D, Tadesse K (2016). Determinants of market participation and intensity of marketed surplus of *teff* producers in Bacho and Dawo districts of Oromia national regional state, Ethiopia. J. Econ. Sustain. Dev. 7(1):13-24.

Gallmann P, Thomas H (2012). Beekeeping and honey production in southwestern Ethiopia. Ethiopia Honey Bee Invest. pp. 1-24.

Getachew N (2009). Honey market chain analysis: The case of Burie district, West Gojjam zone, Amhara national regional state. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Gujarati DN (2004). Basic Econometrics, 4th edition. McGraw Hill, New York.

Kassa T (2017). Structure and Conduct of Honey Market in Chena District Kaffa Zone, Southern Ethiopia. World J. Agric. Sci. 13(1):45-52.

Kassa T, Gonche G Amenay A (2017a). Value Chain Analysis of Honey in Kaffa and Sheka Zones of SNNPR, Ethiopia. Int. J. Res. Agric. Sci. 4(3):142-148.

Kassa T, Jema H, Bosena T (2017b). Determinants of honey producer market outlet choice in Chena district, Southern Ethiopia: A multivariate probit regression analysis. Agric. Food Econ. 5(20):1-14.

Kerealem E, Tilahun G, Preston TR (2009). Constraints and Prospects for Apiculture Research and Development in Amhara region, Andassa Livestock Research Center, Bahir Dar, Ethiopia. Available at: http://www.lrrd.org/lrrd21/10/ejig21172.htm

Kifle B, Mebratu G, Kumlachew A (2015). Integrated management of common bacterial blight (Xanthomonas axonopodis pv. Phaseoli) of common bean (Phaseolus vulgaries) in Chena district of Kaffa zone, Southwest Ethiopia. Malays. J. Med. Biol. Res. 2(2):147-152.

Kaffa Zone Livestock and Fishery Department (KZLFD) (2016). Livestock Extension Profile of the Zone.In: Kassa Tarekegn, Jema Haji and Bosena Tegegne Profitability f Honey Production and honey market performance in Chena District f Kaffazone, SNNPR, Ethiopia. Int. J. Res. Stud. Sci. Eng. Technol. 4(10):30-36

Ministry of Agriculture (MoA) and International Livestock Research Institute (ILRI) (2013). Apiculture Value Chain Vision and Strategy for

Ethiopia: Ministry of Agriculture and International Livestock Research Institute, Addis Ababa, Ethiopia. https://cgspace.cgiar.org/bitstream/handle/10568/67248/LMP_apiculture_2013.pdf?sequence=1

Nuru A (2007). Atlas of Pollen Grains of Major Honey Bee Flora of Ethiopia: Sixth National Annual Conference of the Ethiopian Beekeepers Association (EBA), June 2007, Addis Ababa, Ethiopia.

Samuel S (2014). Market chain analysis of honey production in Sodo Zuria district, Southern Ethiopia. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Shewaye A (2015). Determinants of haricot bean market participation in Misrak Badawacho district, Ethiopia. MSc Thesis, Haramaya University, Haramaya, Ethiopia.

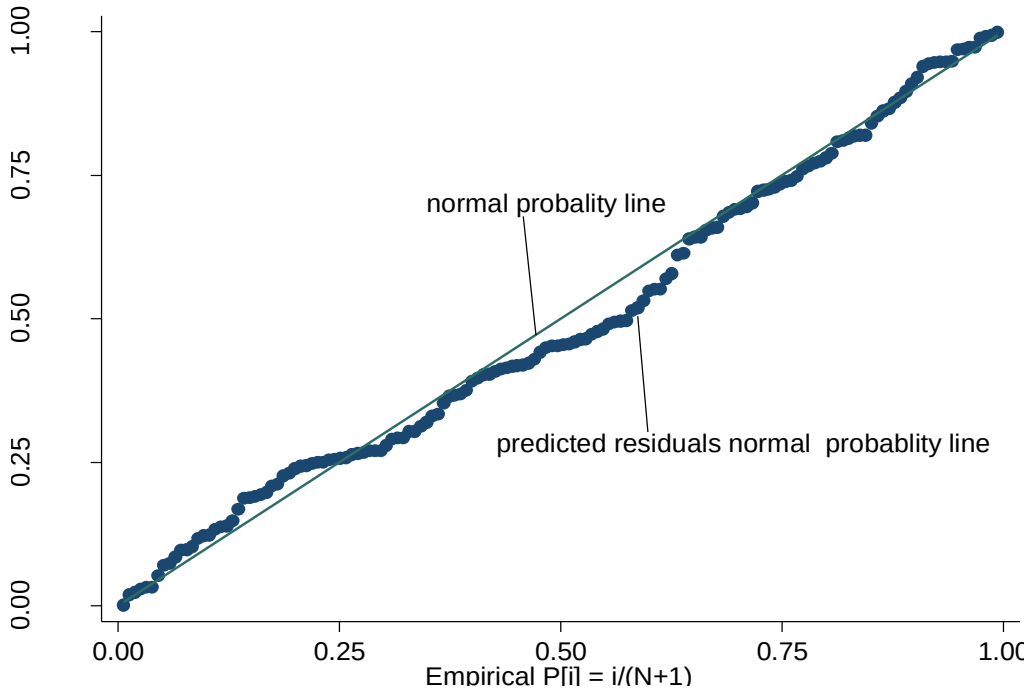
Wooldridge JM (2010). Econometric Analysis of Cross Section and Panel Data, 2nd Edition. Cambridge, MA: MIT Press.

Workneh A (2011). Financial Benefits of Box Hive and the Determinants of Its Adoption in Selected District of Ethiopia. Am. J. Econ. 1(1):21-29.

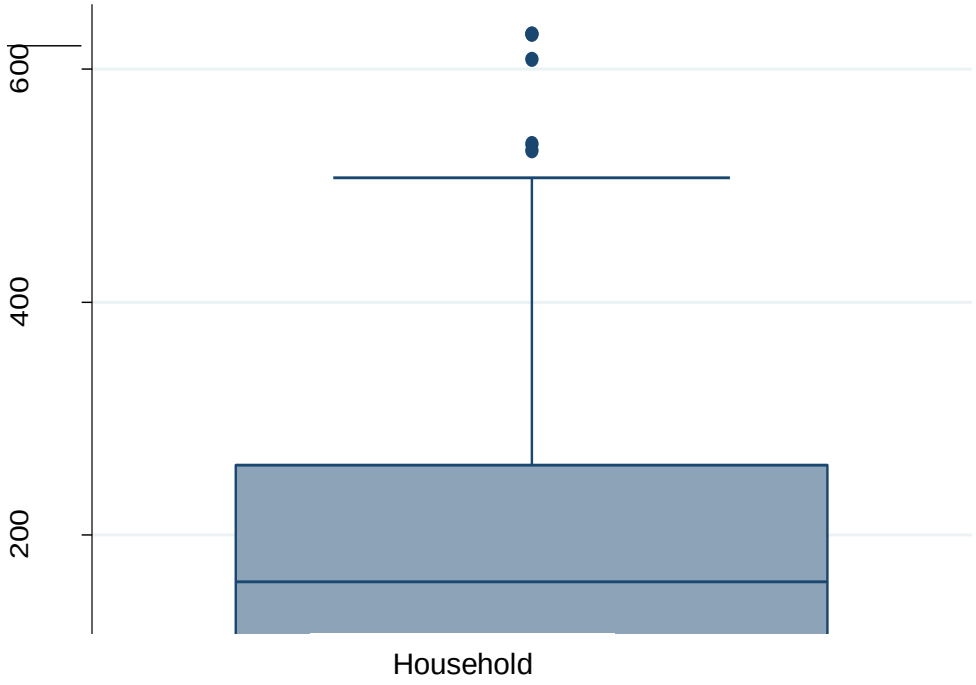
Yamane T (1967). Statistics: An Introductory Analysis, 2nd Edition. New York: Harper and Row.

Yoshimasa I (2014). Local honey production activities and their significance for local people: A case of mountain forest area of Southwestern Ethiopia. Afr. Study Monogr. 48:77-97.

APPENDIX



Appendix Figure 1. Norma probability plot for residuals.



Appendix Figure 2. Boxplot for volume of honey supplied to check outliers.

Appendix Table 1. Multicollinearity test for explanatory variables (VIF).

Variables	VIF	Tolerance
Sex of household head	1.20	0.83255
Level of education	1.14	0.87606
Household size	1.19	0.83745
Total income	1.06	0.94208
Beekeeping experience	1.29	0.77492
Hive type(traditional and improved)	2.33	0.42867
Hive type(improved)	1.60	0.62449
Number of hives	2.30	0.43518
Distance from market	1.10	0.90515
Credit user	1.05	0.95564
Extension contact	1.16	0.86553
Cooperative membership	1.33	0.75088
Mean VIF	1.40	

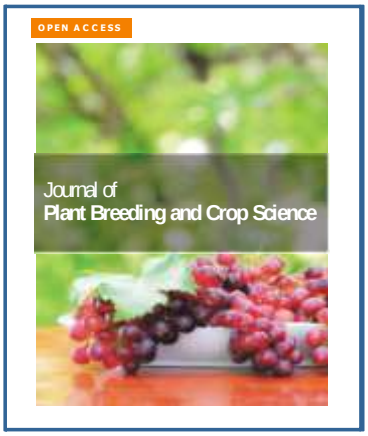
Appendix Table 2. Specification /omitted variable test result (ovtest).

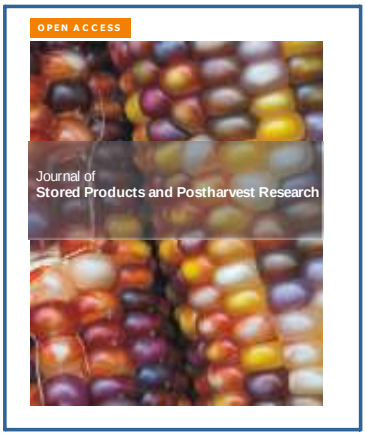
Ramsey RESET test
Ho: model has no omitted variables
F(3, 138) = 1.03 Prob > F = 0.3831

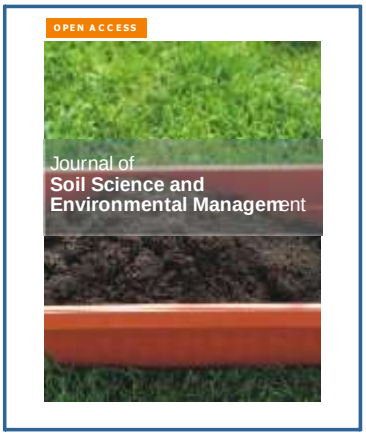
Appendix Table 3. Heteroscedasticity test result (hettest).

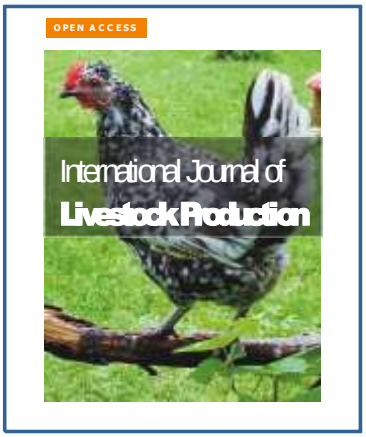
Breusch-Pagan / Cook-Weisberg test
Ho: Constant variance
Variables: fitted values of volume sold(ln)
chi2(1) = 0.07 Prob > chi2 = 0.7923

Related Journals:









academicJournals

www.academicjournals.org