Social Networks and Extent of African Leafy Vegetables’ Commercialization among Kenyan Smallholders: A Double Hurdle Approach

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C. Mwema¹; W. Crewett¹; J. Lagat²; W. Bokelmann¹

1: Humboldt University, Albrecht Daniel Thaer-Institute of Agricultural and Horticultural Sciences, Germany, 2: Egerton University, Agricultural Economics and Agribusiness Management, Kenya

Corresponding author email: cmwema007@gmail.com

Abstract:
Access to market information is an important determinant in agricultural commercialisation. However, most econometric analysis have ignored effects of market information networks that necessitate dissemination among smallholders. This paper aims to assess the effects of social networks on commercialisation of African Leafy Vegetables (ALVs). ALVs which were once considered as poor man’s crop have increasingly become an important crop due to the increased nutritional awareness especially among urban dwellers. We model its commercialisation using a two stage double hurdle model: participation decision and extent of commercialisation. The paper is based on data collected in 2015 from a household survey on 202 small holder vegetable farmers in Kenya. Econometric analysis were conducted on STATA 13. Social networks were found significant determinants in intensifying ALVs commercialisation. Market information received by people outside the village (bridging social capital) increased the likelihood of intensifying ALVs commercialisation by 52%. Market information received by fellow farmers mainly through farmer groups had a positive likelihood of intensifying commercialisation by 365% compared to information received by extension officers. Other positive determinants of ALVs commercialisation were farm size, household size, ALVs income share while negative determinants were livestock unit, age, and share of off farm income.

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1.0 Introduction

Over the recent years, African Leafy Vegetables (ALVs) which were considered as poor man’s crop consumed in rural areas have increasingly become an important crop in both urban and peri urban areas. In Kenya, there is evidence that demand for indigenous vegetables has been growing (Weinberger et al., 2011; Abukutsa-Onyango, 2007; Ngugi et al., 2007; Onyango et al., 2007; Irungu, et al. 2007). This has been exacerbated by the increased nutritional awareness of ALVs especially among urban dwellers (Muhanji et al., 2011). Generally, ALVs have been found to have higher levels of various nutrients than the conventionally cultivated species (Shackleton et al., 2003). For instance, ALVs contain up to 80% of the recommended daily requirement of iron and 18-54% of protein requirement (Abakutsa-Onyango, 2010). The increasing demand of ALVs needs to be encouraged and exploited for the benefit of small-scale producers. It’s of importance to identify and address the major constraints to commercialisation of ALVs so that they can continue to play a significant role in providing jobs, food security and income for the resource poor.

Commercialisation of agri food systems is vital for economic development. Smallholder farmers form the majority of farmers in most of the developing countries. In Kenya, 80% of Fresh Fruits and Vegetables (FFVs) farmers comprise of small scale farmers form (GoK, 2012). Commercialization can therefore achieve the goal of sustainable economic development when smallholders are engaged as part of the solution to global food security problem. Most of the smallholder farmers focus on a subsistence level of production. Access to new and better-paying markets for agricultural products is thus important in enhancing and diversifying the livelihoods of small holder farmers (Barrett, 2008). As a result, changing their production practices from highly subsistence level towards highly market-oriented level. Despite the opportunities for agricultural commercialisation, small holder farmers still face numerous challenges in accessing input and output markets. Among other challenges, high transaction
costs have been found to hinder commercialisation efforts of small holder farmers (Key et al., 2000; Ouma et al., 2010; Okoye et al; 2016). Cost of searching and obtaining market information is among transaction costs that constrain agricultural commercialisation (Key et al., 2000).

Access to market information has been found an important determinant in agricultural commercialisation (Ochieng et al., 2015 Martey et al., 2012, Bahrta and Bauer, 2012; Omiti et al., 2009). Market information allows farmers to take informed marketing decisions that are related to supplying necessary goods, searching for potential buyers, negotiating, enforcing contracts and monitoring. Necessary information includes information on consumer preferences, quantity demanded, prices, produce quality, market requirements and opportunities (Ruijs et al., 2004). Information asymmetry creates welfare losses for market actors (Martey, 2014) and may acts as barriers to entry for potential players hence creating market imperfections. Of equal importance is the source of market information because it determines accuracy and accessibility.

Extension services are important sources of information dissemination amongst rural farmers. However, most small holder farmers experience limited access to public extension services (Shiferaw et al., 2009) which limit access to market information. Private sources of market information are on the other hand beyond the reach of most small scale farmers (Shepherd, 1999). As a result, information is gathered through personal networks based on mutual trust and by personal visits to markets (Shepherd 1999, Lyon et al., 2012). Traders have been found important sources of market information (Barret, 2008). Networks of small holder farmers and farmer groups play a pivotal role in knowledge and information exchange (Ngugi et al., 2007; Martey, 2014). In other instances where there is presence of Non-Governmental Organisations (NGOs), their role in disseminating information is vital (Shiferaw et al. 2009).

Previous studies have assessed determinants of market participation (Ouma et al., 2010; Fischer & Qaim, 2013; Martey, 2014; Ochieng et al., 2015). However they only considered access to market information (as a yes or no). They ignored the effects of the different sources of market information and network effects through which market information is disseminated. This study goes beyond access to market information to exploring effects of market information networks on commercialisation. We asked respondents on where they received market information and which source of market information they considered most important. The study likewise included the number of people inside and outside the villages that a farmer
talked to on market information. These were modelled as a two stage using double hurdle model: Market participation and intensity of participation. Household and farm characteristics, demographic and socioeconomic variables were likewise controlled for in the model. This study contributes to the body of literature through incorporating network effects in understanding agricultural commercialisation.

A network is defined by individual members and the links among them through which resources like information flow (Maertens & Barrett, 2013). Network members could be groups, organizations as well as persons. Agricultural studies have majorly explored the effects of social networks in adoption of new technologies (Muange et al., 2014; Maertens & Barrett, 2013; Bandiera & Rasul, 2006). In determining the influence of social networks on adoption of sunflower- a new crop in Mozambique, Bandiera & Rasul, 2006 found adoption decisions were more correlated within family and friends than religion-based networks. On the other hand, Muange et al., 2014 found out that it’s information networks outside a farmer’s village, rather those inside the village, that determine intensity of exposure to improved cereal varieties in Tanzania. On innovation networks, Spielman et al., (2011) found Public service providers to play the most prominent role in smallholder innovation processes. However, the role of innovation networks was far less evident with respect to developing marketing links or transmitting price information to smallholders (Spielman et al., 2011). In agricultural trade, Fafchamps and Minten, (2002) found out that more networked traders in Madagascar had higher profit margins.

In his seminal works on the ‘strength of weak ties’ Granovetter (1973) found out that most people learned information leading to their current jobs through acquaintances rather than close friends. Connections between actors in the same subgroup, often between family members, neighbours and friends, are considered as ‘bonding ties’ also called strong ties; connections between subgroups or different actors are referred to as ‘bridging ties’ or weak ties (Granovetter, 1973; Woolcock, 2001). High level of homogeneity exists among bonding network ties; as a result, bridging network ties could be a greater source of information diffusion (Granovetter, 1973).

This study aims to assess the determinants of agricultural commercialisation and extent of commercialisation of African Leafy Vegetables in Kenya. Specifically, the paper incorporates effects of market information networks in understanding the determinants of market participation. The two key objectives of the study are to 1) assess the effects of market
information networks on market participation decisions of ALVs farmers 2) assess the effects of market information networks on the intensity of ALVs commercialisation amongst smallholders. The rest of the paper is organised as follows: a discussion of the data and methods, presentations of the results and discussion of the findings, finally, conclusion and policy recommendations.

2.0 Data and methods

This paper is based on data from a household survey conducted in Kenya in 2015 as part of the HORTINLEA programme (HORTINLEA, 2015). The HORTINLEA programme is an interdisciplinary research project addressing food security and poverty alleviation in East Africa. The household survey was conducted in September-October 2015. It covered five purposively selected Counties in Kenya majorly involved in the production and marketing of Indigenous vegetables. While the larger survey captured five producer Counties in Kenya, This paper focuses on data from 202 households in Kakamega County.

Kakamega County, the study site, covers an area of approximately 3050.3 Km². The altitudes of the County range from 1,240 metres to 2,000 metres above sea level. The main crops grown are sugarcane, maize, beans, cassava, sweet potatoes and horticultural crops. The County has high rainfall, almost evenly distributed all year round. The rainfall ranges from 1280.1 mm to 2214.1 mm per year with an average humidity of 67 percent. Majority of farmers produce at small scale with an average land holding size of 0.57ha.

Multi-stage sampling approach was used in sampling. Selection of the sub-counties and divisions was based on information from the respective district agricultural offices. In Kakamega County, a total of ten divisions were selected. From each division selected, wards were randomly selected and households within locations were in turn randomly selected. A total of 202 small holder vegetable farmers were sampled and interviewed in Kakamega County. Using a structured questionnaire, the survey captured socio economic characteristic, crops and livestock production and marketing, incomes and expenditures among others. Above all, the survey incorporated questions related to market information access, social networks in market information sharing and market sales and margins. From whence, forms this paper focuses on. Data collected in the survey was entered and cleaned in SPSS. Data exploration and descriptive analysis were conducted in SPSS 20. Econometric modelling and analysis was performed in STATA 13.0.
Model description

A number of econometric choice models have been applied to study participation behavior among farming households. These models have been applied depending on the nature of data available and the question at hand. In binary dependent variables, where data is collected to assess if there is participation or not; Probit and logit models are commonly used. Censored regression model also called the tobit model (Tobin, 1958) is commonly used to model the extent of participation (Martey et al., 2012; Bellemare and Barrett, 2006). However, a key limitation with the tobit model is that it assumes that variables that determine the probability of adoption (incidence of adoption) also determine the level of adoption (intensity of adoption). The possibility of recording zero sales in marketing studies is plausible and should be treated as genuine corner solutions and not missing values. Two distinct decisions for participation and extent of participation are observed and determined by different set of explanatory variables (Bellemare and Barrett, 2006). Cragg’s independent double-hurdle model ability to relax tobit model assumptions by allowing separate stochastic processes for the incidence and intensity of adoption makes it favorable (Achandi & Mujawamariya, 2016; Mather et al., 2013; Komarek, 2010). Double hurdle is based on two tiers, the first tier is a binary variable of participation represented by one or no participation represented by zero. The second tier is a continuous variable of the volumes sold. In this study, we assess the case for participation and extent of participation in African Leafy vegetables' (ALVs) markets among smallholder farmers in Kenya.

The first hurdle which is the farmer’s decision to participate in ALVs marketing can be represented by:

\[ d_i^* = z_i^* \alpha + \varepsilon_i \quad (1) \]

Where \( d_i^* \) is a latent variable indicating whether or not the farmer participates in ALVs marketing, it takes the value of 1 if the farmer if the farmer participates and 0 if not. \( \alpha \) is a vector of unobserved parameters to be estimated. \( z_i \) is a vector of observed independent covariates that explain an individual’s decision and \( \varepsilon_i \) is an unobserved error term.

The second hurdle which is the extent of participation is indicated by:

\[ y_i^* = x_i^* \beta + \mu_i \quad (2) \]
Where $y_i^*$ is the amount of ALVs marketed and follows continuous numbers. $X_i$ is a vector of covariates that explain this amount. $\beta$ is a vector of unobserved parameters to be estimated and $\mu_i$ is an error random variable.

The model allows for possible differences between factors that affect participation ($z_i^* \alpha$, $\epsilon_i$) and factors that affect extent of participation ($x_i^* \beta$, $\mu_i$).

To curb the threat of heteroscedasticity in the model, we used craggit which is equipped to handle a model for heteroskedastic standard errors (Craggit, 1971; Burke, 2009). Robust standard errors for parameter estimates were used in estimating the Double hurdle model (Wooldridge 2002). Marginal effects were then calculated for each of the explanatory variables by differentiating each of the equations with respect to each explanatory variable (Yen & Su, 1995, Mutlu & Garcia, 2006).

Table 1 presents a description of the variables used in the double hurdle model and their expected outcomes.

**Table 1: Description of variables for Double Hurdle model.**

<table>
<thead>
<tr>
<th>Variable names</th>
<th>Definition</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALVS_partic</td>
<td>ALVs market Participation: 1 for participation, 0 for non-participation</td>
<td></td>
</tr>
<tr>
<td>ALVS_vol</td>
<td>Volumes of ALVs sold</td>
<td></td>
</tr>
<tr>
<td><strong>Independent variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grpmember</td>
<td>Group membership: 1 if a member 0 non-member</td>
<td>+</td>
</tr>
<tr>
<td>Farmsize</td>
<td>Land owned per capita in acres</td>
<td>+</td>
</tr>
<tr>
<td>Mkt_dist</td>
<td>Distance to the market in KM</td>
<td>-</td>
</tr>
<tr>
<td>vill_network</td>
<td>Number of people in the village talked to on market information</td>
<td>+</td>
</tr>
<tr>
<td>outvill_network</td>
<td>Number of people outside the village talked to on market information</td>
<td>+</td>
</tr>
<tr>
<td>HHsize</td>
<td>Number of household members</td>
<td>+</td>
</tr>
<tr>
<td>AGEsq</td>
<td>Age of the household head in years squared</td>
<td>-</td>
</tr>
<tr>
<td>educ_yrs</td>
<td>Number of years of formal education</td>
<td>+/-</td>
</tr>
</tbody>
</table>
Gender
Gender of the household head: 1 if male, 0 if female

ALVINC_share
Share of total household income from ALVs

offfarmINC_share
Share of total household income from off farm sources

TLU¹
Tropical Livestock Unit

mktinfo_source
Source of market information: 1 farmer to farmer, 0 institutional sources

Farmers face different transaction costs that stem from asymmetries in access to assets, information, services, and markets, leading to different market behaviour (Barrett, 2008; Key et al., 2000). Assets, such as financial capital, land, and labor, are important factors of adoption and commercialisation (Shiferaw et al, 2009, Fischer & Qaim, 2013). Furthermore, farm size can play a role, because larger land holdings contribute to incentives for increased production for commercial purposes. We therefore expect a positive relationship between farm sizes and commercialisation.

We expect commercialisation to decrease with old age. Younger farmers have been found to be commercially active (Martey, 2012). Household size has been found to be positively related to commercialisation (Fischer & Qaim, 2013). Larger families provide the much required labour to support production and commercialisation efforts. This is real for ALVs where most of the production activities are done manually. Commercialisation is expected high among female headed households as majority of ALVs producers in Kenya are women (Shackleton et al, 2003; Weinberger et al, 2011). However, the argument that as income from crops increases, male tend to take control of the crop and income from it could result to very opposite results from the expected (Fischer & Qaim, 2012). We therefore include a dummy for gender to account for possible gender effects.

Finally, market information networks variables are key in this study. We include sources of market information for farmers and the number of people a farmer has talked on market related information inside and outside the village. This is to control for network effects in market

¹ Tropical Livestock Units (TLU) are calculated as follows: 1 TLU = [1.0 * Cattle + 1.0 * Donkey + 0.1 * Goats + 0.1 * Sheep + 0.01 * Chicken] (ILCA, 1990).
information access that could influence commercialisation of ALVs. We expect Information networks to significantly influence commercialisation.

3.0 Results and Discussion

Respondents were asked to mention the source for their most important market information. As presented in figure 1, half of the households reported extension officers to be the source of their most important market information. This was followed by group members, as reported by 30% of the households. Less than 1% considered media and research institution as a source of their most important market information. We categorised the various sources of information into three: farmer to farmer sources, institutional sources and traders. These are depicted by the different colours in the graph as presented in figure 1. Majority of the households (58%) sought most important market information from institutional sources especially extension officers and NGOs. Farmer to farmer information exchange was likewise important; almost 40% of the households considered fellow farmers as a sources of important market information. These were mainly members of farmers’ groups (30%), and to a lower extent neighbours (6%) and relatives (2%). Traders and middlemen were considered as sources of important market information by less than 5% of the households (3.9%). Mistrust on the market information offered by traders could be the key reason why few considered them as source of important market information.

**Fig 1: Categorisation of sources for important market information**
Table 3 presents marginal effect estimates for the double hurdle model. The main objective was to assess the effect of social networks on commercialisation of ALVs as depicted by the network of people that a farmer talks to on market related information and sources of important market information. On source of market information, farmers receiving information from traders were few (3.9%) (Fig 1). As a result traders were dropped from the double hurdle analysis due to non-convergence. Institutional sources and farmer to farmer information exchange formed the two categories of market information sources in the model.

### Table 3: Marginal effect estimates for the Double hurdle Model

|                  | Marginal effects (dy/dx) | Delta-method Std. Err. | z   | P>|z| |
|------------------|--------------------------|------------------------|-----|-----|
| **Tier1: Participation** |                          |                        |     |     |
| grpmember        | -0.0629688               | 0.2635027              | -0.24 | 0.811 |
| Farmsize         | 1.685065**               | 0.7408858              | 2.27 | 0.023 |
| Mkt_dist         | -1.110859**              | 0.482908               | 2.30 | 0.022 |
| vill_network     | 0.0274224                | 0.0176405              | 1.55 | 0.120 |
| outvill_network  | 0.0136556                | 0.0145832              | 0.94 | 0.349 |
| HHsize           | 0.1501592***             | 0.0509975              | 2.94 | 0.003 |
| AGESq            | -0.0001597*              | 0.0000817              | -1.95 | 0.051 |
| educ_yrs        | 0.0337578                | 0.0242787              | 1.39 | 0.164 |
| Gender           | -0.4812758               | 0.3889085              | -1.24 | 0.216 |
| ALVINC_share     | 4.246017***              | 1.417106               | 3.00 | 0.003 |
| offfarmINC_share | 0.009059                 | 0.0606943              | 0.30 | 0.766 |
| TLU              | -0.2089965*              | 0.1214793              | -1.72 | 0.085 |
| mktinfo_source   | 0.1201373                | 0.2504848              | 0.47 | 0.642 |
| _cons            | -0.5312098               | 0.6788209              | -0.78 | 0.434 |
| **Tier2: Extent of participation** |                          |                        |     |     |
| grpmember        | 239.7782                 | 1003.378               | 0.24 | 0.811 |
| Farmsize         | 531.7182                 | 473.1363               | 1.12 | 0.261 |
| Mkt_dist         | -26.54929                | 69.49559               | -0.38 | 0.702 |
| vill_network     | 16.79458                 | 17.63461               | 0.95 | 0.341 |
| outvill_network  | 52.40374**               | 21.85603               | 2.40 | 0.016 |
| HHsize           | 148.1778                 | 128.3975               | 1.15 | 0.248 |
| AGESq            | -0.2212213***            | 0.0773052              | -2.86 | 0.004 |
| educ_yrs        | 32.46509                 | 30.16746               | 1.08 | 0.282 |
| Gender           | -242.3235                | 1024.97                | -0.24 | 0.813 |
| mktinfo_source   | 365.1115**               | 418.2568               | 0.022 | 0.222 |
| ALVINC_share     | 1550.834                 | 956.9871               | 1.62 | 0.105 |
| offfarmINC_share | -1247.423*               | 650.8615               | -1.92 | 0.055 |
| TLU              | -1536.347***             | 589.7633               | -2.61 | 0.009 |
Social networks and market information

Outside village network (outvill_network) depicted by the number of household a farmer talked to on market information was positive and significant in the second hurdle: extent of commercialisation. This implies that market information received through bridging social capital (people outside the village) increased the likelihood of households intensifying commercialisation of ALVs. Each additional person outside the village that a farmer talked to about market information, increased the likelihood of intensifying commercialisation by 52%. These findings are consistent with the ‘theory of weak ties’ presented by Granoveter (1973). People are more likely to benefit more from their weak ties (bridging social capital) than strong ties (bonding social capital). Information received within bonding social capital (inside village network) could be redundant as there is no new information circulating. Network connections outside the village (bonding social capital) offers an opportunity for more novel information that could lead to intensifying commercialisation. Farmers who talked with others outside their own villages would get leads on potential market opportunities beyond their villages. Likewise, they would get price information from other villages which could be more competitive than prices in their own villages. These market information would enable farmers make more informed decisions on where to sell and how much to sell for a particular price.

Market information source (Mktinfo_source) positively influenced the extent of ALVs commercialisation. Coded as 1 for farmer to farmer sources and 0 for institutional sources, market information received from fellow farmers increased the likelihood of a household intensifying commercialisation than information received from institutional sources by 365%. Farmer to farmer sources are mainly market information shared by members of farmer groups while institutional sources are from extension officers and NGOs (Fig 1). Comparing the two information categories, farmers receiving market information from fellow farmers would more likely commercialise more volumes of ALVs than farmers receiving market information from extension officers.

This is plausible as most farmer groups support their members in accessing markets through linking them to markets and in facilitating collective action efforts (Fischer & Qaim, 2012; Shiferaw et al., 2009). The weak institutions of extension service delivery (Shiferaw et al., 2009) could be a hindrance in facilitating commercialisation of ALVs among small holders.
This study is consistent to a study by Martey, 2014 who found membership to farmer groups as important in determining the extent of maize commercialisation in Ghana. Contact to extension officers have similarly been found by some studies to decrease commercialisation (Awotide et al., 2016) which could point to the diminishing role played by extension officers in facilitating commercialisation; Bahra & Bauer, (2016) however found contact to extension officer to increase commercialisation levels in South Africa.

Notably, marginal effects for outside the village network and market information sources were not significant for the first hurdle- participation hurdle. Although, they both had a positive direction as those in the second hurdle. This implies that social networks are more important determinants when it comes to intensifying commercialisation of ALVs than the participation decision. More volumes of ALVs are sold by households with higher bridging social capital (people outside village) and those who receive most important market information from members of their farmer groups and fellow farmers.

**Household characteristics**

Household size (HHsize) measured by the number of family members living together had a positive and significant effect on ALVs market participation. The likelihood of a farming household commercialising ALVs increased by 9% for every additional increase of a family member. Large families were more likely to commercialise ALVs due to farm labour requirements easily offset from family labour. Farm labour requirements are mainly done by family members, with multiple crop and livestock enterprises, more family members are able to provide labour for the various farm operations. Household size did not however have a significant influence on the extent of commercialisation though the relationship was positive. Similar studies have found household sizes to have positive influence on market participation decisions (Fischer & Qaim, 2012, Martey et al., 2012). Bahta and Bauer (2012) however found household size to be negatively associated with commercialisation of tomatoes and carrots in South Africa.

Households with younger heads were more likely to commercialise and intensify ALVs commercialisation than households with older heads. For every year increase in the age of a household head, the likelihood of a household participating in ALVs market decreased by 0.02%. Implying that ALVs’ market participation was more favourable to households with younger heads. On the same breadth, the marginal effect of age on extent of ALVs commercialisation was notably higher and more significant than the participation decision.
Every additional year in the age of a household head decreased the extent of ALVs volume sold by 22% at 99% confidence level. Commercialisation is more oriented for younger heads: labour demands and transportation to the market are factor that could be unfavourable to older farmers. Increasing volumes commercialised becomes an even tough hurdle for older household heads. Okoye et al., 2016 similarly found younger cassava farmers more likely to participate in cassava markets. Similar findings were also reported by Bahta and Bauer (2012).

**Market access**

Distance to the market has been used as a proxy for market access (Chamberlain & Jayne, 2011). Market distance (Mkt_dist) had a negative and significant effect to market participation decision. The likelihood of a farmer participating in ALVs marketing reduced by 10% with a kilometre increase to the market. Distant markets involve transaction costs which are a hindrance to market participation. Similar studies have found distance to the market to be negatively related to market participation (Okoye et al., 2016; Ochieng et al., 2015).

In the second tier on the extent of commercialisation of ALVs, distance to the nearest market was not significant. This is plausible since the volumes sold may not necessarily depend on the distance. Once a farmer has found a buyer and began participating in ALVs trade, the distance to the market then does not significantly influence the volumes of ALVs to be sold. Komarek (2010) and Mujawamariya et al., (2016) found similar results: market distance decreased the likelihood of market participation, but had no significant marginal effect on quantities sold.

**Farm characteristics**

Farm size measured by land owned per capita had a positive and significant effect on the participation decision. The marginal effect of farm size on the extent of commercialisation was however insignificant. An acre increase on the farm size increased the likelihood of ALVs commercialisation by 169%. This implies that households with large farm sizes are able to allocate more land to ALVs. They are therefore able to produce excess ALVs beyond the subsistence level; which they sell.

However, farm size was not a significant determinant in increasing the volumes commercialised. Households who wish to intensify commercialisation have the option of leasing in land for production and not necessarily relying on their own land size. The average small land sizes in the area necessitates commercially oriented households to lease in land
outside their locality. Similar findings were reported by Komarek (2010); Martey, 2014; Bahta et al., 2012.

**Household enterprises**

Share of household income contributed by ALVS positively and significantly determined decision to participate in ALVs marketing. A unit increase in the share of income contributed by ALVS on total household income, increased the effect on participation by 425% at 99% confidence level. This implies that households were more likely to participate in ALVs commercialisation if the share of income contributed by ALVs was substantial. This was however not significant for the extent of commercialisation. Possibly because the income from ALVs was reinvested in other income generating ventures.

Off-farm income was negative and significant in influencing the volumes of ALVs sold. Measured by the share of household income, a unit decrease in the share of off farm income to household income increased the intensity of commercialisation by 1247%. The marginal effect of off farm income on the first tier-the participation decision was however not significant. Negative relationship between off farm income and commercialisation implies that households engaged in other off farm activities have less time to participate in ALVs commercialisation. These findings are consistent with other studies where income from off farm employment influenced the extent of commercialization negatively. For instance, maize in Ghana (Martey, 2014) and rice in Nigeria (Awotide et al., 2016). However it contradicts findings by Bahta et al., 2012 who reported a positive relationship between off farm income and commercialisation.

Marginal effects for Tropical livestock unit (TLU) were negative and significant for both hurdles. Households with fewer livestock were more likely to commercialise and intensify commercialisation of ALVs. A unit decrease in livestock increased the likelihood of a household participating in ALVs market by 21% at 90% confidence level. The marginal effect on extent of commercialisation was larger and more significant. A unit decrease in livestock increased volumes sold for ALVs by 1536% at 99% confidence level. Though such a large effect magnitude was not expected on the extent of commercialisation, it follows direction of apriori expectations. As mentioned, farm sizes in the study area are relatively small. Livestock and crop farming are therefore competing enterprises in terms of land and labour allocations. Increasing the herd size limits land available for crop farming- inhibiting levels of commercialisation. Bahra & Bauer, 2012 found similar results where commercialisation of tomatoes decreased with number of livestock.
4.0 Conclusion and Policy recommendations

This paper seeks to assess the effects of social networks in commercialisation of ALVs. Using a double hurdle, we model a two stage decisions for the participation and intensity of participation in the commercialisation of ALVs by small holders in Kenya. We assess the determinants of commercialising ALVs and the extent of commercialisation as measured by the volumes of ALVs sold.

Social networks are important determinants in influencing the extent of ALVs commercialisation. Market information received by people outside the village (bridging social capital) increased the likelihood of households intensifying commercialisation of ALVs. This was however not the case for information received inside the village (bonding social capital). Additionally, market information received by fellow farmers mainly through farmer groups had a positive likelihood of increasing the volumes of ALVs sold compared to information received by extension officers.

We found social networks effects significant in the second hurdle-extent of commercialisation and not significant in determining the first hurdle-participation decision. We therefore conclude and recommend that there is need to improve and strengthen network linkages between farmers as this is more likely to result to increased levels of ALVS commercialisation. This is due to the weak public information system, which mainly focuses on production related information and plays minimal role in market information dissemination (Shiferaw et al., 2009; Spielman et al, 2011).

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