International Journal of Agricultural Economics
2019; 4(5): 207-215
http://www.sciencepublishinggroup.com/j/ijae
doi: 10.11648/j.ijae.20190405.13
ISSN: 2575-3851 (Print); ISSN: 2575-3843 (Online)

Enhancing Crop Commercialisation for Food Security in Rural Tanzania: A Case of Liwale District

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To cite this article:
Nelson Ochieng. Enhancing Crop Commercialisation for Food Security in Rural Tanzania: A Case of Liwale District. *International Journal of Agricultural Economics.* Vol. 4, No. 5, 2019, pp. 207-215. doi: 10.11648/j.ijae.20190405.13

Received: February 7, 2019; **Accepted**: March 6, 2019; **Published**: August 5, 2019

Abstract: This study explores the effect of small-scale agricultural crop commercialisation on household food security in Liwale, Lindi. The study used a household survey data from a sample of 389 households that were collected in 2017. The Principal Component Analysis was used to develop the household food security index and the Cluster Analysis was used to assign the individual households to their respective clusters of food security index. The output side measure of commercialisation was used to develop crop commercialisation index, and lastly, the Ordered Logit Model was used to estimate the effect of commercialisation on food security. The average household food security index is 32%. The majority (64%) of the households were moderately food secured with an average food security index of 32.8% while only 16% of households were relatively more food secure than the rest and with average food security index of 49.1%. The average commercialisation of small-scale agricultural crops is 66%. The results from ordered logit estimation show that crop commercialisation, off-farm income, and access to extension services positively affect the level of household food security while credit negatively affects food security. The implication of the findings is that, small local processing factories should be established in rural areas to promote commercialisation, value addition and increase of market access and linkages to reduce post-harvest losses incurred as a result of poor storage technology and perishability.

Keywords: Agriculture, Commercialisation, Food Security

1. Introduction

Food security considers consumption as one of the main factors in its measurement. It is linked to nutrition and therefore, food insecurity in Tanzania becomes one of the major problems in both economic and health perspectives. The records of food security in Tanzania reveal a downward trend since the 1990s from undernourishment rate of 24.2% in 1992 to 35.7% in 2018 [1]. In a global context, the country ranked 54th out of 79 countries in 2012 and 62 out of 78 countries in 2013 respectively [2]. In 2016 the country ranked 94th out of 113 countries, with the food security index score of 36.9%. This was equivalent to 0.4% increase from the year 2015 [2]. The majority of insecure population is living in rural areas with a low level of education. Furthermore, around 10% of Tanzanians live below the food poverty line and classified as extremely poor and incapable of purchasing basic common food items [3].

The prevalence of food insecurity in the country varies regionally. Regions with the highest proportion of households that are food insecure are Dodoma, Singida, Tabora and Lindi where 45-55% of the households are food insecure [4]. In a supportive weather condition, production of food to meet national demand has been adequate. The areas that suffer from food shortages are due to the existence of inadequate rainfall. Food crops production depends heavily on rainfall especially for major staple crops like maize, bananas, and cassava. Sustainable food security gains require continued support for Tanzania's agriculture sector alongside with promotion of irrigation agriculture to enhance sustainable food production. The main source of income in rural areas used in purchasing food items mostly comes from sales of agriculture products. Tanzania has gone through some efforts in solving the problem of food insecurity in the country, among the strategies used is the establishment of the irrigation schemes. Irrigation is one of the key activities for sustained agricultural production [5]. Crop production in the country is currently dominated by rain-fed systems which make the food availability more volatile and insecure [6].

Tanzania is practicing agricultural produce business, both internal and external which involves both food crops and cash crops. Crop yields' business development is faced by a number of challenges. The main challenges of crop marketing faced by rural farmers are inadequate value addition in agricultural produce, weaknesses of cooperative societies and lack or weak farmers' associations. Consequently, producers do not receive remunerative prices [7]. Therefore, in an attempt to promote crop commercialisation and improve the well-being of people in rural areas through crop production, Tanzania has enacted a number of policies supporting commercialisation one of them being Agricultural Marketing Policy of the year 2008. Among the policy issues under this policy document is value addition, improving marketing infrastructure, and to work on the quality and standard of the produce [7].

The pattern and growth of the economy are influenced by the transformation of the agriculture sector through value addition of primary products which influence investment in the industrial sector. The fifth phase government, through National Five Years Development Plan 2016/17 – 2020/21 had a theme stating "Nurturing Industrialization for Economic Transformation and Human Development" with the main objective of enhancing the pace of progress towards the Tanzania Development Vision 2025 [19]. It insists "*The Tanzania of industrialization",* and therefore, prioritized some agricultural products as an intervention in fostering economic growth and industrial development. The crop products are maize, rice, sunflower, pulses, floriculture, cotton, sisal, grape, and sesame [8]. This necessitates an intensification of industrial inputs crops production, that is, the promotion of commercialisation of the mentioned crops to hit the target.

There exists a linkage between agricultural crop commercialisation and food security. The decision to adopt market-oriented production influences the degree of food availability at national, community and household level. This is through the increase in real incomes at household level which then enhance their consumption of wide varieties of food. Therefore agriculture commercialisation among poor households improves food and nutrition security. Post-harvest losses can be managed through commercialisation initiatives which include adding value to farm products; due to the nature of agriculture products value addition increases its market value and reduces loss. As a result of urbanization, the demand for value-added products increases. This can reduce the post-harvest losses by farmers and increase food availability and food security. Therefore, the objectives of this paper are to determine the status of food security of rural households and the effect of agricultural crop commercialisation on rural household food security

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in Liwale, which is one of the six districts of Lindi region of Tanzania. The district was selected due to its potentiality in crop production (commercial and non-commercial crops) most of which are in the prioritized crops by the government for promoting industrial development. The main two cash crops in Liwale are Sesame and Cashew nuts. Other crops include maize, millet, paddy, cowpeas, cassava, sweet potatoes, and groundnuts. According to 2012 Census, about 91% of the labor force was employed in the agriculture sector and approximately 78% of total private households living in rural parts of the district [3].

2.2. Data Collection, Sample Size, and Sampling Technique

Primary data were collected from the field in the year 2017 using structured questionnaire among household heads who are small-scale farmers. Therefore, the sample size was given by the formula in equation 1.

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

Where 'n' is the sample size, 'N' is the total number of households in the district and 'e' is the sampling error (level of precision) which was 5% for this study. By using the formula in equation 1, 389 rural households were sampled to represent 11,564 households in rural areas of the district. In sampling technique, the multistage sampling technique was employed whereby at first stage Liwale District was purposely selected among Lindi region districts. At the second stage, the population was set into strata of zones by types of crop cultivated from which 10 villages were purposefully selected for the study, and lastly, the households were randomly selected for interview from the villages. The villages which were purposefully selected for study according to their type of crop produced were Mangirikiti, Mirui, Liwale 'B', Naluleo, Naujombo, Kinguluwila, Kimbemba, Mikunya, Kipule and Kipelele. In these villages, nine crops were being produced; these include sesame, cashew nut, maize, paddy, millet, cowpeas, cassava, sweet potatoes, and groundnuts.

2.3 Tools for Analysis and Presentation

Statistical Package for Social Sciences (SPSS) was used for data entry and data management while data analysis and estimations were done using both STATA and R software. In addition, data and output have been presented in a narrative, tabular and in a graphical form of presentations to ease reading and understanding of the subject matter.

2.4. Measuring Food Security

Food security is composed of food accessibility, availability, utilization, and sustainability [18]. Since the data is a cross-section, the part of sustainability was not captured. The study used five indicators which are the size of the farm cultivated, quality and safety of water for domestic use, crop

[1] The method was formulated by Yamane (1967:886). It provides the sample size with a 95% confidence level

diversity, toilet quality, and a number of meals per day in the measurement of the key variables capturing food security as indicated in Table 1. The Principal Component Analysis was used to formulate the (PCA)-based household food security index as suggested by Abafita and Kim in their study of the determinants of food security in rural Ethiopia [9].

Table 1. *Selected variables and indicators in estimating food security index.*

S/N	Food Security Dimension	Selected indicator
1.	Food Access	Farm size cultivated
2.	Utilization	Water supply, crop diversity i.e number of crops cultivated, hygiene i.e. toilet quality
3.	Availability	Number of meals per day

Mathematically, for n numbers of variables, the k principal components are expressed as follows;

$$PC_k = \sum_{i=1}^{n} w_{ki} x_i \quad (2)$$

Where 'PC_k' is the 'k^{th}' principal component, 'w_{ki}' is the weight assigned to the variable 'Xi' in the k^{th} principal component and 'Xi' are variables used to calculate principal components. The idea behind the use of PCA is that it assigns different weights to the different individual selected indicators [10] and [20]. The first principal component (PC_1) accounts for as much of the variability in the data as possible, that is to say, PC_1 has the highest Eigen value and accounts for the highest percentage of variance. Eigen values describe how much variance is accounted for by a certain factor. The second component (PC_2) explains additional but less variation than PC_1 and each succeeding component account for as much of the remaining variability as possible [10].

The maintained principal components were considered in measuring household food security index and they were given different weights according to their magnitude of a percent to which they account for the variation in the dataset. The formula given in equation 3 was thus used to estimate a Non-standardized Food Security Index (NSI). The ratio of variance explained by factor '' to the total variance is the weight given to the respective factor i in forming the index.

$$NSI = \sum_{i=1}^{n} \frac{V_i}{TV} * PC_i \quad (3)$$

Whereby 'n' is the number of factors maintained, 'V_I' is the percent of variation explained by factor I 'TV' is the total variation in the data explained by 'n' retained factors and 'PC_i' is the i^{th} factor. With the use of equation 3, we get the non-standardized welfare index with positive and negative values. This index was thus standardized using equation 4 to obtain values ranging from 0 to 100.

$$FSI = \frac{NSI + (-)\min NSI}{\max NSI + (-)\min NSI} * 100 \quad (4)$$

A similar procedure was adopted in previous studies where the scores were later reversed to make the interpretation easier; the higher the value, the better the economic status of an individual household [10-12].

2.5. Measuring Crop Commercialisation

As suggested by Strasberg et al. crop commercialisation is measured by crop commercialisation index [13]. From the output side, it is the ratio of the gross value of all crop sales over the gross value of all crop production multiplied by a hundred. Therefore; Household Crop Commercialisation (HCI) is given by the following formula;

$$HCI = \frac{outputsold}{totalproduced} * 100 \quad (5)$$

2.6. Econometric Analysis

The Ordinal Logistic model was used to estimate the effect of crop commercialisation (HCI) on the household food security. The response variable which is food security status is an ordinal variable with values 1 if the household is less food secure, 2 if the household is moderately food secure and 3 if the household is relatively more food secure.

$$Y_i = \begin{cases} 1 & if \ y^* \le \mu_1 \\ 2 & if \ \mu_1 < y^* < \mu_2 \\ 3 & if \ y^* \ge \mu_2 \end{cases} \quad (6)$$

$$y_i = \alpha_0 + \sum_{i=1}^{n} \alpha_i X_i + \varepsilon_i$$

Whereby 'Y_i' is the household food security status, 'μ_1' is the cutoff point between less food secure and moderate food secure, 'μ_2' is the cutoff point between moderate food secure and relatively more food secure, 'α_0' is the intercept or the constant term, 'X' is the set of explanatory variables which determine household food security status with inclusion of crop diversification, and 'αi' is the set of coefficients of explanatory variables.

3. Results

3.1. Descriptive Statistics

The descriptive statistics has been summarized in Table 2. The findings show that 74% of the interviewed household heads were males while 26% were females. In most cases a female becomes a household's head in absence of a male capable of being the household's head; most of them are either divorced, separated or widowed [14]. The mean farming experience of the households' head is 15 years. This information indicates that Liwale is characterized by young

energetic and experienced group of people who can perform the farming activities well. Only 10% of respondents had access to credit, furthermore, along with income from agriculture sources, 9% of households could get their income from other non-farm sources.

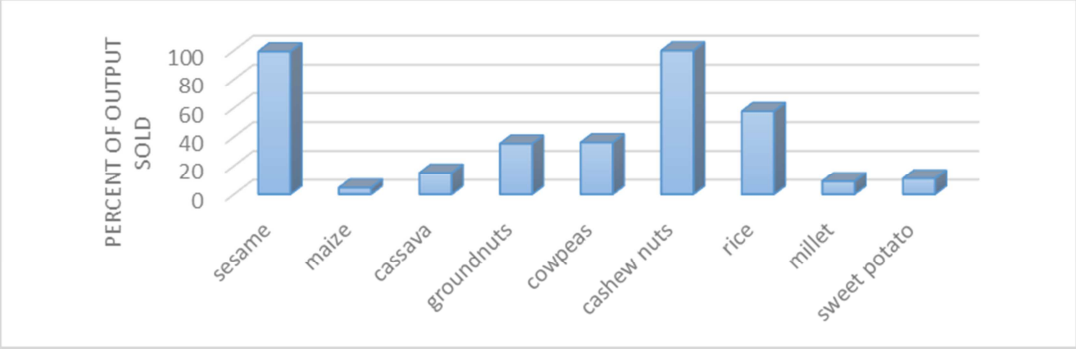
Table 2. *Descriptive statistics for variables used in econometrics.*

Variables	Min	Max	Mean	Std. Dev
Household Food security status	1	3	1.96	0.597
Household commercialisation index	0	100	66.27	36.18
Distance from the nearby market in km	0	8	1.60	2.19
Household head gender	0	1	0.74	0.44
Household head farming experience	2	60	15.20	12.53
Access to credit	0	1	0.105	0.31
Off-farm income	0	1	0.09	0.29
Access to extension service	0	1	0.13	0.34
Number of dependents	0	7	1.65	1.37

Source: Survey results, 2017

3.2. The Level of Household Crop Commercialisation

A total of nine crops cultivated in Liwale District were taken into the study and they were used to compute the household crop commercialisation index (HCI); these crops included sesame, maize, cassava, groundnuts, cowpeas, cashew nuts, rice, millet and sweet potatoes. Applying the formula provided in equation 5 the household crop commercialisation index for every household was constructed, and the commercialisation level for every crop was also computed. Generally, the data depicts that the district crop production is commercialized with an average of 66.27%. Figure 1 shows the average level of commercialisation of each crop under sample study in the district. The top three crops with a high level of commercialisation are cashew nuts, sesame, and rice. Cashew nuts and sesame are purely cash crops and thus their indices are almost 100%, rice is commercialized at 57.6%.



Source: Author's computation from the survey data, 2017

Figure 1. *Average commercialisation index for each crop produced.*

Three levels of crop commercialisation were formed and the households were categorized in accordance with these commercialisation levels. The first household category is the group of subsistence households with commercialisation less than 20%. The second is the semi-commercialized households; the households who are under transition from subsistence to commercialized farming. These are those with the level of commercialisation lying between 20 and 50 percent. The last group is the commercialized households, households with commercialisation index above 50%. Figure 2 shows clearly the three sub-groups of households by their levels of commercialisation.

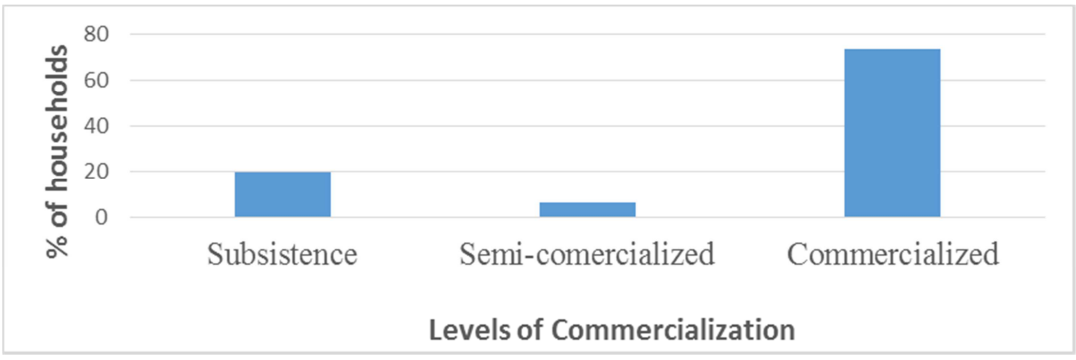


Figure 2. *Household groups by levels of Commercialisation.*

The majority (73.52%) of the households are commercialized, followed by household who perform subsistence agriculture (20.05%) and lastly those under transition who perform semi-commercialized crop cultivation (6.43%). In the District, after maize, pure commercial crops which are cashew nuts and sesame are highly produced. This leads to higher level of commercialisation among farmers. The results show a low percentage of households practicing semi-commercialized cultivation. This is the transition from subsistence to

commercialized crop production. Cashew nuts which are among the pure commercial crops is a permanent plantation, those households who already own cashew nuts plantations rarely drops the production, thus will remain in cashew nuts commercial farming. Those households with no cashew nuts plantation also rarely start new plantations, instead, a shift of ownership by selling and buying the already existing farms takes place. Thus the subsistence and commercialized farming households do not vary much with time and that is the reason of having a very low portion of households under transition.

In evaluating the level of commercialisation by gender, the result shows that majority which is 74% and 72% of both males and females headed households respectively were commercialized. This was then followed by subsistence households and lastly semi-commercialized households as shown in Table 3.

Table 3. *Levels of commercialisation by household head gender.*

Levels of commercialisation	household head gender	
	Males N (%)	Females N (%)
Subsistence households	18	26
Semi-commercialized households	8	2
Commercialized households	74	72
Total	100	100

Source: Survey results, 2017

Despite the same nature of distribution among the three levels of commercialisation for both genders of the household's heads, the participation of females in the subsistence farming is higher than that of males. As shown above, 26% of females against 18% of males engage in subsistence crop production. Under commercialized households the proportion of male-headed households is higher than that of females, that is, 74% and 72% respectively. Furthermore, more proportion of male-headed households are under transition from subsistence to commercial farming than females, that is, 8% of males against 2% of females conduct semi-commercialized farming. The implication of this is that with time the gap between males and females will be higher. In rural areas, males are more equipped, educated and have time to do other generating income activities, unlike females who in most cases take care of the family as their primary duty. Thus males are able to participate more in commercial cultivation and suppress women in subsistence farming in which food crops for the family are grown [15].

3.3. Indicators used in Measuring Food Security Index

The survey data shows that the number of meals per day on average was 2.6 meals. Households in Tanzania that are food secure normally eat three meals per day. During food shortages people tend to reduce the number of meals taken; reasons are either to make the small amount of food kept to sustain the family till the next harvest or due to unaffordability of food cost during shortages. The average farm size cultivated by households was 6ha ranging from 0.5ha to 43ha. Farm size determines the possible number of crops and output a household can produce. The average crop yields were monetary valued because of a variety of crops cultivated by interviewed households. The average value of yields from all crops cultivated was Tsh. 2,328,185 per household and the number of crops cultivated ranged from 1 to 6 crops with an average of 2 crops per household. Liwale's soil supports the growth of more than one crop and thus allows the possibility of crop diversification. The results further show that 74.3% of the interviewed households diversified crops with at least two crops. The process of crop diversification brings about yield stability, nutrition diversity and health status of farmers' households. It is sometimes used as an alternative way to maintain soil fertility and control of pests [16].

Clean and safe water access was determined by the sources of water for domestic use. The quality of toilet facility was determined by considering if the household has a toilet or not, and for the available toilet if it is an improved one or not. The results are summarized in Table 4. The majority (89.2%) of the households had normal pit latrines, the lowest quality toilets. 1.54% had no toilets at all and few (5.14% and 4.11%) had flash toilets and improved pit toilets respectively, which are toilets with the highest quality as per the study. A total of five water sources for domestic use were analyzed to find out the quality and safety of water in use. The majority (61%) of the households were using water from unsafe water sources which are either an open well outside the compound or from the river. The rest 39% of households were using clean and safe water either piped or covered well in the residential compound of the household. Having the majority in the community with poor sanitation and the use of unsafe water are indications that the community is prone to disease outbreaks which in turn limit production capacity of the households.

Table 4. *The quality of toilets and access to clean and safe water.*

Sanitation indicators	Households (%)
Toilet quality	
Flash toilet	5.14
Improved pit toilet	4.11
Pit latrine	89.20
No toilet	1.54
Water Source	
Safe sources	39.07
Unsafe sources	60.93
Source: Survey results, 2017	

3.4. Application of Principal Component Analysis

The PCA was used in forming the food security index (FSI) by constructing principal components using the formula provided in equation 2. The two factors were maintained on the basis of Kaiser Criterion and scree plot as presented in Figure 3. The maintained factors account for the variance in the dataset for 53.2%. The sampling adequacy and Bartlett's sphericity test was ran and the result is that KMO was 58.1 which is acceptable [11] and the p-value for Bartlett's sphericity test was 0.000 which suggest the

existence of correlation between the variables in use and thus validates an application of PCA in security index construction.

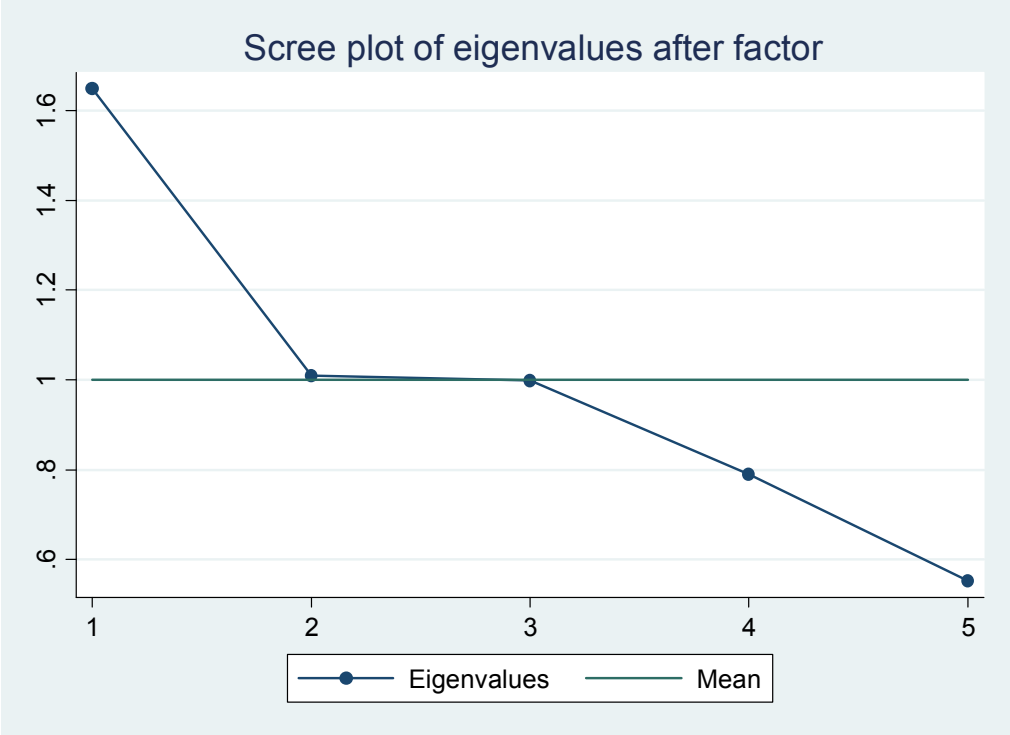


Figure 3. *Scree plot of eigenvalues of factors.*

For every component maintained, there is at least one variable which it accounts for. The results of the PCA show that the first component (PC_1) accounted for 32.98% of the total variation. This component is a reasonable representation of farm size cultivated, crop diversification and quality of toilet facility as shown in Table 5. These variables have higher factor loadings along the first component. The second component (PC_2) explains about 20.21% of the total variation; it is highly associated with the quality and safety of water for household domestic use and the number of meals per day.

Table 5. *Results of PCA: Varimax rotation factor matrix.*

Variable	PC_1	PC_2
Farm size cultivated	0.8120	
Quality of clean and safe water for domestic use		0.30629
Crop diversification	0.6618	
Number of meals per day		0.8576
Quality of the toilet facility	0.6865	
Percent of variance (53.19%)	32.98%	20.21%

Source: Survey results, 2017

3.5. Constructing Food Security Index

The two retained factors explain 53.19% of the total variation, with the first and second factors, explaining 32.53% and 20.66% respectively. Since the mentioned factors explain the variance in different levels of magnitudes, their importance in measuring overall household food security condition is not the same. Applying the formula given in equation 3, a Non-standardized Index (NSI) was developed using the proportion of these percentages as weights on the factor score coefficient as in equation 7.

$$NSI = \frac{32.53}{53.19} PC_1 + \frac{20.66}{53.19} PC_2 \quad (7)$$

To standardize the index, the formula in equation 4 was applied. Thus the standardized food security index (FSI) was estimated as follows;

$$FSI = \frac{NSI + (-)(-1.69016)}{3.541183 + (-)(-1.69016)} * 100 \quad (8)$$

Where FSI is the standardized food security index, and NS_FSI is a non-standardized food security index. The values -1.69016 and 3.541183 are minimum and maximum values of the non-standardized index. With the formula in equation 8, the standardized food security index (FSI) ranges from 0 to 100. The higher the value of index the more food secures a household is.

3.6. Household Food Security Status

The food security index is a continuous variable, thus the cluster analysis was employed to identify the number of clusters to which a household belong. The method automatically guided the decision of how many clusters to retain by calculating measures-of-fit that is Bayesian Information Criterion (BIC) [10].

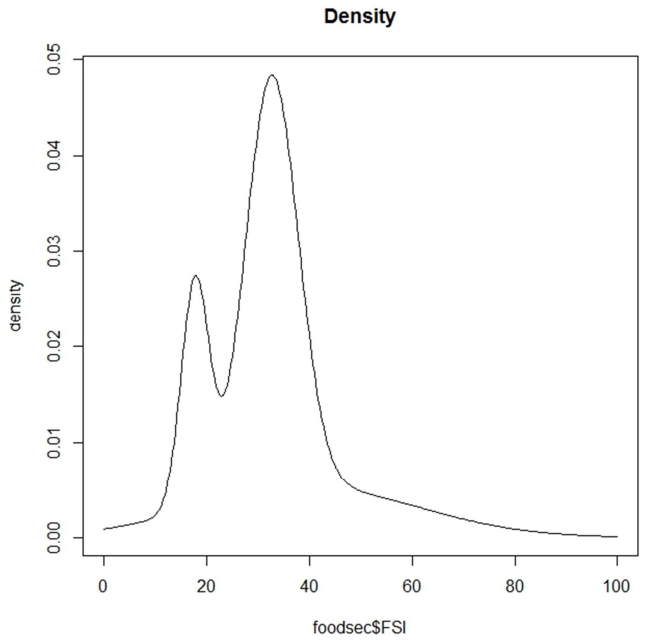


Figure 4. *The density distribution after Clustering.*

The density distribution in Figure 4 shows the existence of three peaks indicating three clusters. Cluster1, cluster2, and cluster3 comprise of 20%, 64.3% and 15.7% of the total households respectively. The majority is therefore found in cluster2 the group of which the food security index is averaged to 32.8% and relatively moderate among the existing three clusters. Few (15.7%) of the households are food secure with the security index of 49.1%. This information as summarized in Table 6 reveals the existence of food insecurity among the majority of households in Liwale villages.

Table 6. *Statistical description of clusters.*

Cluster	Obs	Percent	Prob	Mean (%)
1: Less food secure	78	20.0	0.161	17.7
2: Moderate food secure	250	64.3	0.561	32.8
3: Relatively more food secure	61	15.7	0.278	49.1

Source: Author's computation from the survey data, 2017

3.7. Econometric Analysis

Food security index is an ordered variable with the value of 1, 2 and 3 in their order of an increasing security whereby, the value 1 represents the group of households with the lowest food security and 3 represents the group with the highest security index. This necessitates the use of ordered logit model in estimating food security index. There was no serious problem of multicollinearity, the variance inflation factor (VIF) of all independent variables is below 2 which is less than the tolerable value and the mean VIF is 1.19. The results of the link test revealed the absence of specification error. Table 7 and Table 8 summarize the results of the ordered logistic estimation and the marginal effect respectively.

Table 7. *Ordinal Logistic estimation results for factors affecting rural household food security status.*

Food security status (1=less secure, 2 =moderate 3=more secure)	Odds Ratio	(Std. Err)
Household commercialisation index	0.00855***	(0.00305)
Access to extension services	0.72830**	(0.32998)
Off-farm income	1.05669***	(0.38030)
Distance from the nearby market	-0.067297	(0.04888)
Access to credit	-0.65586**	(333290)
Farming experience	0.0162489	(0.01041)
Number of adults in a household	0.218839	(0.27133)
Number of dependents in a household	-0.0362446	(083836)
Household sex: (1=male, 0=female)	-0.2297626	(0.24217)
Cut1	-0.8627665	(316676)
Cut2	2.429603	(345025)
Number of Observations	388	
LR chi2 (9)	33.30	
Prob > Chi2	0.0001	
Pseudo R2	0.0478	
Log-likelihood	-331.79	

Note: Significance level: *** ($p \leq 0.01$); ** ($p \leq 0.05$)

Table 8. *Marginal effect after ordered logit estimation.*

Variable	Less food secure		Moderate		More food secure	
	dy/dx	Std. Err	dy/dx	Std. Err	dy/dx	Std. Err
Commercialisation index	-0.0013***	(0.0005)	0.00023	(0.0002)	0.00104***	(0.0004)
Extension services	-0.0913***	(0.0343)	-0.01582	(0.0268)	0.10711*	(0.0570)
Off-farm income	-0.1188***	(0.0315)	-0.05275	(0.0497)	0.17153 **	(0.0765)
Access to credit	0.11422*	(0.0658)	-0.04773	(0.0399)	-0.06649**	(0.0282)

Note: Significance level: *** ($p \leq 0.01$); ** ($p \leq 0.05$); *($p \leq 0.1$)

4. Discussion

4.1. Crop Commercialisation

The results are as summarized in Table 7 and Table 8. Crop Commercialisation relates positively to food security status of a household. A unit increase in household commercialisation index is associated with 0.13% less likely for the household to be in a category of less food secure households and 0.104% more likely to be in a category of households which are relatively more food secure. In other words, the commercialisation increases the likelihood of the household to be in higher categories of food security status. Households with higher commercialisation index intensified themselves in the production of cash crops including cashew nuts and sesame. These crops are high paying and have a stable market. Farmers who produce these crops gain more income from sales and have high capacity in investing in other areas including farming itself. It thus enables the household purchase sufficient and nutritious food. The findings are in line with the findings of the study done by Govereh and Jayne in Zimbabwe where agriculture commercialisation was found to promote the production of food crops and generate income for the purchase of food items [17]. Likewise, Strasberg, et al. [13] in Rural Kenya found that agriculture commercialisation increases the production of food crops through fertilizer applications on farms and thus increase food supply.

4.2. Access to Extension Service

Access to extension service positively relates to food security. A household which has an access to extension services is 9.13% less likely to be in a group of households with less food security, 1.58% less likely to be in a group of households with moderate food security, and 10.71% more likely to be in a group of households which are relatively more food secure. The positive association comes in because agriculture extension helps in technology diffusion, that is, it accounts for the transfer of improved agricultural technologies and information at the farm levels which promotes storage, productivity, and stable market accessibility.

4.3. Off-farm Income

Off-farm income has a positive influence on the household's food security. A household which engages in other non-farm activities and earns income is 11.9% less likely to be in a group of households with less food security status, 5.28% less likely to be moderately food secured, and 17.15% more likely to be relatively more food secured. Farming activities in Liwale district are seasonal and mostly depend on rain thus the yields are not stable. Households that depend highly on farm yields are prone to food insecurity during rainfall shortages. The stability of income flow is made by income coming out of farm which supplements the shortages during low- yield periods.

4.4. Access to Credit

Access to credit has a negative correlation with food security index. A household with access to credit is 11.4% more likely to be less food secure, 4.77% less likely to be moderately foods secure, and 6.65% less likely to be relatively more food secure. The negative association of credit access with food security index was not an expectation. However, this means that those who have access to loans for purchase of farming inputs do not produce enough to recover the loans instead some of their productive assets are used to repay the loans and thus reduce their ability to production and food consumption.

5. Conclusion and Policy Implication

The results show that the average household food security index is 32%, and the majority (64%) of rural households fall under the group of households with food security index of 32.8% and very few (16%) of households are relatively more food secure. The level of crop commercialisation is averaged to 66% and the majority of the households are commercialized. Agricultural crop commercialisation is found to have significant positive effect on household food security.

Commercialisation should be promoted through improving market access and linkages; this will help to reduce post-harvest losses incurred during storage as a result of poor storage technology and will increase food security through increased access to wide varieties of food through the income generated from commercialisation. Promotion of strong extension services and training programs which will enforce proper harvesting and post-harvest management strategies including the use of insecticides, handling and storage practices so as to avoid losses and help in increasing food security. Lastly, the household farmers should learn to diversify their income sources to reduce their dependency on agriculture alone since agriculture is highly subjected to various productions and marketing risks including climatic changes; they should engage in different off-farm income generating activities especially during non-farming seasons.

References

[1] FAO, IFAD, UNICEF, WFP and WHO. The State of Food Security and Nutrition in the World 2018: Building climate resilience for food security and nutrition. Rome, FAO. (2018).

[2] International Food Policy Research Institute. 2017 Global Food Policy Report, Washington, DC: International Food Policy Research Institute. (2017). https://doi.org.10.2499/9780896292529.

[3] United Republic of Tanzania, "Population and housing census: population distribution by administrative areas. *National Beural of Statistics: Ministry of Finance, Dar es Salaam-Tanzania"*, 2012.

[4] Kiratu, S., Marker, L., and Mwakolobo, A. Food Security: *The Tanzanian Case,* Series on Trade and Food Security. International Institute for Sustainable Development (2011).

[5] Nakayama, Francis S., and D. A. Bucks, eds. *Trickle irrigation for crop production: design, operation and management*. Vol. 9. Elsevier, 2012.

[6] The United Republic of Tanzania. Agriculture Sector Development Strategy – II 2015/2016-2024/2025, Dar es salaam, Tanzania.

[7] United Republic of Tanzania. National Agriculture Policy: The Ministry of Agriculture Food Security and Cooperatives, Dar es Salaam, 2013.

[8] The United Republic of Tanzania. National Five Year Development Plan 2016/17 – 2020/21.

[9] Abafita, Jemal, and Kyung-Ryang Kim. "Determinants of household food security in rural Ethiopia: an empirical analysis." *Journal of Rural Development/Nongchon-Gyeongje*37.1071-2016-86950 (2014): 129-157.

[10] Hoque, Sonia Ferdous. "Asset-based poverty analysis in rural Bangladesh: A comparison of principal component analysis and fuzzy set theory." *Sustainability Research Institute University of Leeds SRI Paper* 59 (2014).

[11] Krishnan, Vijaya. "Constructing an area-based socioeconomic index: A principal components analysis approach." *Edmonton, Alberta: Early Child Development Mapping Project* (2010).

[12] Smits, Jeroen, and Roel Steendijk. "The international wealth index (IWI)." *Social Indicators Research* 122.1 (2015): 65-85.

[13] Strasberg, Paul J., et al. *Effects of agricultural commercialization on food crop input use and productivity in Kenya*. No. 1096-2016-88433. 1999.

[14] Joshi, Shareen. "Female household-headship in rural Bangladesh: incidence, determinants and impact on children's schooling." *Yale University Economic Growth Center Discussion Paper* 894 (2004).

[15] Leavens, M. Kennedy. "Gender and agriculture in Tanzania." (2011).

[16] Johnston, G., Vaupel, S., Kegel, F., & Cadet, M. "Crop and farm diversification provide social benefits." *California Agriculture* 49.1 (1995): 10-16.

[17] Govereh, Jones, and Thomas S. Jayne. *Effects of cash crop production on Food crop productivity in Zimbabwe: Synergies or trade-offs?*. No. 1096-2016-88413. 1999.

[18] Food and Agriculture Organization. Introduction to the Basic Concepts of Food Security: *Food Security Information for Action, Rome*. (2008).

[19] The United Republic of Tanzania. Planning Commission: The Tanzania Development Vision 2025. *Dar es Salaam: President's Office*. (1999).

[20] Wagstaff, A., O. O'Donnell, and E. van Doorslaer. "Quantitative techniques for health equity analysis." (2007).