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ABSTRACT

This study looked at the factors determining commercialization of smallholder farming in Kenya. The household characteristics were captured by gender of household head, household labour size, age of household head and the education level of household head. On the other hand, farm level characteristics were captured by the size of the farm and application of irrigation. The intervening variables in the study were the access to transport, income from non – farm activities and income from livestock sales. The study used cross-sectional data based on farm household surveyed in 2011 by the Kenya Agricultural Productivity and Agribusiness Program. Probit model was used to model the empirical analysis. The results show that the likelihood of small holder commercialisation statistically increases with the application of irrigation, increase in the household labour force and increase in the land size under farming. On the control variables, access to agricultural credit, access to transport facilities, use of improved seeds, presence of non-farm income, use of extension services were all found to positively and significantly influence commercialisation of small holder farming in Kenya. Based on the findings of the study, the study recommends on the need by both the national and the county governments to invest in empowering the small holder farmers through provision of irrigation infrastructure. Further given that the size of the land is core in influencing commercialisation of small holder farming in Kenya, there is need for relooking at the land tenure system with a view of having putting a cap on the minimum land acreage to prevent high level of land fragmentation which would adversely affect production and ultimately commercialization of small holder farming. The results show that the likelihood of small holder commercialisation statistically increases with the use of irrigation, access to agricultural credit, access to transport facilities, use of improved seeds, presence of non-farm income, use of extension services, size of the labour force and the farm size. The positive association of farm income and market participation suggests that farm and non-farm activities are complementary. This may point to existence of household credit constraints with off-farm income serving to relieve this constraint. Being female and age is associated with a negative effect on commercialization. These findings are supportive of the current national policy to expand irrigation investments in Kenya, improve the rural infrastructure especially through the County governments and calls for development of a coherent credit policy for small holder farmers

Keyword: *Household Characteristics, Farm Level Characteristics, Transport, Income from Non-Farm Activities, Income from Livestock Sales*

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INTRODUCTION

The practice of agriculture dates as far back as ten thousand years ago, when human beings abandoned their foraging lifestyle in favour of settlements, where they cultivated crops and domesticated animals (Greg & Angus, 1993). Foraging gave humans preliminary knowledge of what plants were edible, medicinal or poisonous, as well as what animals to domesticate for labour, meat, skin and milk. A shift in climatic conditions was thought to provide major impetus for the cultivation of crops and domestication of animals (Encyclopedia Britannica, 2013).

The contribution of agriculture to the industrial revolution is articulated by Nosotro (2010) who says that, "In order for a country to industrialize, it must first take care of its food problem. The industrial revolution was dependent upon the agricultural revolution. The surplus of crops produced on farms provided the opportunity for the cities to develop."

Mc-Rae (2003) points out that in order to feed the world's population, expected to stand at 9 billion in 2050, the world shall have to focus on delivering food security, environmental sustainability and economic opportunity. He further states that "This will require producing more food with fewer resources while reinvigorating rural economies. It can be achieved through collaboration, investment and innovation among all stakeholders."

In the past, agricultural innovations in Kenya concentrated on improvement in production of major food crops such as maize, wheat, rice, beans and Irish potato (Government of Kenya [GoK] *et al.,* 2005). However, little attention was placed on the improvement of traditional food crops production and on development of entrepreneurship among smallholder rural farm households necessary for commercialisation of agricultural activities (GoK, 2007). Commercialisation of agricultural activities among smallholder households has been touted as a crucial means of achieving food security (GoK, 2005). Other than increasing income for households, it promotes efficient use of scarce resources in rural areas leading to faster development (Dannson, *et al*., 2004). One major hindrance to achieving food security is low level of value addition especially through agro-processing which can impact on food security by reducing food losses, increasing food availability and improving access to food (GOK, 2004; Thapa, 2000).

In recent times, agriculturists and extension workers in Kenya have incorporated the development of entrepreneurial capabilities among rural farm households and the commercialisation of traditional crops production into their agenda, encouraging farmers to develop entrepreneurial capabilities. However, much of the efforts towards commercialization of small holder farming seem to be donor funded. For example, many of the programmes for smallholder diary commercialization and smallholder horticulture marketing.

Transformation of agriculture through key institutions in agriculture, livestock, forestry and wildlife is core to the realization of vision 2030 (GOK, 2008). This therefore informs the significance of this study. Kenya being an agricultural – based economy, with about 75 per cent of the total population deriving their livelihood directly or indirectly from agriculture, agricultural growth via commercialization is core in poverty reduction. However, despite this realization, a wide gap continues to exist between the policy formulation and implementation. This therefore, informs this research.

Several efforts have been directed towards commercialization of small holder farming in Kenya. Table 1 below presents evidence that commercialization of small holder farms in Kenya is not a new concept but rather it has a long history. However, despite these efforts, conversion of small holder farming from subsistence farming to commercial farming has not fully materialised.

Statement of the Problem

According to the World Development Report of 2008, agriculture is critical in achieving global poverty reduction targets. It is still the single most

important productive sector in most low-income countries, often in terms of its share of gross domestic product and employment.

There is an irrefutable connection between agriculture and economic growth. Periods of high economic growth rates have been synonymous with increased agricultural growth as can be seen from Figure 1 below. Agriculture has, for many years, formed the backbone of Kenya's economy: the agriculture sector contributes about 30 per cent of the gross domestic product (GDP) and accounts for 80 per cent of national employment, mainly in the rural areas. In addition, the sector contributes more than 60 per cent of the total export earnings and about 45 per cent of government revenue, while providing for most of the country's food requirements. The sector is estimated to have a further indirect contribution of nearly 27 per cent of GDP through linkages with manufacturing, distribution, and other service-related sectors (KNBS Reports).

Governments are embracing policies and programmes intended to promote sustainable economic development and poverty reduction (FAO, 2007). This according to World Bank (2009) is because; the MDGs cannot be met in most low-income countries, especially in Africa, without a productivity revolution in agriculture. However, agricultural productivity revolution cannot be achieved unless policies and programs are put in place that enable agriculture to work as an engine of growth and poverty reduction (FAO, 2007).

Raising agricultural production and productivity remains crucial for reducing poverty in a cost-effective manner, especially in developing countries like Kenya (FAO, 2007). The propensity for agriculture to contribute to poverty reduction is a function of the type of the economy the agriculture sector is embedded in and the structure of the sector, especially with regards to the distribution of land. For example – in a smallholder-based and labour-intensive agriculture sector like Kenya, and Africa as a whole, higher land and labour productivity lead to rapid reductions in poverty. China cut poverty very rapidly during the 1980's to mid-1990s during a period of strong agricultural growth, as it started from a situation of relatively equal access to farmland and human capital. FAO, 2007 further details that in order for agricultural growth to include the poor, it should utilize the assets typically owned by the poor. In all cases, the poor own their own labour, and is some cases, this is all they own. Thus, growth that generates employment increases wages and upgrades the quality of jobs especially for unskilled labour, is of crucial importance for reducing poverty and increasing access to adequate food in terms of quantity and quality.

Despite the potential that smallholder commercial farming displays in economic development and improvement of livelihoods of people in emerging countries, there are still hinderances impeding the shift from subsistence to smallholder commercial farming. This is not only for low income countries but also the middle income ones such as India (Singh *et al* 2003). Therefore, for countries to improve agricultural production and productivity there is need for policies that encourage adoption of smallholder commercial farming. However, for this to happen there is need to single out factors that could inhibit the transition from subsistence to smallholder commercial farming. FAO (2012) observes that such a transition reduces poverty levels and grows the economy. The WDR, 2008 presents a robust analysis on how agricultural growth has a two-to-four times impact in improving the livelihoods of the poorest people than from non-agricultural growth (World Bank, 2009).

Participation in agriculture commercialization can be viewed as a binary choice decision problem by farm households that try to maximize utility or net returns. This study therefore seeks to investigate and shed light on the factors determining transition from subsistence to smallholder commercial farming in Kenya. Kenya has vast amount of untapped agricultural potential which if exploited could transform many livelihoods and help achieve envisaged targets for agriculture under the Vision

2030. The results of the study will contribute to formulation of policies and programs meant to unlock commercialisation potential of small scale agriculture in Kenya.

Transforming the subsistence-oriented production system into a market-oriented production system as a way of increasing smallholder farmer's income and reduce rural poverty has been in the policy limelight of many developing countries including Kenya. However, there is paucity of evidence in Kenya with regard to the determinants of commercialization of smallholder farming, a gap that this study seeks to fill.

Objectives of the Study

The main objective of this study was to establish factors determining commercialization of Smallholder Farming in Kenya. Specifically, the study sought to:

- Establish the household characteristics that affect commercialization of smallholder farming in Kenya
- Distinguish the farm level characteristics that affect commercialization of smallholder farming in Kenya
- Examine the intervening effect of access to transport, income from non-farm activities and income from livestock sales on the relationship between household characteristics and farm level characteristics on one hand and commercialization of smallholder farming in Kenya on the other hand.

The study sought to answer the following questions:

- What household characteristics affect commercialization of smallholder farming in Kenya?
- What farm level characteristics affect commercialization of smallholder farming in Kenya?
- What is the intervening effect of access to transport, income from non-farm activities and income from livestock sales on the relationship between household characteristics and farm level characteristics on one hand and commercialization of smallholder farming in Kenya on the other hand?

LITERATURE REVIEW

Theoretical Literature Review

The Concept of Smallholder Subsistence and Commercial Farming

The simplest and conventional meaning of a smallholder is the case when the land available for a farmer is very limited (Chamberlin, 2008; Hazell *et al*., 2007). However, the meaning goes far beyond this conventional definition and consists of some general characteristics that the so-called small farms or smallholders generally exhibit. Chamberlin (2008) has identified four themes on the basis of which smallholders can be differentiated from others: landholding size, wealth, market orientation, and level of vulnerability to risk. Accordingly, the smallholder is the one with limited land availability, poor-resource endowments, subsistence-oriented and highly vulnerable to risk. Nevertheless, the smallholder may or may not exhibit all these dimensions of smallness simultaneously. It is also common to set numeric value as a way to define small farms. Hazell *et al*. (2007), note that some literature define small farms as "those with less than two hectares of crop land" while others define smallholders as those endowed with 'limited resources,' such as land, capital, skills and labour. Similarly, there are also those authors who often describe small farms in terms of the low technology they mostly use, their heavy dependence on household labour and their subsistence orientation.

There seems to also be no consensus on a common definition of subsistence farming (Wharton, 1970). The definition can be approached from the perspective of either consumption or production (Kostov and Lingrad, 2002). As a consumption perspective, subsistence farming is farming "in which crop production, livestock rearing and other activities are conducted mainly for personal consumption, characterized by low productivity, risk and uncertainty" (Torado, 1997). From the

perspective of production, subsistence farming is farming in which less than 50% of production is sold (Kostov and Lingrad, 2004). Accordingly, it can be concluded that there is no clear definition of subsistence farming and its definition tend to be situation specific.

Importance of the Subject Area

The WDR 2008 states that agriculture can "produce faster growth, reduce poverty and sustain the environment" if it is made to work in concert with other sectors of the economy (World Bank, 2007). The report stipulates three ways through which agriculture contributes to development: 1) as an economic activity, 2) as a livelihood and 3) as a provider of environmental services.

As an economic activity, agriculture helps the rural poor to achieve food security since majority of them derive their incomes from agricultural production. Specially, this contribution becomes vivid in the case of Sub-Saharan Africa where majority of the people experience highly variable domestic production, limited tradability of food staples and foreign exchange constraints. As a source of livelihood, agriculture provides shelter to 86% of the rural poor. In fact, nearly half of the world population lives in rural areas and most of these depend on agriculture; smallholder households are about 1.5 billion. Interestingly, the decline in poverty rate of developing countries from 28% to 22% in 2002 is mainly attributed to falling poverty in rural areas; and 80% of the decline in rural areas is related exclusively to better conditions in rural areas. Despite the negative environmental outcomes-such as underground water depletion, soil exhaustion and agrochemical change, associated with agriculture, it is being recognized now that agriculture can positively affect the environment by sequestering carbon, managing watersheds and preserving biodiversity.

Policy Implications of Agricultural Commercialization

The benefits of commercialization are multifaceted. Von Braun and Kennedy (1994) state that commercialization plays a significant role in increasing incomes and stimulating rural growth, through improving employment opportunities; increasing agricultural rural productivity; direct income benefit for employees and employers; expanding food supply and potentially improving nutritional status (Leavy and Poulton, 2007). In most cases, these increased incomes have led to increased food consumption (Bouis, 1994; Pender & Dawit, 2007) and improved nutrition (Kennedy 1994; Pender & Dawit, 2007).

Empirical Literature Review

Commercialization of smallholder farming can achieve its objectives and bring about the required benefits to the poor and rural based households when certain factors influencing its potential success or those that affect a farm household's decision to participate in the market are put in place. These influencing factors may be different for different contexts but empirical data refer to a host of factors common in the context of developing countries. A number of studies have been carried out with respect this area of study.

Von Braun *et al*. (1994) point out that there are several exogenous factors that determine commercialization: population change, availability of new technologies, infrastructure and market creation, and macroeconomic and trade policies are considered to be among the most important driving forces.

Leavy and Poulton (2007) identified three critical conditions that need to be in place if agricultural commercialization is to be a success for the smallholder. These are market access, access to staple foods and asset accumulation. Market access can be achieved in many ways. Many organizations including the Department for International Development, African Development Bank and Swedish International Development Corporation (which advocate the market for the poor policy) believe that smallholder farmers can have better access to the market as a consequence of 'agricultural growth' and better infrastructural developments (Leavy and Poulton, 2007). Market for the poor initiatives also emphasize the need for

better market information, strong farmer organizations and promotion of contract farming as a component of the effort to help farmers access the market.

The second critical condition for viability of agricultural commercialization that Leavy and Poulton (2007) have identified is access to food markets and food production. There are two contrasting views with regard to whether smallholders should focus on food crop or cash crop production. There are those who disagree with the claims of those who suggest that small farms should produce and sell high valued cash crops and buy food crops from the market with the income from the cash crops. They argue that such venture has high risk of food insecurity and price variations given the imperfections of rural food markets in Africa. Hence, smallholder priorities for subsistence farming are considered to be rational even if these farmers could have earned better incomes by diversifying into cash crop production. On the other side, there are those who argue that farm households producing cash crops to the market would mostly integrate food crops in their production system. Thus, they are less susceptible to food insecurity; rather, they get higher yields in their food crop production than the purely subsistence-based households (Von Braun and Kennedy 1994; Leavy and Poulton, 2007).

The third critical factor in the pursuit of commercialization is asset accumulation, according to Leavy and Poulton (2007). Specifically, this refers to land and animal traction (livestock plus equipment). Land is obviously one critical factor that determines the chance of participation of a farm household in commercialization. In a study covering five African countries, Jayne *et al*. (2003) found that poor households are less responsive to market opportunities as a consequence of lack of land, capital and education (Leavy and Poulton, 2007). Moreover, they found out that per capita income of households generally increases with increment in landholding size. Leavy and Poulton (2007) argue that farmers with small land holdings are forced to devote the largest portion of their land for food crop production given the poor food crop markets they are dependent in. Jayne *et al*. (2003) suggest that a strong system must be in place to provide technical advice; supply improved seeds and high value crops; supply fertilizer at an affordable rate to the poor; and create better linkages to a market for a high value crop if the effort to intensify and commercialize small sized farms is to be successful (Leavy and Poulton, 2007).

Pender and Dawit (2007) have developed a long list of factors that affect commercialization at local level based on the findings of different researchers (Pender *et al*., 2006). Accordingly, commercialization is affected by agro-climatic conditions and risks; access to market and infrastructure; community and household resources and endowments; development of local commodity, input and factor markets; laws and institutions; and cultural and social factors affecting consumption preference, production, and market opportunities and constraints.

Mahelet (2007) in his study on commercialization of smallholder farming in Ethiopia identified several factors that can either facilitate or constrain the commercialization of smallholder farming in the context of developing countries in general and Ethiopia in particular. These factors include, among others, distance to the market, transport access and road access; availability of credit, extension services and market information; output, input and factor prices; land size, access to modern inputs and storage facilities; and integration into the output market.

Factors external to the farm includes input/factor markets, output markets and institutional factors (legal, organizational structure, and infrastructure). Input and output market development can be explained in terms of transaction costs (Williamson, 1979). High transaction costs can explain low participation or low commercial orientation (Pingali *et al* 2005). These high transaction costs and hence low development of input markets can be related to poor infrastructure, unsystematic market

information, low bargaining power and a monopoly of suppliers. Factor inputs include fertilizers, pesticides, seed, animal breeds, machinery, and extension services. Although there is widespread acceptance that all of these are relevant to the transition to commercial agriculture, there is lack of empirical studies of the direct relationship between the supply and use of these factors and the commercialization process.

Conceptual Framework

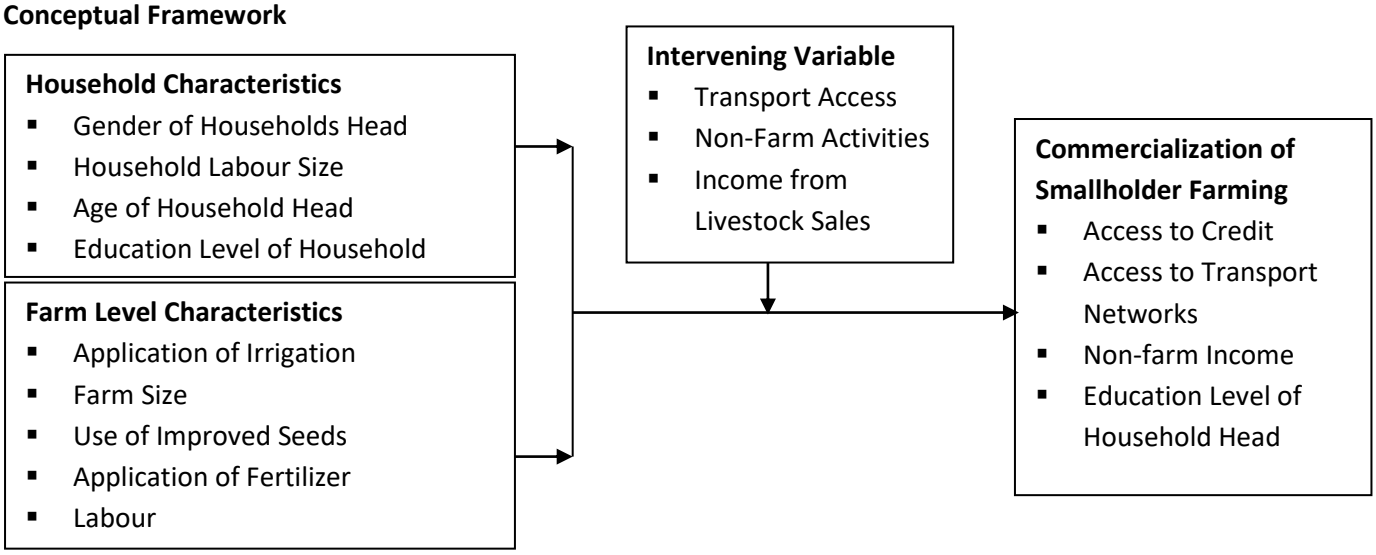

Figure 1: Conceptual Framework

METHODOLOGY

Research Design: The researcher used cross-sectional (or survey) design to analyze Kenya Agricultural Productivity and Agribusiness Program Gender Disaggregated Baseline Household Survey data. The survey was conducted in 2011 by Tegemeo Institute of Agricultural Policy and Development.

Target Population: The target population for the survey was households in Kenya engaging in agricultural activities but within the same locations and divisions where Kenya Agricultural Productivity Programme (KAPP) was being implemented

Sampling Frame: The sampling frame for the household survey was prepared with consultation with the Kenya National Bureau of Statistics (KNBS). The sample size was pre-determined by Tegemeo Institute team.

Sample and Sampling Technique: The survey targeted to cover 2,027 households that were under KAPP and additional 500 households drawn from new locations where KAPAP had expanded thus making a total of 2,527 households. The 500 additional households were to be sampled as control, drawn from locations where the KAPAP was not covering.

Multi-stage sampling method was used in selecting the non-KAPAP locations, sub-locations and villages from where the households were selected. In the selected villages, a team of researchers from Tegemeo together village elders/area assistant chiefs drew a list of all households in each village

Instruments: Three questionnaires were designed for this survey; household; individual; and community. The household and individual questionnaires were largely similar in content and only differed in terms of the scope of the information collected

Data Analysis: The researcher employed descriptive, statistical and econometric methods to analyze the secondary data obtained

RESULTS AND DISCUSSION

Descriptive Statistics

The descriptive statistics of the study variables are presented in tables 1 as follows:

Table 1: Descriptive Statistics

Variable	Frequency		Percent	Cumulative
HCI (Commercialization)				
No market participation	131		5.18	5.18
Presence of market participation	2,398		94.82	100.00
Gender				
Female	824		32.58	32.58
Male	1,705		67.42	100.00
Age				
Young (Age <= 25 years)	174		6.88	6.88
Old (<= 26 yrs Age <= 50 yrs)	1,669		66.02	72.90
Senior (Age >=51 yrs)	685		27.10	100
Education				
No education	359		14.20	15.97
Primary Education	1,241	337	49.07	65.05
Secondary education	592		13.33	78.37
Tertiary Education			23.41	100.00
Farm size				
Less than 3 acres	1,971		77.94	77.94
Greater than 3 acres	558		22.06	100
Use of improved Seeds				
Don't use certified seeds	1,392		55.04	55.04
Use certified seeds	1,137		44.96	100.00
Use of fertilizer (FERT)				
Don't apply fertilizer	1,513		59.83	59.83
Apply fertilizer	1,016		40.17	100.00
Apply Irrigation (IRR)				
Do not undertake irrigation	1,634		64.61	64.61
Undertake irrigation	895		35.39	100.00
Use Credit (CR)				
Do take agricultural credit	1,591		62.91	62.91
Use agricultural credit	938		37.09	100.00
Household Labour Size (L)				
Small labour force	45		1.78	1.78
Large labour force	2,484		98.22	100
Sought extension services				
Don't seek extension services	1,395		55.16	55.16
Seek extension services	1,134		44.84	100.00
Non-farm activities				
Don't participate in non-farm activities	99		3.91	3.91
Participate in non-farm activities	2,430		96.09	96.09
Total income from livestock sales				
Absence of income from livestock	99		3.91	3.91
Presence of income from livestock	2,430		96.09	100
Transport Access				
Lack of access to transport	1,091		43.14	43.14
Presence of access to transport	1,438		56.86	100.00

Out of the 2529 surveyed households, about 94.8 percent (2398) participated in the market. The rest 131 (5.18 percent) did not participate. Looking into the gender composition of the household head, about 32.6 percent of the total households are female headed while 67. 4 percent of the households are male headed. Variables proxying for market participation include use of improved seeds, fertilizer, agricultural credit, extension services, participation in non – farm activities, income from livestock farming and access to transport. The results show that about 55.0, 59.8, 62.9, 55.2, 3.9 and 43.1 percent respectively of the total household surveyed had no access to these facilities.

Diagnostic Statistics

Diagnostic tests carried out included the test of linearity, test for homoscedasticity, multicollinearity test and test of serial autocorrelation. These are presented in Tables below.

Test of Linearity

Test of linearity aims to determine the relationship between independent variables and the dependent variable is linear or not. The decision-making process in the linearity tests are as follows:

- If the p-Value for deviation of linearity > than 0.05, the relationship between the independent variable and the dependent variable are linearly dependent
- If the p-Value for deviation of linearity < than 0.05, the relationship between the independent variable and the dependent variable is not linear

Table 2: Commercialization of Smallholder Farming and Household Characteristics

			Sum of Squares	df	Mean Square	F	Sig.
Commercialization of smallholder farming *Household characteristics	Between Groups	(Combined)	825.316	37	22.306	444.087	.000
		Linearity	791.689	1	791.689	15761.748	.000
		Deviation from Linearity	33.627	36	.934	18.597	.163
	Within Groups		125.119	2491	.050		
	Total		950.435	2528			

Based on the ANOVA output table, the p-value for deviation of linearity is 0.163>0.05. It can therefore be concluded that there is a linear relationship between Commercialization of smallholder farming and household characteristics

Table 3: Commercialization of Smallholder Farming and Farm Level Characteristics

			Sum of Squares	df	Mean Square	F	Sig.
Commercialization of smallholder farming *Farm level characteristics	Between Groups	(Combined)	225.852	17	13.285	46.040	.000
		Linearity	136.49	1	136.490	472.997	.000
		Deviation from Linearity	89.362	16	5.585	19.355	.392
	Within Groups		724.583	2511	.289		
	Total		950.435	2528			

Based on the ANOVA output table, the p-value for deviation of linearity is 0.392>0.05. It can therefore be concluded that there is a linear relationship between commercialization of smallholder farming and farm level characteristics

Test for Homoscedasticity

Homoscedasticity or the test for homogeneity of variance is usually carried out using Breusch-Pagan statistics with an aim of avoiding the ordinary least square method used in multiple linear regression analysis from generating coefficient estimates which may lead to biased conclusions during hypotheses testing as recommended by Brooks (2002). Homogeneity of variance) assumes that the variance of the dependent variable is roughly the same at all levels of the independent variables.

Table 4: Breusch - Pagan Test for Homoscedasticity

Breusch -Pagan Test Statistic	Degrees of Freedom	p-Value
0.634	1	0.443

For Breusch-Pagan test the null hypothesis assumes homoscedasticity which is stated as follows:

Null Hypothesis (H_0): The data (residuals) is homoscedastic

Alternative Hypothesis (H_1): The data is heteroscedastic

The decision rule is:

If p-Value > α; then null hypothesis is rejected.

If p-Value < α; then we fail to reject the null hypothesis.

Where α is the level of significance (alpha)

Test for homoscedasticity in this study generated a p-Value of 0.443 (Table 4). This implies that the model homoscedasticity assumption was satisfied indicating that the variance for commercialization of smallholder farming was not heteroscedastic. Therefore, the regression analysis proposed for this study was suitable for further hypotheses testing.

Test for Multicollinearity

Prior to the running of the linear regression model with both household and farm level characteristics as the independent variables and commercialization of smallholder farming as dependent variable, the data was subjected to multicollinearity test (Table 4.5). As was noted by Mittal and Mehar (2016), it is crucial to look into the problem of multicollinearity among the explanatory variables before estimation of the regression model parameters. Multicollinearity exists when study variables are highly correlated with each other within a data set which may have a negative effect on the parameters of measurement especially in a regression model and could produce misleading results (Brooks, 2002).

Table 5: Tests for Multicollinearity

	Collinearity Statistics	
	Tolerance	**VIF**
Household characteristics (Aggregate)	0.305	3.278
Farm level characteristics (Aggregate.)	0.304	3.290

As illustrated in table 5 above, the tolerance values for all the variables were higher than the acceptable level of 0.1 as suggested by (Menard, 2018) while the VIF for the five predictors variables were less than 10 which is the recommended threshold as suggested by (Kutner *et al.,* 2004). Both VIF and tolerance values indicated that the independent variables were not highly correlated with each other, hence the data was free from multicollinearity problems and worth in further analysis.

Test of Serial Autocorrelation

The cross-correlation of a signal with itself at a different point in time is called autocorrelation. The autocorrelation test helped determine whether there are other omitted variables, misspecification of the regression equation, or systematic errors in the measurement of variables.

Table 6: Durbin Watson Test

Relationship	Durbin Watson Statistics
Household characteristics	2.125
Farm level characteristics	1.842

The Hypotheses for the Durbin Watson test are:
H_0 = No first order autocorrelation
H_1 = First order correlation exists.
(For a first-order correlation, the lag is a one-time unit).
A rule of thumb is that test statistic values in the range of 1.5 to 2.5 are relatively normal. Values outside of this range could be cause for concern. Field (2009) suggests that values under 1 or more than 3 are a definite cause for concern. For the current study, Durbin Watson statistic for all the four predictors between 1.842 (Farm level characteristics) and 2.125 (household characteristics) which falls within the relatively normal range and therefore there was no presence of autocorrelation in the residuals from a regression analysis.

Cross tables between Commercialization of Agriculture and Respective Variables

The tables below showed the results of market participation by different explanatory variables namely gender, irrigation, use of credit, fertilizers, extension services, improved seeds, access to transport services, presence of non – farm income, income from livestock keeping and labour force employed in farming. In this section, HCI denotes the probability of the household participation in the market.

Table 7: Commercialization versus Gender

	Gender		
HCI	0	1	Total
0	40	91	131
1	784	1,614	2,398
Total	**824**	**1,705**	**2,529**

Where being male = 1 and female =0.

Table 7 posits that 784 of female headed participated in the markets while only 40 households did not participate. For male headed households 91 did not participate in the market with 1,614 male headed households participating in the market.

Table 8: Commercialization versus Irrigation

	Use of irrigation		
HCI	0	1	Total
0	74	57	131
1	1,560	838	2,398
Total	**1,634**	**895**	**2,529**

Where use of irrigation = 1 and no use of irrigation = 0.

From table 8, 74 households who did not practise irrigation did not participate in the market with 1,560 households not practising irrigation being involved in commercialization. For household practising irrigation, 57 did not participate in market with 838 being engaged in the market.

Table 9: Commercialization versus Credit

	Use of Credit		
HCI	0	1	Total
0	77	54	131
1	1,514	884	2,398
Total	**1,591**	**938**	**2,529**

Where use of credit = 1 and no use of credit = 0

Table 9 postulates that 77 household who did not use agricultural credit did not participate in the market with 1514 of those not using credit participating while 54 household that used credit did not participate in the market with 884 households participating.

Table 10: Commercialization versus Fertilizers

	Use of fertilizers		
HCI	0	1	Total
0	78	53	131
1	1,435	963	2,398
Total	**1,513**	**1,016**	**2,529**

Where use of fertilizer = 1 and no use of fertilizer = 0

On the usage of fertilizer, 78 households did not use fertilizer and did not participate in the market with 1535 households participating despite of them having not used fertilizer. Out of those who used fertilizer, 53 households did not participate in the market with 963 households participating.

Table 11: Commercialization versus Extension Services

	Use of Extension Services		
HCI	0	1	Total
0	59	72	131
1	1,336	1,062	2,398
Total	**1,395**	**1,134**	**2,529**

Where use of extension services = 1 and no use of extension services =

Table 11 revealed that 59 households did not seek extension services and did not participate in the market as well with 1336 households participating. On the other hand, 72 households sought for extension services but did not participate in the market while 1062 households participated upon seeking extension services.

Table 12: Commercialization versus Transport Access

	Transport Access		
HCI	0	1	Total
0	79	52	131
1	1,012	1,386	2,398
Total	**1,091**	**1,438**	**2,529**

Where ease transport access = 1 and no transport access = 0

Looking at transport access, 79 households who did not have access to good transport infrastructure did not participate in the market with 1012 households participating. On the other hand, 52 households

had access to good transport infrastructure but did not participate with 1386 households participating (Table 12).

Table 13: Commercialization Versus Use of Improved Seed

	Use of improved seeds		
HCI	0	1	Total
0	74	57	131
1	1,318	1,080	2,398
Total	**1,392**	**1,137**	**2,529**

Where use of improved seeds = 1 and no use of improved seeds = 0

Reflecting on the use of improved seeds we find that 74 households did not use improved seeds and did not participate in the market as well with 1318 households participating. On the other hand, 57 households who used improved seeds did not participate on the market with 1080 households participating.

Table 14: Commercialization versus non – Farm Income

	Non – farm income		
HCI	0	1	Total
0	4	127	131
1	95	2,303	2,398
Total	**99**	**2,430**	**2,529**

Where presence of non – farm income = 1 and absence of non-farm income = 0

For non – farm income, 4 households who did not participate in the market had no – farm income with 95 households who participated in market having non – farm income. On the other hand, 127 households who did not participate in the market had non – farm income with 2303 households with non-farm income participating in the market (Table 14).

Table 15: Commercialization versus Livestock Income

	Livestock income		
HCI	0	1	Total
0	4	127	131
1	95	2,303	2,398
Total	**99**	**2,430**	**2,529**

Where presence of livestock income = 1 and absence of livestock income = 0

From table 15 we deduce that 4 households who did not participate and did not have income from livestock as well. On the other hand, 127 households who had income from households did not participate in the market with 2303 households participating.

Table 16: Commercialization versus Labour Force

	Labour Force		
HCI	0	1	Total
0	12	119	131
1	33	2,365	2,398
Total	**45**	**2,484**	**2,529**

Where labour force is greater than mean = 1 and labour force is less than mean = 0

Figure 16 alludes that 12 households who did not participate in the market had labour force that was less than average force for the entire sample households with 33 who participated in the market having labour force that was beyond the average labour force for the sample. On the other hand, 119 households who did not participate had labour force that was above the average for the entire sample with 2365 households with above average labour force participating in the market.

Econometric Analysis: Results and Discussion

Objective one: Household and Farm Level characteristics Determining commercialization of Smallholder Farmers in Kenya

This section presents the findings of the econometric analysis using a probit model as explained in section 3.7. The analysis included all the sampled 2529 households. The Probit regression results are presented in Table 17 below.

Table 17: Regression Results for Probit Model

Dependent variable: Household participates in the market=1, 0 otherwise

	Coef.	Std. Err.	z	P>|z|
Gender	-0.0309	0.0949	-0.330	0.745
Irrigation	0.1526	0.0873	1.750	0.080
Credit	0.0722	0.0878	0.820	0.010
Fertilizer	0.0178	0.0883	0.200	0.040
Extension services	0.2238	0.0876	2.560	0.011
Transport access	0.2907	0.0878	3.310	0.001
Improved seeds	0.0853	0.0883	0.970	0.034
Non - farm income	0.1086	0.2380	0.460	0.048
Education	0.0446	0.0395	1.130	0.258
Labour	0.9156	0.2155	4.250	0.000
Age	-0.0019	0.0037	-0.510	0.612
Farm size	0.0069	0.0082	0.850	0.098
Constant	-0.0343	0.5407	-0.060	0.949

Number of obs = 25280
LR chi2(12) = 47.710
Prob > chi2 = 0.0000
Pseudo R2 = 0.0463

From the results, apart from being female and age of the farmer, all the other characteristics in Table 17 are associated with a higher likelihood that the farmer will participate in the market. These factors are: the use of irrigation, access to agricultural credit facilities, access to transport facilities, use of improved seeds, and presence of non – farm income, use of extension services, the size of the labour force and the farm size. The respective coefficients of these variables are positive and significant. Market participation is also likely to increase with level of education. However, the coefficient is not significant. Although being female is likely to reduce the likelihood of market participation, the effect is insignificant.

However, to determine the significant variables, we check the probability column. From the respective probability values for the variables, we conclude that application of irrigation, use of irrigation, access to agricultural credit facilities, access to transport facilities, use of improved seeds, use of extension services and the size of the labour force, age of the farmer and the farm size and presence of non – farm income are all significant in determining the households' participation in the market. This is

because their respective probability values are less than the 5 percent significance level or the 5 percent error of margin. Therefore, we are 95 percent confident that these variables are more likely to influence the households' commercialization of agriculture.

Further, in order to determine the magnitude of the effect for each respective variable on commercialization of agriculture, we compute the marginal effects for all the variables. These are reported in Table 18.

Table 18: Marginal Effects – Probit model

	dy/dx [Marginal Effects]	Std. Err.	z	P>|z|
Gender	-0.0030	0.0949	-0.330	0.745
Irrigation	0.0148	0.0873	1.750	0.080
Credit	0.0070	0.0878	0.820	0.010
Fertilizer	0.0017	0.0883	0.200	0.040
Extension services	0.0217	0.0876	2.560	0.011
Transport access	0.0281	0.0878	3.310	0.001
Improved seeds	0.0083	0.0883	0.970	0.034
Non - farm income	0.0105	0.2380	0.460	0.048
Education	0.0043	0.0395	1.130	0.258
Labour	0.0886	0.2155	4.250	0.000
Age	-0.0002	0.0037	-0.510	0.612
Farm size	0.0007	0.0082	0.850	0.098

The marginal effects are given by the dy/dx column. From the results we find that intensification of irrigation by 1 percent raises the probability of market participation by about 0.02 percent. Similarly, this marginal effect for agricultural credit is 0.01 percent that of extension services is 0.02 percent, access to transport facilities is 0.03 percent, and improved seeds is 0.01 percent and of non – farm income 0.01 percent. A 1% increase in labour seem to raise the probability of household's commercialization by the highest proportion of about 0.09 percent. The results are as would be expected since use of agricultural credit has the potential to relief working capital constraints, thus leading to an increase agricultural output and production surpluses that can then be sold. In addition, the use of agricultural credit comes with a cost in terms of repayment obligations and therefore the household may need to participate in the market in order to raise the necessary income for the loan repayment. The large effect associated with an increase in the labour force points to labor-intensive small holder farms among the surveyed households.

Looking at the access to transport variable, we find the access to transport facility increases commercialization by assuring the household faster and reliable way of getting the product to the market thus avoiding wastage. In addition, access to better transport facilities would reduce the transport costs thus assuring the farmer more profit margins upon participation in the market. These findings concur with those of Pender and Dawit (2007), Mahelet (2007) and Leavey and Poulton (2007).

Similarly, the use of the improved seeds infers into increased production due to the fact that improved seeds are more resistant to diseases thus increased yield as opposed to the ordinary seeds. This leads to the surplus production that is offered to the market for sale hence increased market participation.

On the other hand, we find that the presence of non – farm income is more likely to cause

commercialization of farming among small holder farmers in Kenya. This is because, if a household has another reliable source of income, then they are empowered to purchase improved seeds, fertilizers, employ more labour thus leading to participation in the market. These results are also in agreement with the findings by Pender and Dawit (2007) who reported that commercialization of agriculture is influenced by among other factors household resources and endowments.

Objective Two: Level of Commercialization

This section presents findings on the determinants of commercialization (HCI) level as explained in Section 3.8. Table 19 below presents the key descriptive statistics for the sample.

Table 19: Descriptive Statistics of Current Level of Commercialization

Variable	min	max	mean	variance	Std. deviation
HCI	0.0000	1.0000	0.63320	0.09767	0.3125

Looking at the level of commercialization we find that the minimum level of commercialization is 0.0 implying the presence of purely subsistence households in our data set while the maximum level is 1.0 implying the presence of fully commercialized households in our data set. On average the level of commercialization for all the households sampled is 0.63 implying 63.32 percent commercialization level. The current level of commercialization for individual households are given in the appendices.

Objective Three: Household and Farm Level Characteristics Explaining Variation in the Level of Commercialization of Smallholder Farmers in Kenya

This section presents the findings of the econometric analysis using a Tobit Model. The analysis included all the sampled 2529 households. The Tobit regression results are presented in Table 20 below.

Table 20: Tobit Model Regression Results

	Tobit regression			**Number of obs = 2528**	
				LR chi2(12) = 31.26	
				Prob > chi2 = 0.0018	
	Log likelihood = 150.33045			**Pseudo R2 = 0.0942**	
	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]
Gender	-0.0119	0.0102	-1.170	0.243	-0.0317 0.0080
Irrigation	0.0196	0.0097	2.030	0.043	-0.0386 -0.0006
Credit	0.0079	0.0096	0.820	0.013	-0.0267 0.0109
Fertilizer	0.0015	0.0095	0.150	0.029	-0.0201 0.0172
Extension services	0.0227	0.0094	2.400	0.016	-0.0411 -0.0041
Transport access	0.0395	0.0095	4.180	0.000	0.0209 0.0580
Improved seeds	0.0084	0.0095	0.890	0.075	-0.0101 0.0269
Non - farm income	0.0130	0.0239	0.550	0.005	-0.0598 0.0337
Education	0.0046	0.0041	1.110	0.016	-0.0034 0.0125
Labour	0.0044	0.0015	0.030	0.026	-0.0030 0.0029
Age	-0.0002	0.0004	-0.490	0.627	-0.0009 0.0005
Farm size	0.0009	0.0012	0.740	0.036	-0.0014 0.0032
Constant	0.9594	0.0341	28.160	0.000	0.8926 1.0262
/sigma	0.2321	0.0034			0.2253 0.2387
Obs. summary:	131 left-censored observations at HCI<=0				
	2397 uncensored observations				
	0 right-censored observations				

From the results, the likelihood ratio chi-square of 150.33 (df = 12) with a p-value of 0.002 tells us that our model as a whole fit significantly better than an empty model that is a model with no predictors). In the table we see the coefficients, their standard errors, the t-statistic, associated p-values, and the 95% confidence interval of the coefficients. The coefficients for irrigation, use of fertilizer, use of credit, use of extension services, access to transport, presence of non-farm income, labour size, education level and farm size are statistically significant at 5 percent significance level with only use of improved seeds being significant at 10 percent significance level.

From the findings of the study noted that, irrigation, use of fertilizer, use of credit, use of extension services, access to transport, presence of non-farm income, labour size, education level and farm size were significant for level of commercialization. These findings were in line with the findings of Leavy and Poulton (2007) who noted three conditions for agricultural commercialization which were access, access to staple foods and asset accumulation. Mahelet (2007) also noted several factors that affect commercialization which were; availability of credit, extension services and market information; output, input and factor prices; land size, access to modern inputs and storage facilities; and integration into the output market. However, Leavy and Poulton (2007) noted that Land is one of the critical factors that determines the chance of participation of a farm household in commercialization.

Summary of Hypothesis

Test of hypothesis was done at 95% confidence level.

Table 21: Summary of Test of Hypothesis

s. no.	Hypothesis (Null)	LR Chi-Sq.	Prob > Chi-Sq.	Decision
1	Household and Farm Level characteristics do not determine commercialization of Smallholder Farmers in Kenya	47.710	0.000	Reject null hypothesis Accept alternative hypothesis
2	Household and Farm Level Characteristics Explaining Variation in the Level of Commercialization of Smallholder Farmers in Kenya	31.26	0.0018	Reject null hypothesis Accept alternative hypothesis

CONCLUSION AND POLICY IMPLICATIONS

Out of the 2529 surveyed households, about 94.8 percent (2398) participated in the market. The rest 131 (5.18 percent) did not participate. Looking into the gender composition of the household head, about 32.6 percent of the total households are female headed while 67. 4 percent of the households are male headed.

apart from being female and age of the farmer, all the other characteristics are associated with a higher likelihood that the farmer will participate in the market. These factors are: the use of irrigation, access to agricultural credit facilities, access to transport facilities, use of improved seeds, and presence of non – farm income, use of extension services, the size of the labour force and the farm size.

The marginal effects are given by the dy/dx column. From the results we find that intensification of irrigation by 1 percent raises the probability of market participation by about 0.02 percent. Similarly, this marginal effect for agricultural credit is 0.01 percent that of extension services is 0.02 percent, access to transport facilities is 0.03 percent, and improved seeds is 0.01 percent and of non – farm income 0.01 percent. A 1% increase in labour seem to raise the probability of household's commercialization by the highest proportion of about 0.09 percent.

Conclusion

The study involved investigating the commercialization of smallholder farming in Kenya. More specifically, the study sought to answer the questions: what is the current level of

commercialization among small holder farmers in Kenya? What are the determinants of farm commercialization of small holder farmers in Kenya? To answer these questions, data from 2529 farm households surveyed in 2011 was used. The survey was conducted by the Kenya Agricultural Productivity Agribusiness Project. A probit model was estimated in attempt to examine the factors driving farm commercialization.

The results show that the main factors that are more likely to increase commercialization of smallholder farming in Kenya are: use of irrigation, agricultural credit, access to extension services, access to transport networks and adequate labour for farm households. Use of irrigation tends to reduce reliance on the rain fed agriculture and therefore ensuring an all year-round production hence participation in the market is guaranteed given the consistency in production. Access to agricultural loans reduce working capital constraints thus enabling acquisition of purchased farm inputs that may go a long way in promoting increased production and probably a surplus that can be offered to the market.

The study also found that the access to good transport network is core in necessitating commercialization of small holder farming in Kenya. This is because a good and reliable transport network reduces transport costs and possible wastage that may arise from poor transport infrastructure. In addition, through the reduced transport costs and reduced time to the market, a good transport network can lead to an increase in the farmers' profit margins thus encouraging more market participation. Lastly, availability of labour is likely to promote commercialization among the small holder farmers. The fact that non – farm income also raises the probability of commercialisation suggests that it is complementary to farm income. This would be expected for credit constrained farm households. For such households, non-farm income can be a source of working capital.

Policy Implications

From the results of the study there are a number of the policy implications that emerge with regard to the commercialization of smallholder farming in Kenya.

Given the study finds that use of irrigation is more likely to cause a household participate in the market, there is need to expand the existing irrigation infrastructure. There is need to increase the budgetary allocation for the expansion and even setting up of new irrigation infrastructure by both the central and the county governments so as to reduce the overreliance on the rain – fed agriculture.

With regard to agricultural credit facility, there may be need to develop a coherent credit policy for small holder farms that takes into consideration the risk associated with individual small-scale farmers. This finding is supportive of upscaling initiatives such as the Programme for Rural Outreach of Financial Innovations and Technologies (PROFIT) housed by the National Treasury that aim at promoting lending to the small holder farm business.

Good maintenance of the feeder roads in the rural roads especially by the county governments is core in facilitating the access to the market thus minimising wastage. The fact that access to non-farm income is associated with higher market participation may imply that the devolution policy that leads to development of local markets would lead to an increase in commercialisation of small holder farms. Country government official need to be alert of these potential multiplier effects.

Areas for Further Research

This study was limited to crop and mixed farm households covered in this survey and to the period of observation. Factors limiting commercialisation of small-scale producers who only keep livestock are therefore missed in this study. There is need for further study on the commercialization of such farms.

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