The Impact of Access to Agricultural Services on Maize Productivity in Uganda

Isaac MUSINGUZI

Department of Entrepreneurship and Management,

Uganda Christian University, Mukono, Uganda

Email: isaacmusinguzi20@gmail.com

ABSTRACT

The study examined the influence of access to agricultural services on maize productivity in Uganda It was motivated by the fact there are low maize yields and yet the government has continuously increased funding to the agricultural sector through providing agricultural services to the maize farmers. The study analysed the access to credit services, extension services and access to markets and their influence on maize productivity. Using the multiple linear regression analysis and the Uganda Census of Agriculture 2008/2009 data, collected by the Uganda Bureau of Statistics (UBoS), we found that access to credit services leads to an increase in maize productivity, access to extension services increase maize productivity and access to markets leads to an increase in maize productivity. On the basis of these observations, we recommend that there is need for government to strengthen measures for farmers to access credit through farmer membership groups, VSLS, farmer banks, need by government to employ more extension workers to cover the largely unreached areas at the village levels and the central government should work together with the local governments in establishing maize produce markets in each sub-county in order to reduce the distance farmers take to reach the markets and through group marketing under farmer groups.

Keywords: Credit; Extension; Market; Maize productivity

JEL Classification Codes: E51; Q16; A11; D24

1. Introduction

Productivity performance in the agricultural sector is critical to improvement in overall economic well-being globally, and it has therefore been the subject of at least seven multi-country studies (Block, 1994; Frisvold and Ingram, 1995; Thirtle et al., 1995; Lusigi and Thirtle, 1997; Rao and Coelli, 1998; Chan-Kang et al., 1999; Suhariyanto et al., 2001; Lilyan et al, 2004). These studies, though they covered different time periods and different sets of sub-Saharan African countries, have been reasonably consistent in reporting positive average productivity gains during the 1960s, deterioration or no gain in productivity during the 1970s, with a recovery to positive gains during the 1980s and early 1990s. The present study aims to provide a more comprehensive understanding of agricultural productivity growth in Uganda, and the potential influence of access to services.

Agriculture remains the backbone of the economies of most African Countries. In Uganda, 85% of the population is engaged in Agricultural production which contributes 42% of the national gross domestic product, 80% of the export earnings and employs 90% of the labour force (UBoS, 2014). According to the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) Development Strategy and Investment Plan 2005/2008, the main Agriculture sub-sectors include crops contributing about 80%, livestock contributing 13% and fisheries contributing about 6%. Over 95% of the farmers are smallholders with landholdings ranging from 0.5 to 10 acres. Majority of these smallholder farmers have rich indigenous knowledge that has sustained their livelihoods, food security as well as land productivity for hundreds of years with very little or no use of artificial fertilizers, pesticides and veterinary drugs.

The importance of rural credit services can be best understood by examining their potential contribution to the development of the agricultural sector. Agriculture forms a significant part of the lives of the rural households, who in the case of Uganda constitute about 85% of the population (UBoS, 2014). Many of the agricultural activities are spread over time (Ray, 1998), for example, adoption of a new technique or a new crop requires investment in the current period with payoffs in the future. Much of the industrial activity in the country is agro-based. Even though its share in total GDP has been declining, agriculture remains important because it provides the basis for growth in other sectors such as manufacturing and services. Being the largest employer, the majority of women (83 per cent) are employed in agriculture as primary producers and contribute 70-75 per cent of agricultural production. In the face of the global financial crisis, agriculture is contributing a lot of foreign exchange revenue from regional trade and therefore improving the country's balance of payments position, and in the process helps to stabilize depreciation of the shilling (UBoS, 2014).

Out of about 31 million Ugandans, 85% live in rural areas of which 73.3% are engaged in subsistence agriculture (UBoS, 2014). Most of the agriculture is characterized by small land holdings with a few isolated commercial holdings (Musiime et al., 2005). In addition to supporting livelihoods, agriculture sector contributes to the national revenue. In 2009, the sector provided about 70% of the employment in the country and contributed to 90 percent of the total export (UBoS, 2010). However, the share of the agriculture sector to Gross Domestic Product (GDP) has continued to decline from 20.2% in 2004/05 to 14.7% in 2009/10 and 13.9 % in 2011/12 (MFPED, 2011). Even though its share in the total GDP has been declining, agriculture remains important because it provides the basis for growth in other sectors such as manufacturing and services (Government of Uganda, 2010).

Agricultural export production in Uganda hinges on the efforts of rural producers and processors who typically receive the least benefits from the marketing and processing of their products. Nurturing and building the capacity of farmers' groups is one way of improving quality, profitability and marketing efficiency. Moreover, because Uganda is landlocked country, regional development initiatives are likely to have significant returns for markets and for efficient transportation and the regulation of product quality. Clearly the effective implementation of policies to expand the access of services to encourage agricultural exports urgently needs to be addressed to benefit smallholder farmers as they produce and process these goods (Kyomugisha, 2008).

The study focused on maize because it is an important crop in Uganda. Maize is the most highly cultivated crop with about 86 per cent of Uganda's agricultural households (UBoS, 2014). Maize is the number-one staple food for the urban poor, in institutions such as schools, hospitals and the military. Also, the crop is the number-one source of income for most farmers in Eastern, Northern and North-Western Uganda (Ferris et al., 2006).

Although the role of agriculture in poverty reduction and overall growth in Uganda is well recognized, investment in the sector remains minimal, at 5% and less than 10% as agreed in the Maputo declaration (UBoS, 2014). The slow pace of socioeconomic transformation in Uganda can therefore be attributed to the neglect of the agricultural sector as an engine of growth (Tibaidhukira, 2011). Many studies from the literature have suggested that modest increases in agricultural production are largely due to expansion in cultivated land, constraints of access to credit services, extension services, access to market services and growth of institutions (Pratt, 2008).

However, few studies have addressed the access to credit, extension, market services and maize productivity and yet the government of Uganda and her partners have continuously invested a lot of funds, from the World Bank funded Agricultural Extension Project in 1992 to the current NAADS phase II, agricultural productivity has slowly grown with the maize crop fluctuating between seasons (Delgado, 2003; Fernandez-Cornejo, 2006; Okoboi, 2011; Okoboi, Kuteesa, & Barungi, 2013). This research therefore contributed to the growing literature addressing the issue of maize productivity in developing countries with specific emphasis on the access to credit services, access to extension services and access to market services.

This study analyzed the influence of access to agricultural services on maize productivity in Uganda. Specifically, to examine the influence of access to credit services on maize productivity, to find out the influence of access to extension services on maize productivity and assess the influence of access to markets on maize productivity.

2. Literature Review

2.1 Theoretical literature review

The study is based on the theory of production. The theory explains the process of combining various inputs to produce an output for consumption (Battese, 1992).

The Production function signifies a technical relationship between the physical inputs and physical outputs of the firm, for a given state of the technology.

$$Q = f(X_1, X_2, X_3, \ldots, X_n)$$

Where X_1, X_2, X_3,…,X_n are various inputs such as land, labor, capital among others. In this study agricultural services as access to credit, access to extension and access to markets are used as proxies for the inputs in this theory of production.

Q is the level of the output for a firm.

If labor (L) and capital (K) are only the input factors, the production function reduces to;

$$Q = f(L, K)$$

The above production function describes the technological relationship between inputs such as land, labour, capital and output of the firm (Battese, 1992).

In this study, the independent variable was agricultural services, specifically access to credit services, access to extension services and access to markets while the dependent variable was maize productivity. The household was considered to be both a maize farm and enterprise, just like in the production theory and uses various inputs such as access to credit services, access to extension services and access to markets to produce an output that is yield.

The strength of the theory of production is that it enables the understanding of the relationship between inputs and output, which benefits producers by minimizing the costs associated with inputs and consumers due to the lower prices derived from lower costs for the producer. This relationship is also essential in distinguishing between the short-run and the long-run, where the short-run is the period of time where at least one factor of production is fixed and in the long-run all factors of production are variable and the state of technology changes.

However, notwithstanding its strengths, the theory of production has also weaknesses such as: it is extremely difficult to measure the productivity of a single employee, let alone measure how this productivity increases or decreases as one more worker is added, the theory does not explain the role and effect of legal and social limitations as well as it does not account for exogenous factors such as management which influence production.

The competing theories are the theory of economic efficiency (technical and allocative efficiency) (Chukwuji, *et al.*, 2006), the theory of the farm household (Barnum and Squire, 1997), and the transaction costs theory (de Janvry et al., 1991).

The theories of economic efficiency, whether technical and allocative efficiency measures only the technical or allocative efficiency of the firm, in this case the household (Barnes, 2008). Therefore the theory of production is better suitable for this study since it considers the amount of maize output per hectare.

In the farm-household model, agricultural households are assumed to maximize utility subject to the production function and time and income constraints (Barnum & Squire, 1997). This is not a case for most households in Uganda which do not consider utility maximization and thus the theory of production was better suitable for this study.

The transaction costs theory explains the farmers' behaviour in terms of transaction costs as a determinant in the input and output markets (de Janvry et al., 1991). Though, this is relevant with most of small holder maize farmers; most times there are other determinants for the output markets. Therefore, the theory of production is better for this study.

Theory of production has been extensively used to the development work of most economies. In Uganda, the theory of production has been applied in the National Agricultural Advisory Services (NAADS) as one of five core programmes under the Plan for Modernization of Agriculture (PMA).

Other studies have also employed the theory of production to model production and productivity in agriculture and other sectors (Nyamekye, 2016; Felipe & Adams, 2005; Battese, 1992). Most of these have modelled productivity

2.2 Empirical Literature Review

2.2.1 Credit Facilities and Maize Productivity

Mulinga (2013) looked at an economic analysis of factors affecting technical efficiency of smallholders maize production in Rwanda and found out that access to credit were significant variables leading to technical inefficiency. Kamau & Otieno (2013) report similar results in Kenya, that there is a significant relationship between credit financing and maize production.

Martey et al (2015) argues that provision of credit enhances timely purchase and efficient allocation of factor inputs to produce the maximum output. The study used the propensity score matching analysis was used to compare the average difference in technical efficiency between farmers with credit and those without credit in Northern Ghana.

Using a logistic regression, Kiplimo (2013) clearly pointed out that access to credit has significant positive effects to smallholder farms in both Eastern and Western regions of Kenya. However, Simtowe et al (2009) mentions that there is a possibility for increasing the cultivation of hybrid maize in Malawi if credit is targeted at younger farmers that are credit-constrained.

Marsden et al. (1990) stressed the British farm lending model which was reformulated during the 1980s to allow new modes of lending criteria based on farm business profitability in agriculture. This replaced the banks' traditional focus on the applicant's equity in the land that he/she was purchasing

In the Australian and New Zealand farm sectors (Le Heron, 1991; Stockle, 1994; Henderson, 1996; Smailes, 1996; Argent, 1996, 1997), the historical importance of credit, particularly concessional lending was found to increase agricultural productivity.

The Agricultural Credit Facility (ACF) was set up by the Government of Uganda (GoU) in partnership with Commercial Banks, Uganda Development Bank Ltd (UDBL), Micro Deposit Taking Institutions (MDIs) and Credit Institutions all referred to as Participating Financial Institutions (PFIs) to facilitate the provision of medium and long term loans to projects engaged in agriculture and agro-processing on more favorable terms than are usually available from the PFIs. Loans under the ACF are disbursed to farmers and agro-processors through the PFI. The scheme is administered by the Bank of Uganda (BoU). It operates on a refinance basis in that the PFIs disburse the whole loan amount to the sub-borrower and applies to BoU for the 50 percent GoU contribution. The Scheme became operational in the year 2009 (Government of Uganda Report, 2009)

There are many sources of credit in Uganda to help farmers and they include; Commercial banks, Microfinance Institutions, Money Lenders, Input supply, self-help Group, Internal (Family and friends), Government, NGOs (Government of Uganda Report,2009).

2.2.2 Extension Services and Maize Productivity

In Ethiopia, by estimating a Cobb-Douglas type stochastic frontier production function, Yilma et al (2008) clearly pointed out that participation in an extension program was found to increase the productivity of maize farmers. They thus suggested that improving the extension access of farmers could help in increasing the technical efficiency of maize production.

Msuya et al (2008) showed that lack of extension services had a negative effect on technical efficiency of smallholder maize farmers in Tanzania. The study used a stochastic frontier production model proposed by Battese & Coelli (1995) using a sample of 233 smallholder maize farmers.

Bindlish & Evenson (1993) study in Kenya found out that access to extension services, as measured by the log of the extension-staff-to-farms ratio, had a positive and statistically significant impact on the value of farm production. Gautam & Anderson (1999) using the same data after incorporating district fixed effects, the positive impact disappeared. In Uganda, Muwonge (2007) found that the significant positive impact of NAADs on yields disappears once endogeneity is controlled for.

Using cluster sampling, a total of 154 farmers in Kakamega District in Kenya were interviewed and the results indicated that farmers who access formal and informal agricultural extension services have higher maize production compared to those without such access. Therefore, the strengthening of the formal and informal agricultural extension services increases the maize production by smallholder maize farmers (Nambiro et al, 2010).

Similarly, according to Urassa (2015), inadequate extension services were found as one of the key constraint that hinders maize productivity in the Rukwa region in the Southern highlands of Tanzania. The study collected data from households that cultivate the maize crop in the three districts of Rukwa which are the most reliant maize producers in Tanzania.

Mulinga (2013) found out that extension services had no significant impact on smallholder maize farmers' inefficiency in Rwanda. The study was conducted in Musanze and Bugesera districts of Rwanda using the Stochastic Production Frontier (SPF) analysis.

Adegboye et al (2013) recommended that the transfer of extension information to women maize farmers should be strongly strengthened as extension information is significant in enhancing the output of the women maize farmers in the study area. This followed their study carried out to examine the sources of extension information among women maize farmers and the effect of extensive information on the output of maize farmers in the Soba Local Government area of Kaduna State, Nigeria.

Abate et al (2015) examined the production and agricultural input data of the Central Statistical Agency (CSA) and found out that increased extension services were found as the key factor in promoting the accelerated growth of maize productivity in Ethiopia.

The interaction between extension agents and farmers and the extent to which farmers perceive extension agents as useful to them is paramount to bringing about change in agriculture output. Agricultural extension agents' contacts have significant influence on technological transfer to maize growers which in turn increase maize productivity in Kilindi District of Tanzania (Mcharo, 2013)

Menyha (2010) examined the agricultural module of the Uganda National Household Survey (UNHS) 2005/06 by Uganda Bureau of Statistics (UBoS). Using a multiple linear regression model (Meta production function), he found out that access and use of extension services is vital in boosting household crop production.

It is widely accepted that farmers' performance is affected by human capital, which encompasses both innate and learned skills, including the ability to process information (Jamison & Lau, 1982). The goals of extension include the transferring of knowledge from researchers to farmers, advising farmers in their decision making and educating farmers on how to make better decisions, enabling farmers to clarify their own goals and possibilities, and stimulating desirable agricultural productivity (Van den Ban & Hawkins, 1996).

The top–down public agricultural extension systems in China left millions of farmers without access to extension services. As a result of this and given the importance of extension services, a pilot inclusive agricultural extension system was introduced to better meet the diverse needs of small-scale farmers in order to increase on agricultural productivity (Hu et al, 2012).

There are mixed results regarding the impact of agricultural extension on productivity as a result of how the methodological issues of endogeneity, heterogeneity and measurement of productivity variable are addressed. Productivity-agriculture extension literature reveals a number of methodological challenges that make it difficult to make broad generalizations about the productivity effects of agricultural extension services (Odhiambo & Nyangito, 2003; Betz, 2009; Anderson & Feder, 2004; World Bank, 2011). For example, the available empirical research on the effect of agricultural extension services, show large positive rates of return to extension services (CerdánInfantes et al, 2008). However, in the absence of random assignment to treatment and control groups, this methodology is likely to provide biased estimates of causal effects, due to endogeneity of program participation and the presence of unobservable characteristics that might determine participation and be correlated with the outcome variable (see e.g Betz, 2009, Cerdán-Infantes et al, 2008, Dercon et al, 2008, Owen et al, 2001).

Evenson & Mwabu (1998) used the quantile regression technique and the results reveal that extension services have a discernible impact on productivity and that the impact was at the highest top end of the distribution of yields residuals, "suggesting that productivity gains from agricultural extension may be enhancing unobserved productive attributes of farmers such as managerial abilities. The implication of this finding is that other factors such as farm management abilities and experience affect the effectiveness of extension as a determinant of agricultural productivity (Odhiambo & Nyangito, 2003).

2.3.3 Market Access and Maize Productivity

Barrett (2008) review of market participation studies concluded that farmers' limited resource endowments and the unavailability of more productive technologies suitable to varied agro-ecological conditions constrain production and hence ability to produce a marketable surplus. This suggests that the market can exist and the challenge is the amount to supply to that market.

Factors associated with transport and transaction costs are sometimes statistically significant but typically explain a very small part of the variation in market participation (Mather *et al*. 2013). Therefore this affects the access of markets by the farmers which in turn affects the level of productivity at their farms.

Chapoto & Jayne (2011) established that there is a high degree of correlation between the distance traveled to the point of maize sale and the distance to the nearest place where vehicular transport can be accessed in Zambia. Therefore, proximity to feeder roads is an important determinant of traders' willingness and ability to enter into remote areas to provide markets for smallholder farmers' surplus production.

According to IFAD (2003), severities such as low population densities in rural areas, remote location and high transport costs present real physical difficulties in accessing markets. This leaves the rural poor constrained by their lack of understanding of the markets, their limited business and negotiating skills, and their lack of an organization that could give them the bargaining power they require to interact on equal terms with other, larger and stronger market intermediaries. Furthermore, rural producers from developing countries face significant impediments in accessing rich countries' markets (IFAD, 2003).

In Malawi, Zeller et al (1998) found out that apart from factor endowment and exposure to agro-ecological risks, differences in the household's access to commodity markets significantly influence its cropping shares and farm income, thus in turn affects productivity.

Maziku (2015) in estimating the effects of transaction costs on market participation and sales of maize in the major maize producing districts (Mbozi and Sumbawanga) of Mbeya and Rukwa regions, located in the Southern Highland of Tanzania. Using the two-stage Heckman model, the findings showed that the distance to market had shown negative effects on farmers' market participation. This implies that smallholder farmers' market participation will increase with the reduction in the distance to the market.

Markets are often seen as one of the main determinants of agricultural productivity (Rosenzweig & Binswanger, 1993). Recently, evidence suggests that the intensification of farming systems over much of Sub-Saharan African countries has been more limited and less beneficial to farmers in comparison to tropical areas of Asia and Latin America, and several researchers point to poor access to markets or inefficient markets as root causes (Heady et al. 2013; Binswanger & Savastano, 2014).

In northwestern Ethiopia, Minten et al. (2013) found out that transaction and transportation costs increased fertilizer prices at the input distribution center between 20 and 50 percent which reduce crop productivity. Similarly, Zerfu & Larson (2010) showed that the other challenge is the transportation time by farmers in rural Ethiopia to reach the markets.

In addition, the distance from market affects the price and availability of improved seeds in most parts of Africa which in turn negatively affects agricultural productivity (Shiferaw, Kebede & You 2008; Heisey et al. 1999; Yorobe & Smale 2012; Heady et al., 2013).

In particular, access to markets is hindered by both observable and unobservable costs in agriculture. Observable (tangible) costs are associated with transport, handling, packaging, storage costs whereas unobservable (intangible) costs include information asymmetries, search costs, bargaining costs and the costs of enforcing contracts (See Cuevas & Graham, 1986; Staal et al, 1997; Hobbs, 1997; Key et al, 2000; Holloway et al, 2000; Birthal et al. 2005; Jensen et al, 2007). All these costs limit agricultural productivity.

3. Methodology

3.1 Research Design

The study used the cross-sectional research design. This is because the data used contains multiple variables that were captured at a particular point in time and this enabled many findings and outcomes to be analyzed.

3.2 Study Population

The study population comprised of a total of 3, 787,487 households enumerated in Uganda based on the Uganda 2002 Agricultural Module of Population and Housing Census.

3.3 Sample Size and Sampling Procedure

3.3.1 Sample Size

A sampling scheme of 3,606 Enumeration Areas (EAs) and 10 agricultural households in each selected Enumeration Area (EA), leading to 36,060 households which were adopted as the sample size.

The required sample size of enumeration areas was selected from each district with probabilities proportional to size (PPS), using the systematic sampling algorithm described in Hansen, Hurwitz, & Madow (1953) while Agricultural Households were selected with equal probability systematic sampling procedure. The Measure of Size (MOS) which was used for sample selection was the number of Agricultural Households determined from the Uganda Population and Housing Census (PHC, 2002).

3.3.2 Sampling Techniques and Procedure

A stratified two-stage sample design was used for the small and medium-scale household-based agricultural holdings. At the first stage Enumeration Areas (EAs) were selected with Probability Proportional to Size (PPS), and at the second stage, households which were the ultimate sampling units were selected using systematic sampling.

For each of the sampled enumeration areas, listing took place in the field and a number of filter questions (using Uganda Census of Agriculture (UCA) Form 1: Listing Module) were administered to determine eligibility (i.e., only the Households with Agricultural Activity would be eligible). Further, the eligible households were stratified into two strata namely, the small/medium holdings stratum and the Private Large-Scale holdings stratum.

3.4 Data Types and Collection Methods

3.4.1 Data types

The study used secondary data. The data used in this study comes from the 2008/2009 Uganda Census of Agriculture (UCA). The census was administered by the Uganda Bureau of Statistics (UBoS) and covered all the 80 districts in the country as of 1st July 2007.

3.4.2 Data Collection Methods

The Uganda Bureau of Statistics (UBoS) collected data using questionnaires. The 2008/2009 Uganda Census of Agriculture (UCA) collected data on various structural characteristics of the agricultural holdings such as: Number and size of holdings; Land access/ownership/tenure and use; Demographic characteristics of the holder and his/her household; Use of agricultural labour; Access and use of implements and farm machinery etc.; Irrigation; Agricultural credit/loans; Agricultural buildings/storage facilities; Mode of transportation; Sources of agricultural information and, Access to facilities for example electricity, roads, markets, inputs among others.

3.5 Validity and Reliability of Data Collection

The researcher eliminated outliers and inconsistencies from the final dataset as much as possible in order to ensure that the dataset used is clear of minimal errors.

Missing data was dealt with to ensure data reliability by analysing only the available data while dropping the missing data and also imputing the missing data with replacement values, and treating these as if they were observed (e.g. last observation carried forward, imputing an assumed outcome such as assuming all were poor outcomes, imputing the mean, imputing based on predicted values from a regression analysis).

The variables were clearly defined and described so that the intended variables were captured for the measurement intended in order to ensure validity and reliability of data.

3.6 Ethical Considerations

The study used secondary data from Uganda Bureau of Statistics (UBoS) which was obtained from the institution's website. The farmers whose details are recorded in the data were anonymous since, their names were not captured to ensure confidentiality. The secondary data is also public and thus there was no need for obtaining consent.

3.7 Data Analysis

Data was organized, processed and summarized using STATA-13 software. STATA-13 software was used because it has capacity to handle large datasets and it is both command and menu intensive. The data used is quantitative and secondary in nature.

3.7.1 Univariate Analysis

The individual characteristics of the maize farmers were analyzed using measures of central tendency and dispersion organized in a table such as mean, standard deviation and frequencies. The variables included age, literacy, access to credit, access to extension, access to markets, family labour, hired labour, fertilizers, farmer membership and marital status. This was done to give a description of the variables used.

3.7.2 Bivariate Analysis

This looked at the relationship between access to credit, access to extension, access to market and maize productivity. The relationship between variables was done using Pearson correlation. This is because the variables correlated were continuous in nature. The 5 percent level of significance was used for acceptance or rejection of significance of the correlation coefficient. The comparison of the relationships showed how the variables were related to one another.

3.7.3 Multivariate Analysis

Multivariate analysis is the measure of the influence of various independent variables on a dependent variable. It shows how much each individual explanatory variable influences the dependent variable. The study employed a multiple linear regression model. This was used because the dependent variable which is maize productivity (yield) is continuous in nature. The 5 percent level of significance was used for acceptance or rejection of significance of the coefficients of the model.

3.7.4 Diagnostic Tests

In using cross sectional data, heteroscedasticity leads to biased parameter estimates. This is as a result of errors which may also increase as the values of independent variables increase or become more extreme in either direction and also due to measurement error and model misspecifications (Williams, 2015). Therefore heteroscedasticity was tested by Breusch-Pagan test and if found was dealt with by estimating robust standard errors.

Cross-sectional data was used in this study, which may not be normally distributed across the sample (Deaton, 1997). Use of irregularly distributed data in a regression analysis may result into inefficient estimates (Greene, 1993). Hence, data for continuous variables was tested for normality using the normality distribution graph procedure such as the histogram. Variables that were found not to be normally distributed were normalised by transforming the values into natural logarithm.

Multicollinearity among regressors is a common occurrence with cross sectional data. This happens when there is existence of a perfect or exact linear relationship among some or all regressors. The consequences for estimation and inference in the presence of multicollinearity include; unreliable estimation results; high standard errors; coefficients with wrong signs and implausible magnitudes among others (Belsley et al., 1980). It was detected by running a pair wise correlation among the regression, so that if the correlation coefficients between two regressors are high, then multicollinearity exists. Therefore multicollinearity was dealt with by clearly specifying the model through redefining the regressors.

3.8 Model Specification and Estimation

3.8.1 Model Specification

Maize productivity is a measure of the total Maize output that can be produced from a given set of inputs. It can be defined either as total output of a single product per unit of a single input or in terms of an index of multiple outputs relative to an index of multiple inputs (Precious, 2008). In this analysis, the research will measure Maize productivity as Yield (Metric Tons per Hectare).

Accordingly, a productivity equation for a given household is specified as below;

$$\mathbf{Yield_i = f\,(C_i, E_i, M_i)}$$

Where

$Yield_i$ is the total maize output per hectare for the i^{th} household

C_i is indicates access to credit services by the maize farmers for the i^{th} household

E_i indicates the access to extension services by the maize farmers for the i^{th} household.

M_i indicates the access to markets by the maize farmers for the i^{th} household.

The research assumes the production function, such that the equation to be estimated becomes a multiple linear regression model, given that the dependent variable is continuous and linear as below;

$$\mathbf{Y_i = \beta_0 + \beta_1 C + \beta_2 E + \beta_3 M + u_i}$$

Where

Y is Maize productivity or yield.

$\boldsymbol{\beta_i}$ are coefficients.

C is access to credit services.

E is access to extension services.

M is access to markets.

$\mathbf{u_i}$ is a disturbance term.

The variables and how they were captured are described as in the table below;

Table 3.1: Description of the variables

Variable	**Description**
Maize productivity or yield	Metric Tons per Hectare
Access to credit services	Loan amount received
Access to extension services	Number of extension visits received by the farmer in past 12 months
Access to markets	Distance to the local market (Kms)

3.8.3 Model estimation procedure

In estimating production functions, the Cobb-Douglas model is commonly used. However, the Cobb-Douglas although popular, has been questioned because of its restrictive assumptions such as homogeneity, separability and elasticity for substitution (Lyu *et al*, 1984). Therefore, the log-log functional form was estimated using ordinary least squares (OLS) as shown below.

$$\ln Y_i = \beta_0 + \beta_1 \ln C_i + \beta_2 \ln E_i + \beta_3 \ln M_i + u_i$$

4. Descriptive and Empirical findings and discussion

4.1 Univariate Analysis

The table below presents a descriptive summary of maize producers' demographic characteristics.

Table 4.1: Distribution of Maize Farmers' characteristics

Variable	Obs	Mean	Std. Dev.	Min	Max
Age (Years)	29897	45.78182	16.25202	12	99
Literacy (Yes=1)	29897	0.294946	0.4560261	0	1
Loan amount received	29896	124164	0.3297738	0	26132100
Access to extension (Number of visits)	29897	0.7728535	2.218576	0	60
Access to markets (Distance to the local market, Kms)	29897	5.337319	13.91947	0.001	500
Family labour (Individuals)	29897	1.906646	0.9841609	0	14
Hired labour (Individuals)	29897	6.773456	29.37577	0	960
Fertilizers (Yes=1)	29897	0.3097301	0.46239	0	1
Farmer membership (Yes=1)	29897	0.1540957	0.3610465	0	1
Yield (Metric tons per hectare)	29897	0.8768817	1.675912	0.006968	7.901247

Source: Author's calculations based on UCA 2008/2009

Table 4.1 above shows that on average the farmers had about 1 visit from the extension service officers and the some farmers were not visited at all and the maximum visits made were 60. The disparity in the number of extension visits is 2. This implies that fewer visits could affect the farmers maize productivity, given that it is too low and yet farmers need the extension services.

A maize farmer was on average 46 years and the disparity in the farmers' age was 16 years. The youngest farmer was 12 years and the oldest was 99 years. This shows that farmers are above the youthful age which could make them concentrate on their farms.

From the table above, it is clear that a higher proportion of the farmers were illiterate that is, they cannot read and write (0.3). This could lead to a reduction of maize productivity, since some farming practices require a farmer to read and write especially on recording the inputs used.

On average, maize farmers access credit of 124164 Uganda shillings. This is low and could negatively affect their maize productivity, since they need more credit to purchase inputs such as seedlings, hoes, tractors among others.

The average distance to the local market is about 5 kms. The disparity in the market access is about 14 kms. This is quite far away from the farmers and therefore farmers may not be able to sell their produce. This in turn could lead to a reduction in their maize productivity.

On average, 2 individuals were used as family labour and average of 7 individuals were used as hired labour on the maize farm. Since on average, more labour used is hired than family labour, then this could lead to more maize productivity, given the laziness of most family labour on the farms.

A higher proportion of the maize farmers did not use fertilizers (0.3). This could affect negatively their maize productivity since fertilizers tend to generally increase productivity on the farm.

Furthermore, a higher proportion of the maize farmers did not have membership to a farmer organization. This limits their access to agricultural services like extension, credit and markets among others, which in turn reduces their maize productivity.

Also, on average a maize farmer produces about 0.9 metric tons per hectare. This is too low, given the amount of arable land available in Uganda. However, this could partly be due to inaccessibility of agricultural services like credit, extension and markets among others.

4.2 Bivariate Analysis

The results are presented using Pearson correlation analysis since they are continuous in nature. Pearson correlation was used in order to ascertain the relationship between the variables used in this study and a 5% level of significance was considered as shown in the table below;

Table 4.2: Pearson Correlation Analysis Results

	Access to credit	**Access to extension**	**Access to markets**	**Maize productivity**
Access to credit	1			
Access to extension	0.1566* 0.000	1		
Access to markets	0.0278* 0.000	0.0021 0.239	1	
Maize productivity	0.0363* 0.000	0.0186* 0.000	-0.0333* 0.000	1

Correlation coefficient is significant at $p < 0.05$*

Maize productivity and access to credit have a very low positive correlation (0.0363) and this correlation is highly significant at 5%. It indicates that when access to credit increases (decreases), it leads to an increase (decrease) in maize productivity.

There is a very low positive correlation between maize productivity and access to extension (0.0186) and this correlation is highly significant at 5%. It indicates that when access to extension increases (decreases), it leads to an increase (decrease) in maize productivity.

There is a negative correlation between maize productivity and access to markets (-0.0333) and this correlation is highly significant at 5%. It implies that when access to markets increases (decreases), it leads to a decrease (increase) in maize productivity.

There is a low positive correlation between access to extension and access to markets (0.1566) and correlation is highly significant at 5%. This means that when access to extension increases (decreases), and then also access to markets increases (decreases).

Access to markets and access to credit have a very low positive correlation (0.0278) and this correlation is highly significant at 5%. It implies that when access to markets increases (decreases), and then also access to credit increases (decreases).

Access to markets and access to extension have a very low positive correlation (0.0021) and this correlation is not significant at 5%. It suggests that when access to markets increases (decreases), and then also access to extension increases (decreases).

4.3 Diagnostic Tests

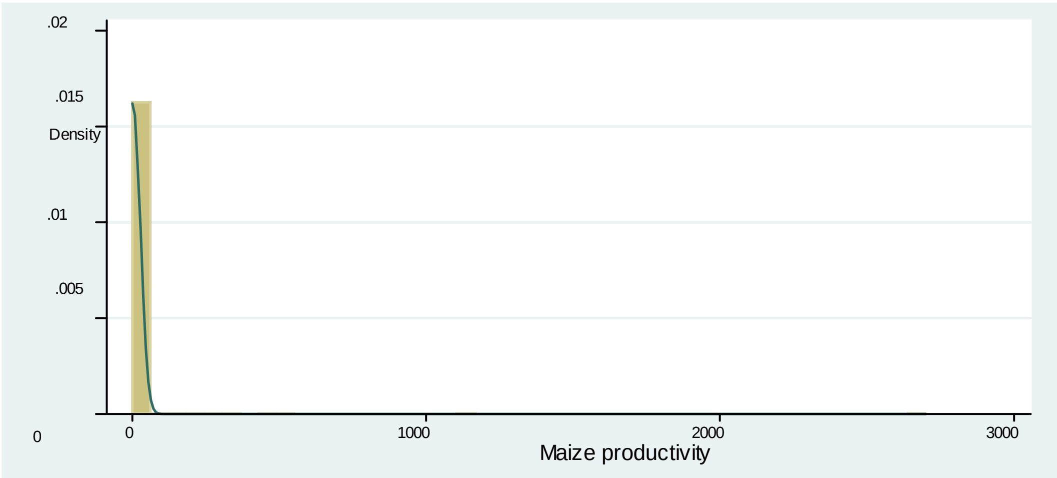
Testing for Heteroscedasticity

The study used the Breusch-pagan test and found out that the chi-square = 23.09 and this was significant at 5% level (p = 0.0000), thus implying that there was heteroscedasticity.

Since heteroscedasticity was detected, OLS with robust standard errors were run.

Testing for Normality

Use of irregularly distributed data that is which may not be normally distributed in a regression analysis may result into inefficient estimates (Greene, 1993). Hence, normality of the variables was tested using the normality distribution graph procedure such as the histogram. Variables that were found not to be normally distributed were normalised by transforming the values into natural



logarithm.

Figure 4.1: Maize Productivity Distribution

The above histogram shows that maize productivity is not normally distributed. Therefore this was normalised by transforming the values into natural logarithm.

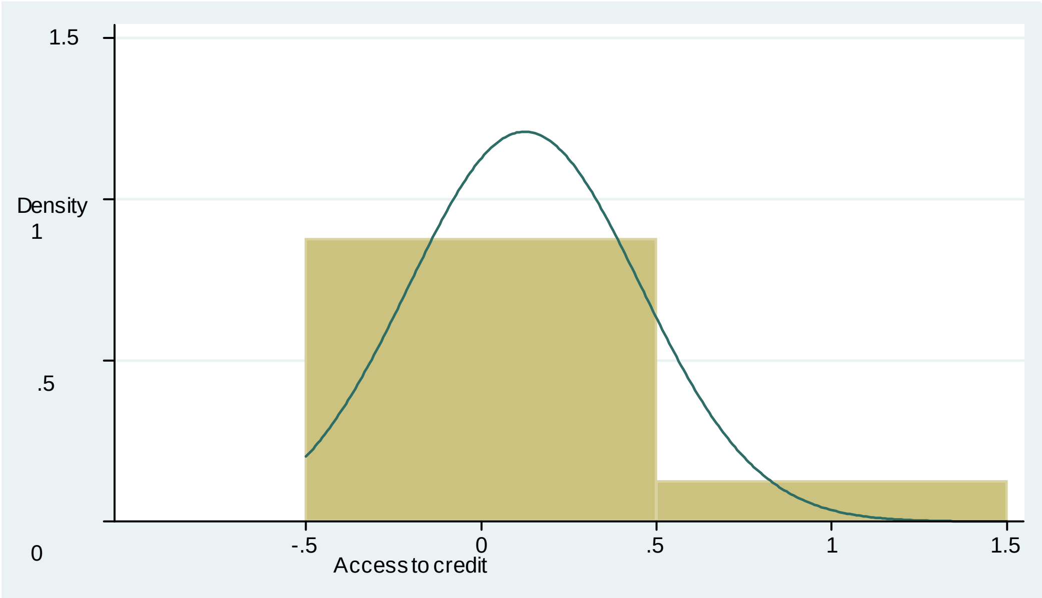


Figure 4.2: Access to Credit Distribution

From the above graph, access to credit is not normally distributed and therefore will be transformed by introducing natural logarithm to its values.

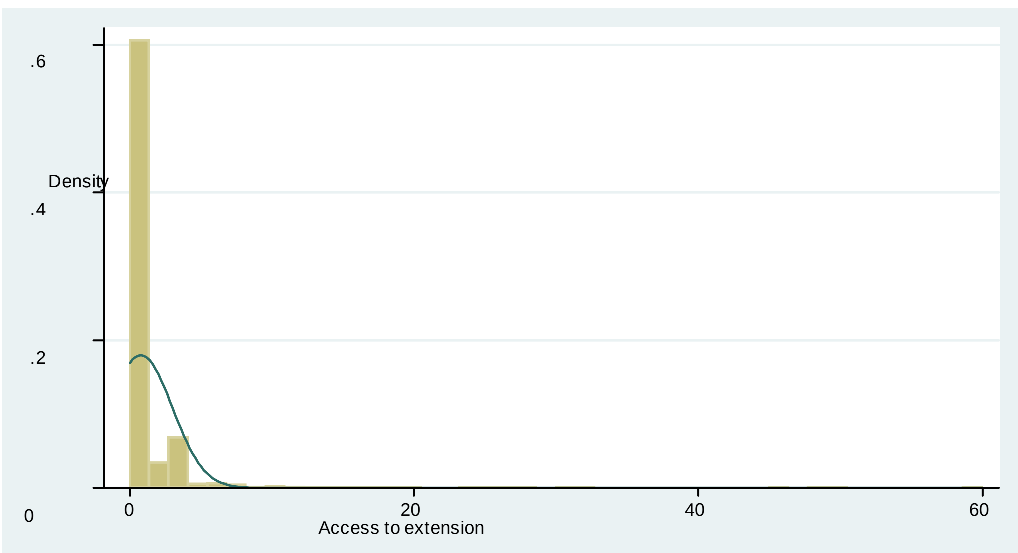


Figure 4.3: Access to Extension Distribution

Access to extension is also not normally distributed and thus will be transformed by introducing natural logarithm to its values.

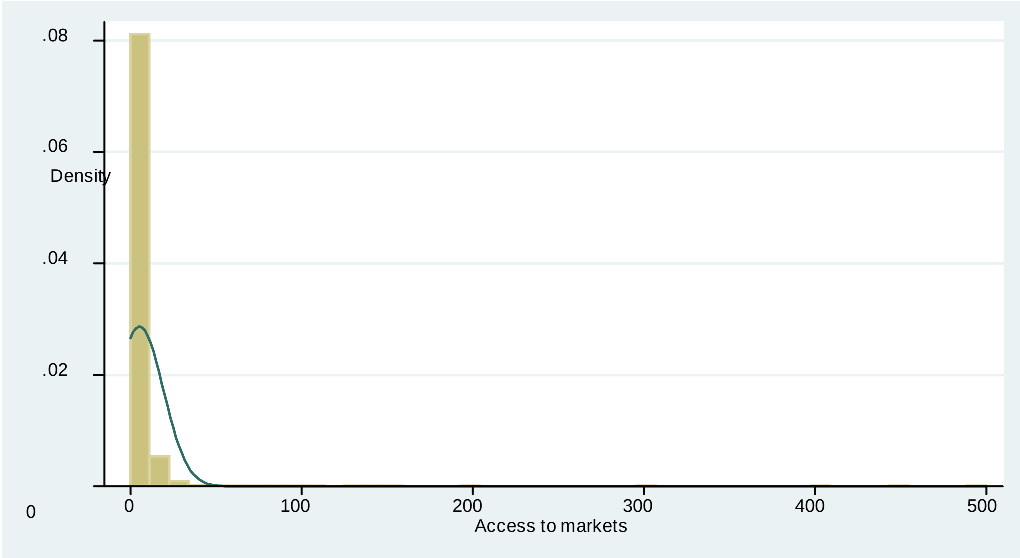


Figure 4.4: Access to Markets Distribution

Access to markets was found not to be normally distributed and was normalised by transforming the values into natural logarithm.

Testing for Multicollinearity

The table below shows a pair wise correlation which was run to establish the existence of multicollinearity.

Table 4.3: Pair wise correlation to establish the existence of multicollinearity

	Access to credit	Access to extension	Access to markets
Access to credit	1		
Access to extension	0.1380	1	
Access to markets	0.0278	0.0188	1

The correlation coefficients between the regressors are low. The correlation between access to credit and access to extension is 0.1380. The correlation between access to credit and access to markets is 0.0278. The correlation between access to extension and access to markets is 0.0188. This shows that multicollinearity does not exist.

4.4 Multivariate Analysis

The results are presented using multiple linear regression model since the dependent variable that is maize productivity is continuous in nature. The model was used in order to establish the influence of the independent variables that is access to credit, access to extension and access to markets on the dependent variable that is maize productivity. The 5% level of significance was considered as shown in the table below;

Table 4.4: Multiple Linear Regression Results

InMaize productivity (Yield)	**Robust Coefficients**	**Standard Errors**	**T**	**P>t**	**95% Confidence Interval**	
InAccess to credit (Loan amount received)	0.0675525	0.0278759	6.73	0.000	0.13291	0.24219
InAccess to extension (Number of visits)	0.0017866	0.0043977	0.41	0.685	-0.0068	0.010406
InAccess to markets (Distance to the local market, Kms)	-0.0041388	0.0007089	-5.84	0.000	-0.0055	-0.00275
Constant	0.8794538	0.0114587	-76.75	0.000	-0.9019	-0.85699
Number of obs = 29896 F(3, 29892) = 26.26 Prob > F = 0.0000 R-squared = 0.68						

From the table 4.3 above, the model is best fit (F (3, 29892) = 26.26, Prob > F = 0.0000). The independent variables that are access to credit, access to extension and access to markets explain 68% of the variation in the dependent variable that is maize productivity.

4.5 Interpretation and Discussion of model results

The maize productivity is equal to 0.8794538 metric tons, when access to credit, access to extension and access to markets is equal to zero.

A 1% increase in access credit leads to an average percentage increase in maize productivity by about 6.7%, keeping access to extension services and access to markets constant. This is statistically significant at 5% level (P>t = 0.000). The result is consistent with previous studies (Kiplimo, 2013; Mulinga, 2013; Kamau & Otieno, 2013) that access to credit services leads to increase in maize production. However, Simtowe et al (2009) emphasizes that there is a possibility for increasing the cultivation of hybrid maize in Malawi if credit is targeted at younger farmers that are credit-constrained.

A 1% increase in access to extension services leads to an average percentage increase in maize productivity by about 0.2%, keeping access to credit services and access to markets constant. This is not statistically significant at 5% level (P>t = 0.685). This is in line with (Bindlish & Evenson, 1993; Yilma & Berg, 2000; Nambiro et al, 2010; Adegboye et al, 2013; Mulinga (2013); Urassa, 2015) who asserted that extension services had positive effects on maize production.

A 1% increase in access to markets leads to an average percentage increase in maize productivity by about 0.4%, keeping access to credit services and extension services constant. This is statistically significant at 5% level (P>t = 0.000). The result supports the argument made by Maziku (2015) that the distance to market had shown negative effects on farmers' market participation. This implies that smallholder farmers' market participation increases with the reduction in the distance to the market. Likewise, Siziba et al (2011) also found a negative and significant effect of the distance to markets to agricultural production and argue that this underscores the adverse impact of increased transportation cost on market participation.

5. Conclusions

The findings of this study revealed that a 1% increase in access credit leads to an average percentage increase in maize productivity by about 6.7%, keeping access to extension services and access to markets constant. This is statistically significant at 5% level (P>t = 0.000). Therefore, the above null hypothesis was rejected in favour of the alternative that access to credit significantly influences maize productivity.

This study found out that a 1% change in access to extension services leads to an average percentage increase in maize productivity by about 0.2%, keeping access to credit services and access to markets constant. This is not statistically significant at 5% level (P>t = 0.685). Therefore, the researcher failed to reject the above null hypothesis that access to extension does not significantly influence maize productivity. This statistical insignificance could be due to a few visits or the quality of the extension services provided by the extension workers.

The findings of this study also show that a 1% change in access to markets leads to an average percentage increase in maize productivity by about 0.4%, keeping access to credit services and extension services constant. This is statistically significant at 5% level (P>t = 0.000). Therefore, the above null hypothesis was rejected in favour of the alternative that access to markets significantly influences maize productivity.

5.1 Recommendations

Given that access credit services leads to increase in maize productivity, suggests the need by government to strengthen measures for farmers to access credit through farmer groups, VSLS and farmer banks.

The fact that access to extension services leads to increase in maize productivity means that there is need by government to employ more extension workers to cover the largely unreached areas at the village levels

The central government should work together with the local governments in establishing maize produce markets in each sub-county in order to reduce the distance farmers take to reach the markets and through group marketing under farmer membership groups.

References

Abate, T., Shiferaw, B., Menkir, A., Wegary, D., Kebede, Y., Tesfaye, K., Keno, T., 2015. Factors that Transformed Maize Productivity in Ethiopia. Food Security, 7(5), 965-981. doi: 10.007/s12571-015- 0488-z

Adegboye, G.A., Oyinbo, O., Owolabi, J.O. and Hassan, O.S., 2013. Analysis of the sources and effect of extension information on output of women maize farmers in Soba Local Government Area of Kaduna State, Nigeria. *European Scientific Journal*, *9*(9).

Anderson, J.R. and Feder, G., 2004. Agricultural extension: Good intentions and hard realities. *The World Bank Research Observer, 19*(1), pp.41-60.

Anne, Lothoré & Patrick, Delmas., 2009. *Market Access and Agricultural Product Marketing; Promoting Farmer Initiatives.* AFD, CTA and inter-réseaux développement rural, France.

Antiago P Aubourg & Isabel Medina., 1999. *Influence of storage time and temperature on lipid deterioration during cod (Gadus morhua) and haddock (Melanogrammus aeglefinus) frozen storage.* Journal of the Science of Food and Agriculture, Volume 79, Issue 13.

Apekey, A., Manyire, H. and Olupot, M., 2015. Road Map for Mainstreaming Gender into Rural Agricultural Services for Poverty Reduction in Africa.

Argent, N., Burch, D., Rickson, R.E. and Lawrence, G., 1996. The globalized agriculture-finance relation: South Australian farm families and communities in a new regulatory environment. *Globalization and agri-food restructuring: perspectives from the Australasia region.*, pp.283-299.

Barrett, C.B., Sherlund, S.M. and Adesina, A.A., 2008. Shadow wages, allocative inefficiency, and labor supply in smallholder agriculture.*Agricultural Economics*, *38*(1), pp.21-34.

Barnum, H.N. and Squire, L., 1979. An Econometric Application of the Theory of the Farm-Household, *Journal of Development Economics* 6, pp.79-102.

Bart, Minten., 1999. *Infrastructure, market access, and agricultural prices: Evidence from Madagascar*. International Food Policy Research Institute, Washington, D.C, U.S.A

Battese, G.E. & Coelli, T.J., 1995. *A model for technical inefficiency effects in a stochastic frontier production function for panel data*. Empirical Econ. 20, 325–332.

Belsley, D.A., Kuh, E. and Welsch, R.E., 1980. Regression diagnostics. J.

Berthe, S.C., Derocles, S.A., Lunt, D.H., Kimball, B.A. and Evans, D.M., 2015. Simulated climate-warming increases Coleoptera activity-densities and reduces community diversity in a cereal crop. *Agriculture, Ecosystems & Environment*, *210*, pp.11-14.

Betz, M., 2009, July. The effectiveness of agricultural extension with respect to farm size: The case of Uganda. In *Paper provided by Agricultural and Applied Economics Association in its series 2009 Annual Meeting*.

Bindlish, V. and Evenson, R.E., 1993. *Evaluation of the performance of T&V extension in Kenya* (Vol. 23). Washington, DC: World Bank.

Binswanger-Mkhize, H.P. and Savastano, S., 2014. Agricultural intensification: the status in six African countries. *World Bank Policy Research Working Paper*, (7116).

Birthal, P.S., Ali, J., Nayyar, R. and Sharma, A.N., 2005. Potential of livestock sector in rural transformation. *Rural transformation in India: The role of non-farm sector*, pp.377-392.

Block, G. and DiSogra, C., 1994. WIC dietary assessment validation study. Final report. *US Department of Agriculture, Food and Nutrition Service, Alexandria, VA*.

Cerdán-Infantes, P., Maffioli, A. and Ubfal, D., 2008. The impact of agricultural extension services: the case of grape production in Argentina.*Office of Evaluation and Oversight, Inter-American Development Bank*.

Chan-Kang, P, Chan-Kang, S., Wood, J.R & Cremers, M., 1999. *Reassessing productivity growth in African agriculture.* Paper Presented at the AAEA Meetings, Nashville.

Chapoto, A. and Jayne, T.S., 2011. Zambian farmers' access to maize markets.

Chukwuji, C.O., Inoni, O.E. and Oyaide, W.J., 2006. A quantitative determination of allocative efficiency in broiler production in Delta State, Nigeria. *Agriculturae Conspectus Scientificus (ACS)*, *71*(1), pp.21-26.

Cuevas, C.E. and Graham, D.H., 1986. Rationing agricultural credit in developing countries: The role and determinants of transaction costs for borrowers. *Agriculture in a turbulent world economy*.

Deaton, A., 1997. *The analysis of household surveys: A Micro-econometric Approach to Development Policy*. World Bank Publications.

De Janvry, A., Sadoulet, E., & De Anda, G. G., 1995. NAFTA and Mexico's maize producers. *World Development*, *23*(8), 1349-1362.

Delgado, M.D.M., Ramos, E., Gallardo, R., Ramos, F., Huylenbroeck, G.V. and Durand, G., 2003. Multifunctionality and rural development: a necessary convergence. *Multifunctional agriculture: A new paradigm for European agriculture and rural development*, pp.19-36.

Dercon, S., 2008. Fate and fear: Risk and its consequences in Africa. *Journal of African Economies*, *17*(suppl 2), pp.ii97-ii127.

Etonihu, K.I., Rahman, S.A. and Usman, S., 2013. Determinants of access to agricultural credit among crop farmers in a farming community of Nasarawa State, Nigeria. *Journal of Development and Agricultural Economics*, *5*(5), pp.192-196.

Evenson, R.E. and Mwabu, G., 2001. The effect of agricultural extension on farm yields in Kenya. *African Development Review*, *13*(1), pp.1-23.

Fernandez-Cornejo, J. and Caswell, M.F., 2006. The first decade of genetically engineered crops in the United States. *USDA-ERS Economic Information Bulletin*, *11*.

Ferris, H. and Bongers, T., 2006. Nematode indicators of organic enrichment. *Journal of nematology*, *38*(1), p.3.

Foltz, J.D., 2004. Credit market access and profitability in Tunisian agriculture. *Agricultural Economics*, *30*(3), pp.229-240.

Frisvold, G. and Ingram, K., 1995. Sources of agricultural productivity growth and stagnation in sub-Saharan Africa. *Agricultural Economics*, *13*(1), pp.51-61.

Gautam, M. and Anderson, J.R., 1999. *Reconsidering the evidence on returns to T&V extension in Kenya* (Vol. 2098). World Bank Publications.

Government of Uganda., 2009. "*Macroeconomic Framework, Investments and Financing Options 2010/11-2014/15"*

Greene, William II., 1993. Econometric Analysis. New York: Macmillan.

Hansen, M.H., Hurwitz, W.N. and Madow, W.G., 1953. Sample Survey Methods and Theory.

Hardenburg, R.E, Watada, A. E & Wang, C.Y., 1986. *The Commercial Storage of fruits, Vegetables, florist and nursery stocks.* "Agriculture Handbook, USDA.

Henderson, D.R., Handy, C.R. and Neff, S., 1996. *Globalization of the processed foods market* (No. 04; HD9000. 5, G5.). US Department of Agriculture, ERS.

Heisey, P.W. and Edmeades, G.O., 1999. *World Maize: Facts and Trends 1997/98* (pp. 1-36). Mexico, DF: CIMMYT.

Hu, R., Cai, Y., Chen, K.Z. and Huang, J., 2012. Effects of inclusive public agricultural extension service: Results from a policy reform experiment in western China. *China Economic Review*, *23*(4), pp.962-974.

Humphrey, T.M., 1997. Algebraic production functions and their uses before Cobb-Douglas. *FRB Richmond Economic Quarterly*, *83*(1), pp.51-83.

Hobbs, R., 1997. Future landscapes and the future of landscape ecology. *Landscape and urban planning*, *37*(1), pp.1-9.

Holloway, L. and Kneafsey, M., 2000. Reading the space of the farmers' market: a preliminary investigation from the UK. *Sociologia Ruralis*, *40*(3), pp.285-299.

IFAD., 2003. Promoting Market Access for the Rural Poor in Order to Achieve the Millennium Development Goals. Discussion Paper. IFAD.

Jamison, D.T. and Lau, L.J., 1982. *Farmer education and farm efficiency*. Published for the World Bank [by] Johns Hopkins University Press.

Jensen, T., Apan, A., Young, F. and Zeller, L., 2007. Detecting the attributes of a wheat crop using digital imagery acquired from a low-altitude platform. *Computers and Electronics in Agriculture*, *59*(1), pp.66-77.

Kaganzi, E., Ferris, S., Barham, J., Abenakyo, A., Sanginga, P. and Njuki, J., 2009. Sustaining linkages to high value markets through collective action in Uganda. *Food policy*, *34*(1), pp.23-30.

Kamau, D. and Otieno, D., 2013. The Influence of Non-Equity Financing on Maize Production in Uasin Gishu County, Kenya. *Journal of Economics and Sustainable Development, ISSN*, pp.2222-2855.

Kiplimo, J.C., 2013. *Determinants of access to credit by smallholder farmers in Eastern and Western Kenya* (Doctoral dissertation, Strathmore University).

Koskela, J., Nygren, P., Berninger, F. and Luukkanen, O., 2000. Implications of the Kyoto Protocol for tropical forest management and land use: prospects and pitfalls.

Krugman, P., 1994. Competitiveness: a dangerous obsession. *Foreign affairs*, pp.28-44.

Kyomugisha, Elizabeth., 2008. *Value chains for agriculture exports in Uganda. International Food Policy Research*, Washington Dc, USA.

Le Heron, R., 1991. New Zealand Agriculture and Changes in the Agriculture—Finance Relation during the 1980s. *Environment and Planning A*, *23*(11), pp.1653-1670.

Lilyan, Fulginiti E., Richard K. Perrin & Bingxin Yu., 2004. *Institutions and agricultural productivity in Sub-Saharan Africa. Department of Agricultural Economics,* University of Nebraska, Lincoln, NE 68583, USA.

Lusigi, A. and Thirtle, C., 1997. Total factor productivity and the effects of R&D in African agriculture. *Journal of International Development*, *9*(4), pp.529-538.

Lyu, S.J.L., White, F.C. and Lu, Y.C., 1984. Estimating effects of agricultural research and extension expenditures on productivity: a translog production function approach. *Journal of Agricultural and Applied Economics*, *16*(2), p.1.

MAAIF (Ministry of Agriculture, Animal Industry & Fisheries)., 2010. Agriculture for Food and Income Security Agriculture Sector Development Strategy and Investment Plan:2010/11- 2014-15.

Mather, D., Boughton, D. and Jayne, T.S., 2013. Explaining smallholder maize marketing in southern and eastern Africa: The roles of market access, technology and household resource endowments. *Food Policy*, *43*, pp.248-266.

Maziku, P., Hella, J. and Makindara, J., 2015. Effects of non tariff barriers on market participation for maize smallholder farmers in Tanzania. *Journal of Development and Agricultural Economics*, *7*(11), pp.373-385.

Manuel, Villar et al., 2012. *Disentangling food quantity and quality effects in zooplankton response to P-enrichment and UV radiation.* The Association for the Sciences of Limnology and Oceanography, Inc.

Mcharo, A.C., 2013. *Perception of farmers on effectiveness of agricultural extension agents in knowledge transfer to maize growers in Kilindi district* (Doctoral dissertation, Sokoine University of Agriculture).

Martey, E., Wiredu, A.N. and Etwire, P.M., 2015. Impact of Credit on Technical Efficiency of Maize Producing Households in Northern Ghana. *Selected Paper Prepared for Presentation at the Centre for the Study of African Economies (CSAE) Conference*.

Marsden, T., 1990. Towards the political economy of pluriactivity. *Journal of rural studies*, *6*(4), pp.375-382.

Menyha, E., 2010. *Effect of Agricultural Inputs and Extension Services on Household Crop Production in Uganda* (Doctoral dissertation, Makerere University).

Minten, B., Tamru, S., Engida, E. and Kuma, T., 2013. Ethiopia's value chain on the move: the case of teff.

Mugisha, J., Katungi, E & Katwijukye, A.K., 2010. *Enhancing potato production and market access in Uganda.* Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda.

Mulinga, N., 2013. Economic Analysis of Factors Affecting Technical Efficiency of Smallholders Maize Production on Rwanda. *Rwanda Journal*,*1*(1), pp.52-62.

Musiime E., Keizire B., & Muwanga M., 2005. *Organic Agriculture in Uganda: The Need for a Coherent Policy Framework*. ACODE Policy Research Series No.11, 2005.

Muwonge, A., 2007. Local government financing and provision in an institutionally constrained decentralized system: The case of agricultural extension in Uganda.

Msuya, E.E., Hisano, S. and Nariu, T., 2008. Explaining productivity variation among smallholder maize farmers in Tanzania.

Nambiro, Elizabeth, Jonas Chianu, and Alice W. Murage. "The association of agricultural information services and technical efficiency among maize producers in Kakamega, western Kenya." In *2010 AAAE Third Conference/AEASA 48th Conference, September 19-23, 2010, Cape Town, South Africa*, no. 95961. African Association of Agricultural Economists (AAAE) & Agricultural Economics Association of South Africa (AEASA), 2010.

Nyamekye, I. and Ntoni, J.O., 2016. Effect of Human Capital On Maize Productivity In Ghana: A Quantile Regression Approach. *International Journal of Food and Agricultural Economics*, *4*(2), p.125.

Odhiambo, W., Nyangito, H. and Nzuma, J., 2003. *Measuring and analysing agricultural productivity in Kenya: A review of approaches*. Kenya Institute for Public Policy Research and Analysis.

Okoboi, G., 2011. Improved inputs use, productivity and commercialization in Uganda maize production. *A PhD Desertation, Makerere University*.

Okoboi, G., Kuteesa, A. and Barungi, M., 2013. The impact of the National Agricultural Advisory Services Program on household production and welfare in Uganda. *African Growth Initiative. Working Paper*, *7*.

Owen, D.L., Swift, T. and Hunt, K., 2001, September. Questioning the role of stakeholder engagement in social and ethical accounting, auditing and reporting. In *Accounting forum* (Vol. 25, No. 3, pp. 264-282). Blackwell Publishers Ltd.

Pratt, A.N. and Diao, X., 2008. Exploring growth linkages and market opportunities for agriculture in Southern Africa. *Journal of Economic Integration*, pp.104-137.

Precious Zikhali., 2008. *Fast Track Land Reform and Agricultural Productivity in Zimbabwe.* Environment for Development, Washington DC.

Ransom, J.K., Paudyal, K. and Adhikari, K., 2003. Adoption of improved maize varieties in the hills of Nepal. *Agricultural Economics*, *29*(3), pp.299-305.

Rao, D.S.P. and Coelli, T.J., 1998. A cross-country analysis of GDP growth catch-up and convergence in productivity and inequality. *Centre for Efficiency and Productivity Analysis (CEPA) Working Paper No. 5*, *98*.

Rosenzweig, M.R., Binswanger, H.P., 1993. Wealth, Weather Risk and The Composition and Profitability of Agricultural Investments. Economic Journal 103, 56–78.

Ray, D., 1998. *Development economics*. Princeton University Press.

Roberts, E.H., 1990. *The design of seed storage facilities for Genetic conservation.* University of Reading, UK.

Shiferaw, B.A., Kebede, T.A. and You, L., 2008. Technology adoption under seed access constraints and the economic impacts of improved pigeonpea varieties in Tanzania. *Agricultural Economics*, *39*(3), pp.309-323.

Staal, S., Delgado, C. and Nicholson, C., 1997. Smallholder dairying under transactions costs in East Africa. *World development*, *25*(5), pp.779-794.

Statistics, U.B.O., 2001. Statistical Abstract. *Uganda Bureau of Statistics*.

Stockle, C.O., Papendick, R.I., Saxton, K.E., Campbell, G.S. and Van Evert, F.K., 1994. A framework for evaluating the sustainability of agricultural production systems. *American Journal of Alternative Agriculture*, *9*(1-2), pp.45-50.

Sink, D.S., Tuttle, T.C. and DeVries, S.J., 1984. Productivity measurement and evaluation: what is available?. *National Productivity Review*, *3*(3), pp.265-287.

Siziba, S., Nyikahadzoi, K., Diagne, A., Fatunbi, A.O. and Adekunle, A.A., 2011. Determinants of cereal market participation by sub-Saharan Africa smallholder farmer. *Journals of Agriculture & Environmental Studies*, *2*(1).

Simtowe, F., Zeller, M. and Diagne, A., 2009. The impact of credit constraints on the adoption of hybrid maize in Malawi. *Review of Agricultural and environmental studies*, *90*(1), pp.5-22.

Smailes, P.J., Burch, D., Rickson, R.E. and Lawrence, G., 1996. Entrenched farm indebtedness and the process of agrarian change: a case study and its implications. *Globalization and agri-food restructuring: perspectives from the Australasia region.*, pp.301-322.

Sokoni, C.H., 2008. Commercialisation of smallholder production in Tanzania: implications for sustainable resources management. *The Geographical Journal*, *174*(2), pp.158-161.

Suhariyanto, K. and Thirtle, C., 2001. Asian agricultural productivity and convergence. *Journal of Agricultural Economics*, *52*(3), pp.96-110.

Tibaidhukira, S.K. and Consult, S., 2011. Agricultural Sector Budgetary Allocations in Uganda.

Thirtle, C., Lin, L. and Piesse, J., 2003. The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America. *World Development*, *31*(12), pp.1959-1975.

Uganda Bureau of Statistics (UBoS)., 2010. Uganda Census of Agriculture 2008/2009, Crop Area and Production Report, Vol IV.

UBoS (Uganda Bureau of Statistics) 2007. Statistical Abstract 2007, Kampala, Uganda

Uganda, M.F.P.E.D., 2010. *National Development Plan* (Vol. 15). 2010/11–2014.

Urassa, J.K., 2015. Factors influencing maize crop production at household levels: A case of Rukwa Region in the southern highlands of Tanzania.*African Journal of Agricultural Research*, *10*(10), pp.1097-1106.

Van den Ban, A.W. and Hawkins, H.S., 1996. *Agricultural extension*. Blackwell Science Ltd.

Vlek, P.L.G.,1990. *The role of fertilizers in sustaining agriculture in sub-Saharan Africa.* International Fertilizer Development Center-Africa, Lome, Togo.

Von Braun, J., 1995. Agricultural commercialization: impacts on income and nutrition and implications for policy. *Food policy*, *20*(3), pp.187-202.

Waddington, S.R., Li, X., Dixon, J., Hyman, G. and De Vicente, M.C., 2010. Getting the focus right: production constraints for six major food crops in Asian and African farming systems. *Food security*, *2*(1), pp.27-48.

Wicksteed, P.H., 1894. *An Essay on the Co-ordination of the Laws of Distribution* (Vol. 12). Macmillan & Company.

World Bank, 2011, Agriculture for Development: World Development Report 2008, Washington, DC

Yilma, T., Berg, E. and Berger, T., 2008. The Agricultural Technology–Market Linkage under Liberalisation in Ghana: Evidence from Micro Data. *Journal of African Economies*, *17*(1), pp.62-84.

Yorobe, J.M. and Smale, M., 2012. Impacts of Bt maize on smallholder income in the Philippines.

Zerfu, D. and Larson, D.F., 2010. Incomplete markets and fertilizer use: evidence from Ethiopia. *World Bank Policy Research Working Paper Series, Vol*.

Zeller, M., Diagne, A. and Mataya, C., 1998. Market access by smallholder farmers in Malawi: Implications for technology adoption, agricultural productivity and crop income. *Agricultural Economics*, *19*(1), pp.219-229.