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# Characterization of the levels of cassava commercialization among smallholder farmers in Kenya: A multinomial regression approach

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**Cassava commercialization is a concept that has been used by many development practitioners because of its possible strategic role in transforming livelihoods of smallholder farmers in sub-Saharan Africa, including Siaya and Kilifi Counties in Kenya. This concept can easily be implemented when the levels of commercialization is known. However, empirical evidence reveals little information on the levels of cassava commercialization amongst smallholder farmers in these counties. Thus effective policy interventions on cassava commercialization for these farmers are difficult to implement, since there is no proper understanding of their levels of cassava commercialization. Therefore the main objective of this paper was to characterize levels of cassava commercialization among smallholder farmers. Factors influencing cassava commercialization were also evaluated. The data was collected from 381 farm households in Siaya and Kilifi Counties (Kenya).This data was used to calculate the Household Commercialization Index (HCI) and Value Addition Indices (VAI) which were then integrated to form the Commercialization Index (CI). This integrated index formed the basis for categorizing the levels of commercialization. A multinomial regression model was used to evaluate factors that affect levels of commercialization. The results obtained revealed that majority of smallholder farmers' operate at low and medium categories with very few of them at high level. Distance to the market, cassava acreage, schooling years, gender and marketing costs were the key determinants of the levels of commercialization. In order to promote high level commercialization, the study recommends developing policies that enhance formal education among farmers, optimal usage of land and minimization of transportation costs through infrastructural development.**

**Key words:** Commercialization, cassava, smallholder farmers, value addition, market participation.

## INTRODUCTION

In sub-Saharan Africa, agricultural sector is one of the key sectors that have contributed to rural development. Majority of rural household dwellers, who represent 70% of the poor, depend upon agriculture for their livelihood (Diao et al., 2010). Thus agriculture primarily contributes towards economic development of most African countries

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by reducing poverty as well as creating employment opportunities (FAO, 2012; World Bank, 2008). The contribution of agricultural sector towards poverty reduction has been realized to have a multiplier effect which is greater than the other sectors in the economy (Wiggins, 2009). One of the major features of agriculture in the developing world is that farming is mainly oriented towards small scale. This is whereby production is mainly for household consumption with extra output for small-scale commercial purpose. As summarized by (Dixon et al., 2003; Wiggins, 2009; FAO, 2015), smallholder farming is production based on small volumes, limited resources, and is predominated by family labor.

In sub-Saharan Africa, smallholder farmers are the majority of the population and they contribute enormously towards agricultural production. In addition, they account for approximately 75% of sub-Saharan Africans' land (Lowder et al., 2016). For these reasons, small holder farming has been realized to be an important activity especially in the developing nations as a stimulant to economic growth which can be done in a coordinated and smart approach. Because of agriculture's comparative advantage to other sectors much focus has been drawn towards transforming the sector through entrepreneurial activities such as commercialization. This concept has gradually gained prominence especially among smallholder farmers and to a greater extent replacing subsistence farming (Wright, 2009). It entails promoting market-oriented agriculture whereby farm households are integrated into input or output markets with an aim of boosting income (Von Braun, 1995; Barrett, 2007; Jaleta et al., 2009). Until recently, agricultural commercialization in sub-Saharan Africa had been associated with large scale farming focusing mainly on cash crops. However; this has so far changed since most of the dependable cash crops are highly rain fed and due to the climatic changes, there has been declining production hence the need for crop diversification. In line with this argument, traditional crops such as cassava and sorghum are being promoted because of their resilient to drought making them a target for food security strategy in sub-Saharan Africa (Martey et al., 2012; Obisesan, 2012).Cassava, (*Manihot esculenta* Crantz) is a species of the tuber crops which is widely produced in Africa as well as Latin America. In sub-Saharan Africa, the crop is mainly grown by small scale farmers for subsistence purposes (Nweke, 2004; Ogisi et al., 2013). Studies have revealed that there exist great entrepreneurial opportunities for cassava crop which has not been fully tapped (Ojogho and Alufohai, 2009; Agbola et al., 2010; Agwu, 2012). However, there are promising cases of smallholder farmers embracing cassava commercialization. This has been observed mainly in West African countries with very little evidence in East Africa specifically Kenya. The underlying question that the paper tries to address is whether farmers are operating at different levels of commercialization and if so, what are some of the factors that influence their operation at the various levels.

This information is very important, more so when targeting interventions for farmers operating at the different levels. Kenya provides a good case study in understanding cassava commercialization bearing in mind that 75% of Kenyan land lies in arid and semi-arid areas and agriculture is the dominant sector. Furthermore, the overriding need for poverty reduction has presented cassava production and commercialization as a target for many interventions which also led to the development of National Policy on Cassava (MOA, 2007).

In Kenya, majority of farm households have directed their efforts on other crops such as maize and beans which are highly dependent on rainfall with minimum attention on cassava. These crops normally fail in ASAL regions due to inadequate rainfall leading to high poverty levels being experienced. Cassava may therefore provide a better alternative crop. Cassava crop has abundant opportunities such as value addition and market participation that still remains untapped.

Furthermore, the population growth and the changing demand patterns have generated high demand for various tuber crops, but farmers have not taken advantage of these opportunities. Also, diet changes amongst households have contributed towards commercialization as pointed out by Tschirley et al. (2015). Therefore it remains empirically unclear why farmers have not paid as much attention to cassava especially its commercialization as they have to commercialization of maize and beans (Muricho, 2015; Ochieng et al., 2015).

Evidences from Kenyan studies indicate that much focus on cassava has been on the promotion of production and other agronomical practices (Kamau et al., 2011; Obiero, 2013; Danda et al., 2014). Besides, farmers have been trading with raw cassava products mostly in informal markets or sometimes with low value added products (Karuri et al., 2001).

In addition, studies on commercialization have dwelt on cash crops and market participation with minimal attention on underutilized crops (Muricho, 2015; Ochieng et al., 2015). It has also been observed that a number of factories which are meant to enhance cassava commercialization are dormant.

This study was therefore motivated by the fact that value addition has not been explicitly argued in understanding commercialization and yet it is a concept that enhances commercialization. It is important to identify the different levels of cassava commercialization as well as understand some of the challenges that can be addressed so as to enable farmers operate at higher levels of commercialization which is associated with high income. In this study we contextualized commercialization as integration of value addition and market participation. This is a remarkable departure from past researches.

This study contributes to the modeling of the levels of commercialization by use of a multinomial regression model. Value Addition Index based on the different forms of value additions has been developed. This was then combined with Household Commercialization Index to form Commercialization Index. This index was later used to profile farmers based on the commercialization levels. We chose multinomial logistic model because the responses of the levels of commercialization are more than two and additionally it explicitly enumerates details for each level which are believed to be very important in understanding the barriers to cassava commercialization among smallholder farmers.

## Understanding agricultural commercialization

The concept of agricultural commercialization has been greatly applied in understanding the linkages between farm households and markets. However, understanding of the theory differ in focus and breath as evidenced by Zhou et al. (2013). Jaleta et al. (2009) and Martey et al. (2012) similarly acknowledged that there is no standard way of gauging the degree of household commercialization hence leading to varying definitions. Tipraqsa and Schreinemachers (2009) summarized agricultural commercialization as the process by which farm households increasingly integrate with both agricultural input and output markets. Von Braun and Kennedy (1994) on the other hand viewed agricultural commercialization as a combination of decision making behaviour ranging from both production and marketing activities.

Dutta et al. (2014) and Kotchikpa and Wendkouni (2016), similarly argued that agricultural commercialization occur when farm households produce marketed supply of output. Based on the household commercialization index, they identified three ways of classifying commercialization levels as non-commercial, semi-commercial and commercial farmers in which full commercialization was presented by an index of one, while non-commercialization was presented by zero. In support of this criterion, Lawal et al. (2014) and Martey et al. (2012) asserted that commercialization is based on the proportion of sales that households make relative to the total production. Considering other studies which have dwelt on other crops besides cassava, Ochieng et al. (2015) similarly echoed that commercialization is all about market orientation and participation. In their study, they measured the extent to which bananas and legumes are oriented towards market using Household Commercialization Index. Fischer and Qaim (2012) similarly studied cassava commercialization and how collective action has enabled women to participate in banana commercialization. Kabiti et al (2016) on the other hand diverted the focus on agricultural crops to livestock commercialization, while Kirui and Njiraini (2004) addressed the role of ICT as a determinant of agricultural commercialization. Mujeyi (2009) conceptualized commercialization of Jatropha, is a tree species, as derivation of financial benefits from selling trees or processing them into other usable products. Further studies by Kambewa (2010), Agwu (2012), Gebreselassie et al. (2015) and Hagos and Geta (2016)) concluded that the conventional way of classifying the levels of commercialization is informed by the intensity of market participation. Based on the reviewed studies, it is evident that the concept is applicable in many ways not only in relation to crops but other agricultural sectors such as trees and livestock.

From these studies, the role of value addition has not been strongly argued yet it is a fundamental aspect of commercialization thus provoking further understanding on cassava commercialization and its determinants among smallholder farmers. There is enough evidence from past studies that agricultural commercialization is influenced by a number of factors. Jaleta et al. (2009) observed that population and demographic changes, technology, infrastructural and market factors as well as macro-economic policies majorly influence household commercialization. In relation to this, Muricho (2015) grouped the determinants of commercialization as exogenous or endogenous in which he argued that health environment is another important factor that should be considered. Gebreselassie et al.(2015), Martey et al. (2012) and Zhou et al.(2013) similarly pointed out some of the key determinants of agricultural commercialization as the amount of output, access to market information, transaction costs as well as household characteristics such as gender, age, farm size and family size. Agwu et al. (2015) identified various forms of value added cassava as well as evaluated factors such as gender, education, income, household size and value addition using a binary logistic model. Other studies on cassava commercialization include; Asogwa et al. (2013), Falola et al. (2016), Kehinde and Abaoba (2016) which revealed that diversification of cassava products into various value added forms stand out strongly as a way of increasing income as well as creating more employment opportunities, hence, making it a key component of cassava commercialization.

In summary, the reviewed studies on commercialization identified availability of processing equipment, off-farm activities, gender, age of the household head, farmer experience, market access, cassava output, farm size and transaction costs which also include marketing and transport costs, access to extension services by farmers and social networks as some of the pointers towards cassava commercialization.

## Modelling commercialization under household farm model

This study is grounded on household farm model which analyzes household farm economics and examines

household behavior based on production, the choice of technology and labor allocation (Taylor and Adelman, 2003). Commercialization can be addressed from two perspectives: first, as an increase in the marketed output, which is measured as the ratio of output sold to the production output, and secondly as the amount of inputs purchased per unit of output (Gebremedhin and Jaleta, 2010).

Cassava farm households have varying choices to make which are either aimed at maximizing profit or utility (Mottaleb et al., 2014). Utility maximization theory and profit maximization theories are premised on the household farm model and their augmentation expounds on the responsiveness of farmers towards commercialization. Even though profit maximization theory is a recessive separable process where a farm household's goal is mainly to make profits, this is not always the case with smallholder farmers. Modelling of farm households' behaviour is therefore based on interdependence between commercialization decisions as well as household consumption (Mottaleb et al., 2014). Under perfect market conditions, it is assumed that farm households maximize profits as producers and utilize the earnings generated to maximize their utility as consumers (Lofgren and Robinson, 1999).

Nevertheless, this is not realistic especially for smallholder farmers who in many cases are confronted with a set of competitive markets especially when production is both market and non-market oriented which are non-separable (Taylor and Adelman, 2003). In this context, the micro-economic theories are applicable since smallholder farmers are constrained by budget and resources hence the undertakings such as value addition and market participation must be supported by the value for the profit generated (Yan, 2007). It is therefore expected that cassava production and commercialization should contribute towards the constraints either in terms of meeting food demand or generating income from the marketed surplus.

This further suggests that there exist imperfections in the market which are caused by transactional costs, such as cost of transport, information costs amongst others which is the Kenyan case (Olwande et al., 2015). Price, which is an endogenous variable, significantly influences various transaction costs. In addition, non-existence of markets and risks involved in commercialization undertakings could be a deterrent to further engagements in commercialization. This could be attributed to some unobserved and heterogeneous factors as supported by (Gebreselassie and Sharp 2008; Nandi et al., 2011).

This study is supported by household model because the decision to commercialize is conditioned by various factors which are non-separable. Farm households are able to perform certain activities such as value addition and market participation if they have marketed surplus and this is influenced by production decisions. Therefore the variance in commercialization is explained by the interaction between factors such as household characteristics, institutional and market factors, technical factors. For instance, household size explains the availability of family labour and influence on household consumption levels. Larger households are likely to provide labour that might be required to move cassava to the market and this would be expected to increase market participation thereby leading to a decrease in proportional transaction costs. On the contrary, large families may reduce the probability of commercialization since they reduce the marketed surplus.

Technical changes are also very important when making commercialization decisions. This explains production output by smallholder farmers in rural areas is mostly sold in either informal (in the neighborhoods) or formal local markets. Also, marketing factors such as transaction costs, market information, and distance to the market have a direct influence on the levels of cassava commercialization. In addition, access to market information increases both formal and informal market participation. Similarly institutional factors like improved credit access, group membership and extension services are hypothesized to enhance commercialization.

Contact with extension officers equips farmers with improved production methods and technology which could lead to increased production as well as value addition. Likewise, social networks are expected to reduce information costs since members within the networks are able to access information about prices and markets through interaction. Studies have found that membership of a farmer based organization or group increases access to information which is important to marketing decisions (Olwande and Mathenge, 2010). Conversely, access to reliable means of transport as well as distance to the markets influences cassava commercialization. Unreliable means of transportation and long distances increase transport cost which in turn increases transaction cost (Gebremedhin and Jaleta 2010; Ochieng' et al., 2015).

## MATERIALS AND METHODS

### Study area, sampling and data collection

The study was conducted in two different counties which lie in the Western and Coastal regions of Kenya. The two counties are the main cassava producing regions in Kenya and they are located within the arid and semi-arid land which is characterized by low rainfall and prolonged drought periods. Majority of the developing countries occupy 75% of arid and semi-arid land. Cassava crop is one of the predominant crops with high resilience to drought and has the potential to secure income as well as food security in such regions. The two regions have also experienced high rates of poverty levels of 45% and 70.8% in Siaya and Kilifi respectively. This is contributed by low productivity of rainfall-reliant crops such as maize and beans (GOK, 2011). A comparison study was necessary because of the perceived uniqueness of the regions in production and commercialization of cassava. Therefore, the study purposed to synthesize the similarities, differences and patterns of

commercialization that could guide in policy interventions for the specific regions. Data collection was based on the production year 2015 (January to December) with the respondents being smallholder farmers who had been engaged in cassava production during this period. A four stage multisampling technique was used. In the first stage, two sub-counties were purposely chosen from each county based on the intensity of cassava production. They include Alego-Usonga and Ugenya from Siaya County; Ganze and Magarini from Kilifi County. A random sampling of two locations from each sub-county was done. The third stage involved random sampling of six and five villages from Siaya and Kilifi Counties respectively. Finally, eight and ten respondents from Siaya and Kilifi Counties correspondingly were drawn through simple random sampling. The total responses were 200 and 181 farm households from Kilifi and Siaya Counties, respectively. Primary data were collected using well-structured questionnaires which were administered through oral interviews. Both descriptive and inferential statistics were used to analyze the data.

**Empirical specifications**

The study developed another index, commercialization index using both household commercialization index (HCI) and composite weighted index for value addition. HCI has been extensively used to categorize the levels of commercialization (Musah et al., 2014; Martey et al., 2012; Omiti et al., 2009; Muricho, 2015). It is an estimated single index for market participation taking into account the gross value of sales and production. The index measures the orientation of farmers towards market participation which range from 0 to 1.The interpretation of the index is that the closer it is to one, the greater the intensity of market participation. Household commercialization index was estimated as follows:

$$HCI = \frac{Gross\,value\ of\ cassava\ sales}{Gross\ value\ of\ all\ cassava\ production} \quad (1)$$

A composite weighted price index on value addition which is an inclusive approach was mathematically computed guided by studies such as (Grupp and Mogee, 2004; Sharpe and Andrews, 2012). The weighted index was based on the argument that value addition changes the price value of cassava products which further increases opportunities for market participation (Osmani and Hossain, 2015).The index is computed as follows:

$$\text{Composite weighted value addition index} = \frac{\sum p_i q_i}{\sum p_h q_i} \quad (2)$$

Where $p_i$ = price of value added cassava in kg; $q_i$= Quantity sold and $p_h$= Highest price of cassava in kg

Commercialization index was therefore computed as an average of the two indices (equation 1 and 2). The index value ranged from 0 to 1.This was later used to categorize the levels of commercialization into none, low, medium and high levels.

**Modelling using multinomial logistic regression model**

Multinomial logit model is a choice model that is devised from utility maximization theories. The assumption made is that household farmer' choses areas as a result of their preferences which range from production for consumption to commercialization. The model is a very useful method in analyzing data which has more than two responses and uses the logit link (Greene, 2000; Reddington et al., 2000). Similar to binary logistic regression model, it uses maximum likelihood estimation to evaluate the probability of the response variable (Madhu et al., 2014). Previous studies have used the model to investigate factors affecting various choices (Pryanishnikov, 2003; Kohansal and Firoozare, 2013). They found the model convenient and appropriate because it does not assume normality, linearity and homoscedasticity. In addition, the model is easily interpretable since the effect of the predictor variable is usually explained in terms of the odds ratio. In this study, the logit model was used to determine the likelihood of smallholder farmers' participation in four levels of commercialization namely none, low, medium and high levels. This model was also regarded appropriate because it supports the theoretical framework which states that smallholder farmers have a set of mutually exclusive alternatives to choose from. The decision on commercialization is informed by certain level of utilities. In the model, the variables $u_j$ and $u_k$ represent a household's utility for the two choices. The random utility model could then be disintegrated into two parts as shown below:

$$u_{ij}\left(B_j X_i + e_j\right) > u_{ik}\left(B_j X_i + e_j\right), k \neq \forall_i \quad (3)$$

From equation 3, perceived utilities of the levels of commercialization choices are $j$ and $k$, respectively, $x_1$ being the vector of explanatory variable that influences the perceived desirability of each choice. In case smallholder farmers decide to commercialize which is option $j$, it is expected that the utility derived from the choice will be greater than the utility from the other option $k$. The probability that a household will choose to commercialize, that is to choose method *j* instead of *k*– could then be defined as follows:

$$P\left(Y = 1/X\right) = P\left(u_{ij} > u_{ik}\right) \quad (4)$$

$$P\left(B_j X_i + e_j - B_k X_i - e_k > 0/X\right) \quad (5)$$

$$P\left(B_j X_i - B_k X_i + e_j - e_k > 0/X\right) \quad (6)$$

Multinomial regression logistic model was also appropriate because commercialization responses had more than one category. One of the categories of dependent variables represented the non-commercialization which was also nominated as a reference or base category. Calculation for the other logits was done with reference to the base category and the probability for each category was estimated using the following equations:

$$Log\left(\frac{\rho_{ij}}{\rho_{il}}\right) = \beta_j \chi_i \text{ whereby } j = 1,.....J \text{ and } i = 1....N$$

$$Logit\left[P(Y=1)\right] = \alpha + \beta_1 x_1 + \beta_2 x_2 + .....+ \beta_k x_k \quad (7)$$

The probability of $\rho_{ij}$ can be obtained as follows:

$$\rho_{ij} = \exp\frac{\left(\beta_j \chi_j\right)}{\sum^{j}{}_{j=1} \exp\left(\beta_j \chi_i\right)} \quad (8)$$

Equation 8 can further be expanded and estimated using maximum likelihood as shown below

**Table 1.** Summary statistics of the variables used in the multinomial model (Siaya County).

| Variable | None | | Low | | Medium | | High | |
|---|---|---|---|---|---|---|---|---|
| | n=58 | | n=9 | | n=97 | | n=17 | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Gender (Male) | 0.172 | 0.381 | 0.262 | 0.445 | 0.278 | 0.451 | 0.235 | 0.437 |
| Extension service (Yes) | 0.189 | 0.395 | 0.444 | 0.527 | 0.464 | 0.501 | 0.588 | 0.507 |
| Distance to market (km) | 0.059 | 0.211 | 0.056 | 0.110 | 0.275 | 0.369 | 0.200 | 0.269 |
| Schooling (Years) | 4.81 | 4.253 | 5.444 | 3.087 | 6.526 | 3.992 | 8.176 | 3.627 |
| Household size (No.) | 5.431 | 2.61 | 4.889 | 2.522 | 5.866 | 2.714 | 7.059 | 2.304 |
| Value addition experience (Years) | 12.569 | 15.189 | 19.111 | 22.133 | 13.845 | 12.676 | 4.118 | 3.371 |
| Marketing Cost (KES) | 2.413 | 13.418 | 18.889 | 39.511 | 178.258 | 1056.112 | 30.588 | 40.693 |
| Cassava acreage (Hectare) | 0.180 | 0.203 | 0.234 | 0.242 | 0.250 | 0.203 | 0.296 | 0.282 |

Source: Household survey data (2016) Note: 1 USD = Kes 103.70.

**Table 2.** Summary statistics of the variables used in the model (Kilifi County).

| Variable | None | | Low | | Medium | | High | |
|---|---|---|---|---|---|---|---|---|
| | n=66 | | n=45 | | n=78 | | n=11 | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Gender (Male) | 0.272 | 0.448 | 0.333 | 0.477 | 0.269 | 0.446 | 0.455 | 0.522 |
| Extension service (Yes) | 0.561 | 0.500 | 0.622 | 0.490 | 0.526 | 0.503 | 0.364 | 0.505 |
| Distance (km) | 0.238 | 0.507 | 0.928 | 0.755 | 0.788 | 0.653 | 0.568 | 0.447 |
| Schooling (Years) | 3.772 | 4.213 | 3.888 | 3.651 | 4.807 | 4.671 | 6.455 | 4.906 |
| Household size (No.) | 7.469 | 3.054 | 7.289 | 3.409 | 6.897 | 3.273 | 8.273 | 5.569 |
| Value addition experience (Years) | 7.341 | 8.998 | 8.844 | 10.392 | 5.962 | 8.919 | 4.091 | 3.081 |
| Marketing cost (KES) | 2.413 | 3.630 | 70.222 | 145.293 | 79.167 | 172.200 | 84.545 | 149.623 |
| Cassava acreage (Hectare) | 0.180 | 0.536 | 0.475 | 0.303 | 0.747 | 0.609 | 0.689 | 0.259 |

Source: Household survey data (2016) Note: 1 USD = Kes 103.70.

$$p(Y=j)=\frac{\exp(\alpha+\beta_1 x_1+\beta_2 x_2+\ldots\ldots\ldots\ldots+\beta_k x_k)}{1+\exp(\alpha+\beta_1 x_1+\beta_2 x_2+\ldots\ldots\ldots\ldots\ldots+\beta_k x_k)} \quad (9)$$

Where $\beta_i$ is the estimated coefficient which explains the effect of $x_i$ on the log odds when other variables are held constant, j =1, 2 and 3 since the model has four responses.

Therefore the above model was used to predict the levels of commercialization as a function of explanatory variables which were empirically identified.

## RESULTS AND DISCUSSION

### Summary statistics of variables used in multinomial logistic model

The summary statistics of the variables for Siaya and Kilifi Counties respectively are reported in Tables 1 and 2. The dependent variable was considered categorical with four responses namely; none, low, medium and high levels of commercialization. It was found that 5%, 54% and 9% of farm households from Siaya County participated in the low, medium and high level categories respectively while the rest (32%) were in the non-commercialization level. Kilifi County on the other hand had 200 respondents out of which 23%, 39% and 5% were in the low, middle and high level categories, respectively, while 33% did not commercialize (Table 2). The explanatory variables fitted in the model consisted of gender of the household head, which is a dummy variable and takes the value of one if the household head is a male and zero if she is a female. It is observed that less than 30% of the men from Siaya participated in all the levels of commercialization, while for Kilifi 45% of the men participated in high level commercialization.

The study also found that 58.8% of the respondents from Siaya County who had access to extension services engaged in high level commercialization while for Kilifi County 50.5% of the respondents accessed extension services as well as commercialized. Extension contacts are important as they bridge the gap of information asymmetry, therefore farmers who receive extension services are believed to be more knowledgeable and informative than their counterparts (Rahut et al., 2015).

The results shows that the mean distance for farm households in Siaya County was higher for the medium (0.28 km) and high (0.20 km) levels as compared to the low and none levels while for Kilifi the distances were high across all the levels. The mean distance for farm households in Siaya County was higher for the medium (0.28 km) and high (0.20 km) levels as compared to the low and none levels while for Kilifi the distances were high across all the levels. Distance to the market is hypothesized to influence market accessibility. Households which are located farther away from market places are less likely to engage in value addition as well as market participation (Barrett, 2007; Rios et al., 2008; Omiti, 2009).

Household size also varied across the counties in which Kilifi County had a larger mean household size (8.27 persons) as compared to the mean household size for Siaya (7.05 persons). Household size may have a two sided effect on commercialization. In the first case, large households can be a source of labor for cassava activities which are known to be labor intensive hence help in reducing cost of labor. On the other hand, the higher household size can be an impediment towards commercialization. This is because it may reduce the available cassava marketed surplus as well as increase diversification into other activities (Shapiro, 1990; Onya et al., 2016).

Farmer experience is expected to be larger for farm households that undertake high level commercialization (Agwu, 2012). This was however not the case in both regions as evidenced by the mean value addition experiences which were (4.12 years) and (4.09 years) for Siaya and Kilifi Counties, respectively. Notably, Siaya respondents had a higher mean value of value addition experience compared to Kilifi, and therefore they were expected to engage more in commercialization activities. Marketing costs can be a constraint to output market participation by smallholder farmers (Musumba and Costa, 2015). This study found that the mean marketing costs spent were very low in both counties, although the medium group had fairly larger costs (Kes 178.25) than the high level category (Kes 30.58) for Siaya County, while for Kilifi County the medium and the large categories had mean values of (Kes 79.16) and (Kes 84.54). Another important variable is cassava farm acreage which is believed to scale up production decisions consequently affecting commercialization. Farm households from Kilifi County had larger acreage of land compared to their counterparts from Siaya County. The mean acreage for Kilifi County (0.68 acres) was almost double to that of Siaya County (0.29) for the high level category.

**Estimation of levels of cassava commercialization for Kilifi and Siaya using multinomial logit model**

The multinomial logistic regression model was fitted and the summary results presented in Tables 3 and 4. The diagnostic results which describe the relationship between the dependent and independent variables are also presented. It can be observed that the chi square statistic values are 135.95 and 90.25 for Siaya and Kilifi Counties, correspondingly, had p-value<0.05. This confirms adequacy of the model and implies that at least one of the coefficients of the explanatory variables is significant. The strength of the model was also tested using Pseudo R square. The results for Siaya and Kilifi were (35.4%) and (16.5%). This implies that 35.4% and 16.5% of variation in the levels of commercialization among smallholder farmers was explained by the independent variables in the model.

Cox and Snell and Nagelkerke R squares on the other hand indicate that 50.7% and 57.4% of the variation in the model for Siaya county is explained by the explanatory variables fitted while Kilifi was explained by 38% and 40.6%.With regards to the selection of the reference group, the non-commercialization category was chosen as a base category.

Three logit models were fitted, the first logit model compared low commercialization to the reference group. The results for Siaya (Table 3) showed that only distance to market and marketing costs were statistically significant. The coefficient of distance to the market (-4.075) was negative while for marketing cost (0.801) was positive. The negative coefficient suggests that if farm households are located farther from the markets then the probability of engaging in low level category reduces.

Furthermore, as they progress to higher levels of commercialization, the coefficients become larger (medium -4.416 and high -4.486) indicating a more negative effect. It therefore implies that farmers are less likely to engage in high level commercialization than medium if they are farther from the market center and is due to increased transaction costs which results from the extra expenses incurred on transportation and time wasted in the movement of products to the market. This can be a hindrance to market participation. This finding is consistent with that of Omiti et al. (2009), Agwu (2012), Gebremedhin and Jaleta ( 2010), who found that distance to the market limits market access and participation of smallholder farmers. A similar finding was obtained from the interpretation of the relative risk in Table 3. The ratio implies that farmers who are farther from the market centres are less likely to engage in higher levels of commercialization. This is consistent with the above findings.

Marketing costs had a mixed effect for low and medium levels had a positive effect, thus implying that farm households are more likely to engage in low and medium levels of commercialization when the costs are increased. However, for higher levels of commercialization it is evident that farmers are less likely to engage in commercialization when marketing costs are increased. This implies that at lower levels of commercialization,

**Table 3.** Parameter estimates of the levels of commercialization (Siaya County).

| Variable | Low commercialization | | | Medium commercialization | | | High commercialization | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coefficient** | ***P[\|Z\|>z]*** | **RRR** | **Coefficient** | ***P[\|Z\|>z]*** | **RRR** | **Coefficient** | ***P[\|Z\|>z]*** | **RRR** |
| Constant | -3.311 | 0.097 | 0.036 | -4.256 | 0.002 | 0.014 | -7.900 | 0.000 | 0.000 |
| Gender ( Male) | -15.438 | 0.988 | 1.97e-07 | -0.639 | 0.371 | 0.527 | -1.146 | 0.222 | 0.318 |
| Extension service ( Yes ) | 0.846 | 0.318 | 2.330 | 0.840 | 0.127 | 2.318 | 1.085 | 0.137 | 2.959 |
| Distance to market (km) | -4.075** | 0.017 | 0.017 | -4.416*** | 0.005 | 0.012 | -4.486*** | 0.006 | 0.011 |
| Schooling years | 0.601 | 0.223 | 1.825 | 0.632** | 0.042 | 1.880 | 1.333** | 0.016 | 3.793 |
| Household size (No.) | -0.635 | 0.306 | 0.529 | 0.022 | 0.957 | 1.022 | 0.843 | 0.255 | 2.324 |
| Value addition (Years) | 0.161 | 0.744 | 1.174 | 0.653** | 0.052 | 1.921 | 0.272 | 0.541 | 1.313 |
| Marketing Costs (KES) | 0.801*** | 0.005 | 2.229 | 1.154*** | 0.000 | 3.172 | 1.030*** | 0.000 | 2.804 |
| Cassava acreage (Acres) | 0.869 | 0.237 | 2.385 | 0.911* | 0.059 | 2.487 | 1.328** | 0.027 | 3.773 |
| **Multinomial logistic regression** | | | | | | | | | |
| Number of observations | | | | | 179 | | | | |
| LR $chi^2$ (24) | | | | | 135.95 | | | | |
| Prob>$chi^2$ | | | | | 0.000 | | | | |
| Log likelihood | | | | | -123.995 | | | | |
| Pseudo R2 | | | | | 0.354 | | | | |
| Cox and Snell | | | | | 0.507 | | | | |
| Nagelkerke | | | | | 0.574 | | | | |

*** p=0.01, ** p=0.05 and * p=0.10

perhaps the costs incurred are less and insignificant as compared to higher levels which may demand for more costs especially on processing, storage, packaging and handling activities. This finding is in contrary to the expected results as well as other studies which have found an inverse relationship (Gebremedhin and Jaleta, 2010; Gebreselassie et al., 2015; Ocheing' et al.,2015). The studies found that various marketing costs reduce the interaction of farmers with other actors along the chain and their engagement in market participation.

The years of schooling in this study was used as a proxy to education. The coefficients were statistically significant for the medium and the high logit models at ($p<0.05$). However; the coefficient of the high level category is larger (1.33) than the one for medium category (0.63) thus implying that as farm household heads advance in formal education, they become endowed with a number of skills such as production, processing and managerial skills. These skills are essential in making coherent farming decisions as demonstrated by Enete and Igbokwe 2009.

The results clearly indicate that education has a significant contribution towards cassava commercialization in Siaya County. This county is known to put high premium on education. These results are supported by the findings of Mottaleb et al. (2014), who also found a positive relationship between education and commercialization. Contrary to the finding, Lawal et al. (2014) found that higher levels of education reduce the probability of undertaking commercialization. In fact, commercialization decision decreases as households opt for off-farm activities which are believed to have high income, Value addition experience had mixed results, which was only significant in the middle level category. This indicates that farmers who have at least some level of value addition experience are more likely to participate in advanced levels of commercialization than those who have no experience. This finding compares favorably with that of Parveen et al. (2014) which revealed that

**Table 4.** Parameter estimates of the levels of commercialization (Kilifi County).

| Variable | Low commercialization | | | Medium commercialization | | | High commercialization | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Coefficient** | ***P[\|Z\|>z]*** | **Odds ratio** | **Coefficient** | ***P[\|Z\|>z]*** | **RRR** | **Coefficient** | ***P[\|Z\|>z]*** | **RRR** |
| Constant | 0.518 | 0.600 | 1.678 | 0.012 | 0.991 | 1.012 | -0.874 | 0.389 | 0.417 |
| Gender (Male) | -0.212 | 0.645 | 0.808 | -0.955* | 0.092 | 0.385 | -1.034** | 0.040 | 0.387 |
| Extension service (Yes) | -1.372*** | 0.003 | 0.253 | 0.126 | 0.801 | 1.134 | -0.913 | 0.839 | 0.913 |
| Distance to market (km) | -1.004*** | 0.004 | 0.366 | -0.533 | 0.162 | 0.586 | -0.870** | 0.011 | 0.419 |
| Schooling years | 0.479** | 0.029 | 1.615 | 0.126 | 0.596 | 1.134 | 0.208 | -0.209 | 1.231 |
| Household size (No.) | -0.783* | 0.055 | 0.457 | -0.833* | 0.065 | 1.522 | -0.422 | 0.301 | 0.656 |
| Value addition (years) | 0.087 | 0.735 | 1.091 | -0.097 | 0.724 | 0.908 | 0.288 | 0.237 | 1.335 |
| Marketing Costs (KES) | 4.804*** | 0.984 | 122.06 | 5.769*** | 0.000 | 144.414 | 4.998 | 0.983 | 148.069 |
| Cassava acreage (Acres) | 0.122 | 0.548 | 1.129 | 0.682** | 0.027 | 1.251 | 0.298*** | 0.003 | 1.348 |
| **Multinomial logistic regression** | | | | | | | | | |
| Number of observations | | | | | 200 | | | | |
| LR $chi^2$ (24) | | | | | 90.25 | | | | |
| Prob>chi2 | | | | | 0.000 | | | | |
| Log likelihood | | | | | -123.995 | | | | |
| Pseudo R2 | | | | | 0.165 | | | | |
| Cox and Snell | | | | | 0.380 | | | | |
| Nagelkerke | | | | | 0.406 | | | | |

*** p=0.01, ** p=0.05 and * p=0.10.

marketing of different forms of cassava processed products requires some value addition skills and knowledge which can be sharpened through experience.

As expected, the coefficients for cassava acreage were significant and increased progressively along the levels of commercialization. This implies that an increase in farm acreage enhanced the likelihood of farmers being in the medium (0.911) and high (1.328) level categories. The RRR further showed that the effect for the high category is 1.286 times that of the medium category. This signifies that landholding is a major influencer of commercialization levels in Siaya County.

Furthermore, farm acreage determines the allocation of various crops to land holdings. Farm households with large parcels of land are more likely to produce marketed surplus that they can process into various forms and sell. Martey et al. (2012) similarly found that farmers with more acreage of land are better positioned to undertake commercialization compared to those with challenges of land acreage.

The estimated results for Kilifi County were slightly different from that of Siaya and this was however expected since the two counties have distinctive characteristics as observed from the descriptive statistics. Three logit models were fitted. In the first logit model that compared the low level category with none category shown in Table 4 reveals that, years of schooling and marketing costs were positively significant while access to extension services, distance to the market and household size negatively influenced households' decision to engage in low commercialization. The positive and statistically significant sign of the coefficient for years of schooling showed that farm households are likely to engage in low commercialization with additional year of schooling. The variable was however not statistically significant in the medium and high levels of commercialization.

The implication is that farm household heads that are educated are less likely to engage in

higher levels of cassava commercialization. This could be argued that farmers' technical capacity can be built through experience but not necessarily education. Furthermore, an educated household head will be attracted to white collar jobs which in many cases are found in urban set ups. This lowers the possibility of engaging in farming activities. This finding gains support from the works of Mathijs (2002) who argued that a more educated household head focuses more on off-farm activities than farm activities. This was however unexpected since education, being a form of human capital, can influence the uptake of knowledge which further stimulates commercialization decisions.

The results revealed that marketing cost was significant and increased positively in both the low and the medium levels. This contradicts the apriori expectation of the study which hypothesized a negative effect of marketing cost on the levels of commercialization. This is because generally marketing costs are an impediment to active engagement in marketing activities and this result is similar situation to the one found for Siaya county, hence it concludes that other than marketing costs there are other factors which influence the choice of commercialization levels which could be that farmers are willing to spend more on marketing activities especially if the venture is profitable and the returns outweigh the costs. This requires a further in depth study.

From Table 4 it is clear that cassava acreage was positive and significant at 5% and 1% significant levels for the medium and high levels categories, although we observe a greater probability in the medium category than the high. The positive signs indicate that additional allocation of land to cassava increases the likelihood of up scaling commercialization in the medium and high categories. Further implication is that land is an incentive to enhanced production which can be partly consumed as well as marketed (Martey et al., 2012). Considering households that engaged in high levels of commercialization, land was not deemed very important. This is because the change in the coefficient was lower for the high level category than the medium level category. Unlike in Siaya, where land was highly significant especially among those who engage in high levels of commercialization, Kilifi farmers have other considerations which influence commercialization. Land was in abundance in Kilifi but a greater portion of it was on rocky ground and therefore unproductive. To a greater extent a number of farm households are rented land to supplement farm production.

Converse to Siaya results household size negatively influenced the probability of being in the low (-0.783) and medium (-0.833) categories in Kilifi County. However, the variable was statistically insignificant in the high category. The results suggest that large households are less likely to engage in commercialization since large size can exert a lot of pressure on the limited household resources including production. This would therefore mean that all or a greater proportion of production is channeled to meet the household demand therefore limiting commercialization. The composition of the membership greatly matter. In this case majority of household members in Kilifi County were small children who in many cases cannot participate in commercialization activities either because they are attending school or they are very minor. This confirms an observation made by Gebremedhin and Jaleta (2010) those smallholder farmers can barely meet their daily requirements especially when the household size is large.

Table 4 also shows that distance to the market was significant although with a negative effect on low and high categories. However; the relative risk for high category (0.419) indicates a decrease more than that of the low category (0.366). This is similar to the findings of Ochieng' et al. (2015) who found that long distances increase transaction costs which is a deterrent to market entry. These results contradicts the findings of Lawal et al. (2014) which found that an increase in transport cost increases the likelihood of farm households' participation in commercialization. This is especially when the costs are low and insignificant.

Extension services had mixed results on the different levels of commercialization. For the low level category, it was statistically significant but negatively influenced commercialization. For the other levels, it was not significant. This implies that farm households are less likely to engage in low level commercialization despite making contacts with extension officers. As expected, contacts with extension officers act as networks for disseminating information and this is likely to heighten commercialization (Rahut et al., 2015). Probably farm households have other social networks where they can gather information related to farming and therefore they rarely interact with extension officers.

In addition, the results in Table 4 shows that gender negatively influenced the choice of being in the medium (-0.955) and high (-1.034) categories. The negative effect of the gender variable implies that male headed households are less likely to engage in advanced levels of commercialization. Studies argue that a man's social life is less interactive compared to a woman and this lowers their integration into cassava commercialization activities (Agwu et al., 2015). The implication is that men emphasize more on off farm than farming activities so as to supplement household income. Women on the other hand are motivated to engage in cassava commercialization since farming is their main economic activity as they do take charge of their homes while men are a way.

This argument contradicts the findings of Forsythe et al. (2016) in Nigeria who demonstrated that both men and women actively participate in cassava commercialization activities at different levels; men are mainly involved in marketing of cassava while women engage more in processing activities (Forsythe et al., 2016); but in overall,

they assist each other in various cassava related activities.

## CONCLUSIONS AND POLICY RECOMMENDATIONS

The primary objective of the paper was to identify and explore the different levels of cassava commercialization using cross-sectional data. This paper contributes to literature on cassava commercialization by contextualizing the concept as value addition and market participation, thus, recognizes the fact that value added cassava products provide tremendous market opportunities through diversification, further promoting commercialization. Based on this concept, different levels of commercialization were categorized using commercialization index which was developed from household commercialization index and value addition index.

To further explore factors determining every level of commercialization, a multinomial regression model was employed. The results showed that majority of cassava farm households from both counties engaged in medium level commercialization. However, a low proportion of those who commercialized were involved in high level commercialization while a good number of farmers were not involved in commercialization activities which could imply that cassava was either consumed in raw or value added form without engaging in marketing activities.

The study found that there were variations in the two counties in relation to the cause and effect of the variables influencing the different levels of commercialization. Econometric analysis found that cassava acreage and distance to the market had a significant influence on the levels of commercialization in both counties. Although land size determined the levels of commercialization, the effect was not significant for farm households from Kilifi County who highly commercialized compared to the medium level. This shows that land alone may not contribute to high levels of commercialization unless it is supported by other factors.

The study also found that farm households from Siaya had small parcels of land and this limited their engagement in high level commercialization. Also, distance to markets influenced the decision to undertake cassava commercialization or not. Farm households did not undertake higher levels of commercialization because either the roads were in poor states or markets were located farther away from the farm households, thus, reduced their participation in markets due to increased transaction costs. Considering the specific counties, Siaya County exemplifies the importance for education because it has a significant effect on the levels of commercialization. Conversely, Kilifi County had gender imbalance on cassava commercialization and very few men participated in commercialization related activities. Based on the findings, the study recommends that policy makers should strengthen market interaction by ensuring that road networks linking farmers with the main roads are maintained and markets are well structured. In addition farmers should be sensitized on the role of cassava commercialization in the households as an effort to improve land allocation to cassava for production.

Value addition should be promoted and embraced by farmers in order to provide competitive cassava products to the market and also farmers should be given incentives such as reasonable prices which can stimulate commercialization. Gender disparity should also be addressed if farm households were to engage in higher levels of commercialization. This can be achieved by empowering and integrating men into cassava commercialization activities through trainings and capacity building so that they can support women in advancing into higher levels of commercialization. More members of the households should be encouraged to participate in cassava commercialization. Policy makers also need to support education system through programs such as free primary education.

Finally, a deeper analysis should be conducted for each County to explore other factors that could determine the different levels of commercialization.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests

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