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RESEARCH ARTICLE

IMPACT OF MAIZE FARM-GATE PRICE ON FOOD SECURITY IN LUDEWA DISTRICT OF NJOMBE REGION, TANZANIA: ESTIMATION OF THE LOGIT MODEL

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ABSTRACT

Tanzania is one of the countries where the problem of food insecurity has been prominent to poor rural households. Due to this, Tanzania supports the second target of Sustainable Development Goals of eradicating hunger. Mostly, Tanzania target on maize for food security; traditionally, shortage of maize has been equated to food shortage. Although many studies have been carried out, less weight has been put in analysing the relationship between expected farm-gate price and farm household food security. Thus, this study intends to estimate the relationship between expected maize farm-gate price and rural household food security in Ludewa district of Njombe region-Tanzania using logit model. Among others, the main results indicated that farm-gate price has the negative significant effect on farm household food security. This leads to conclusion that farm-gate price is important for increased maize production. Thus, the study recommends measures that will increase producer price for motivating more production while ensuring the only surplus is sold.

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INTRODUCTION

The concepts and definitions of food security and insecurity have been discussed for a long period of time. Since its inception, it is defined in different ways by international organizations and researchers and there close to 200 definitions (Blessing *et al.,* 2013). Blessing *et al.* (2013) revealed that the most acceptable definition is the one forwarded by World Food Summit in 1996 which establish that *Food security exists when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life'*. Food security is a grown concern worldwide (Abafita and Kim, 2012). About 842 million people (i.e., equivalent to one in eight people) in the world were estimated to be suffering from chronic hunger in 2011–2013 of which, 827 million resided in developing regions (United Nations, 2014). This is in line with Aidoo *et al.* (2013) who states that the majority of the world's poorest countries are in Africa and most of these face persistent poverty and food insecurity. For Sub-Saharan Africa, while the overall significant progress is registered towards the second Sustainable Development Goal, it remains the region with the highest occurrence of undernourishment (IFAD *et al*., 2013). In particular, Tanzania is one of the poorest countries in the world which food production has remained low, failing to meet household and national requirements (Runyoro, 2006 cited in Kiratu *et al.,* 2011).

Food Insecurity in Tanzania: Tanzania faces profound challenges in ensuring food security (Bese *et al.,* 2009). Food insecurity in Tanzania is both transitory and chronic in nature (URT, 2006). In Tanzania, food insecurity has been more of prevalent among poor rural households (Amani, 2004). Food insecurity also manifest in the nutrition status of children. By year, 2010, 22% of children in Tanzania were underweight at the age of 5. Also, generally, 30% of Tanzanians were living below the poverty line (Nazir *et al.,* 2010).

A national assessment of food insecurity in Tanzania conducted by Oxfam in January 2010 identified four key vulnerable groups:

- Poor households in urban and rural areas that are reliant upon the market for most of their food requirements;

- Marginal producers who are not capable of producing enough food to meet their daily needs;
- Farmers whose crop production has been affected by specific diseases (such as cassava mosaic and banana wilt); and
- Pastoralists subject to repeated drought and diminishing herd size.

The most rapid increase in chronic hunger in Tanzania occurred between 2003 and 2005 and 2007. According to FAO's "provisional estimates, 75 million more people were added to the total number of undernourished in 2007 compared to 2003–05" (Ghanem, 2008). One of the strategies to reduce food insecurity is to involve rural households to produce more food and cash crops so that they could feed their families and at the same time earn cash for non-food needs. Therefore, progress in reducing food insecurity and malnutrition in Tanzania depends greatly on the performance of the agricultural sector (Amani, 2004). As informed by Nazir *et al.,* 2010), the government needs to have sound policies for all people to have physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life.

Importance of Maize to Food Security in Tanzania: Maize is an important food crop not only because it is consumed worldwide, but also it has nutritive value. Currently, maize is the first popular food in Tanzania in terms of caloric intake (Nazir *et al.,* 2010). Maize provides more carbohydrates than wheat and sorghum; and, it is a good source of phosphorus and it also contains small amounts of calcium, iron, thiamine, niacin, and fat (Mboya *et al*., 2011). Furthermore, maize has high yield per unit compared to other crops and this justifies its importance in the supply of food and promoting food security in the country (FAO, 2008). In several developing countries including Sub-Saharan countries, maize supply is linked to food security: Also, Njukia (2006) reports that *where there is NO Maize there is NO Food.*

For the Tanzania case, the availability of maize has been equated to national food security, and lack of food has been equated to low supply of maize (Mwakalinga and Massawe, 2007). Usually, maize serves as a staple food preferred by Tanzanians and throughout the East African Countries. Due to its importance, maize has been traditionally linked to politics and subjected to trade restrictions and protectionism (USAID, 2010). In Tanzania, maize influences food security via two different channels: one is through consumption because it is an important component of the nation's caloric intake. The other is, through production because it is an income-generating activity. In 2001, maize produced in Tanzania accounted for about 33% of the recommended daily caloric intake. In 2010, maize produced accounted for 43% of the recommended daily caloric intake (Table 1). In 2017, United States Department of Agriculture revealed that maize provides 60% of dietary calories and more than 35% of utilizable protein to the Tanzanian population. Maize makes up a considerably larger proportion of food consumed in Tanzania than it does in Kenya and Uganda (although in 2001 Kenya surpassed Tanzania).

Justification, Gap, and Objective of the Study: Although revitalisation of agricultural sector is a precondition for achieving high and sustainable economic growth, poverty reduction, and food security, strategies undertaken to revamp the sector's performance, e.g., the *Kilimo Kwanza Policy* (meaning *Agriculture First Policy*), give little or no recognition to transaction costs in crop marketing occasioned by structural factors that impede development and transformation of agriculture in Tanzania. As a result, as noted by Agricultural Council of Tanzania (ACT) (2010), the potential of food production particularly the production of rice and maize has not yet been exploited fully. Adverse effects of inflated transaction costs on crop production and socio-economic well being of agricultural crop producers and other households and firms in Tanzania need not be overemphasized. In the literature, it is acknowledged that the inflated transactions costs affect not only consumer price but also producer price. Southern Agricultural Growth Corridor of Tanzania (SAGCOT) (2010), for example, reveals that, if the marketing system is not efficient farmers becomes price takers and retailers and subsequent consumers pay high prices due to the high transactions costs. This large price band affects household decisions, such as production diversification resulting in inefficient outcomes, particularly low food production and hence food insecurity.

Typically, therefore, the burden of transactions costs is imposed on crop producers by crop buyers in a form of low farm-gate prices which in turn affect agricultural production and hence undermine economic growth and poverty eradication strategies. Unfortunately, improving competitiveness in food marketing by addressing transaction costs in crop marketing system in Tanzania has not been a major research and policy issue. Instead, making farming commercially viable has taken a back seat. Despite the wide documentation of adverse effects of transaction costs in the study area and Tanzania in general, what is not known is to what extent they affect crop production and hence rural household food security. These existing gaps from the reviewed literature become the motivation for this study. Therefore, the study intends to quantify the influence of farm-gate prices on rural household food security.

MATERIALS AND METHODS

This section describes the approaches employed in addressing the study's objective. Mainly, the section describes an overview of the study area; sampling technique, sample size and data collection; and analytical techniques.

Study Area: The study was conducted in Ludewa district of Njombe region. The region covers an area of 21,347sq.kms and about 59% of the area is arable. Njombe's climate is classified as warm and temperate. When compared with winter, the summers have much more rainfall. The least amount of rainfall occurs in August. The average in this month is 1mm. In March, the rainfall reaches its peak, with an average of 258 mm. The temperatures are highest in November, at an average of 18.0 °C. At 12.8 °C, July is the coldest month of the year. The variation in the rainfall between the driest and wettest months is 257 mm. The annual temperature is around 5.2 °C. Njombe DC has a climate that is influenced by several factors including high altitude, hilly landscape, and vegetation which have the strong influence on the climate resulting into micro climate in specific localities and macro climate in larger areas. This causes the formation of two climatic zones, the Highlands zone and Lowlands zones (URT, 2016). Agriculture continued to be the main source of livelihood for the residents of Njombe district council, in the 2012 population and housing census, the sector employed more than 72 percent of the adult population.

Despite agriculture being the leading sub-sector in the economy of the council, its performance has been declining due to several factors such as frequent use of inferior agriculture tools such as hand hoes, inadequate knowledge of new agricultural products, pest problems, and sometimes, low purchasing power of the people which tends to discourage the use of modern agricultural inputs or implements. In addition, marketing arrangements for most crops are inadequate coupled with the poor transport system and lack of credit facilities for peasant farmers. Food crops mainly produced in the council are maize, beans, and Irish potatoes while coffee, tea, and pyrethrum are produced as cash crops. Also, people in Njombe district council use food crops as cash crops in order to enhance their incomes and ensure food availability throughout the year (URT, 2016).

Sampling Technique, Sample Size, and Data Collection

The data for this study were obtained from a sample survey of farming households conducted in Ludewa district of Njombe region, Tanzania. The area of study was decided purposively based on its potentiality in maize production. The pilot survey done recognized that the proportion of the farmers' households is approximately 0.85 (farmers' households divide by total households). Following the information obtained from the pilot survey, about 20% of the farming households were selected using simple random sampling technique (i.e., 427 households). Enumerators were trained for data collection exercise and semi and structured questionnaires were designed such that both qualitative and quantitative information was collected. Main information collected was about household's characteristics, maize produced, maize bought, maize sold, family/household information (age, gender, and education level), maize farm-gate price, transaction costs information etc.

Model specification: The model specification follows the analytical technique employed by Babatunde *et al*. (2007) with modification done to suit the current study. Babatunde *et al.* (2007) first constructed food security index to determine food security status of each household based on the food security line using the recommended daily calories required approach. Then, they estimated a logit model to estimate the effect of various factors on food security status. So, the current study involved the process of calculating the number of grams of maize available for each household for consumption per year (G): G = Grams produced + grams bought + grams received as a gift – grams sold – grams given out as gift - grams used for local brews. The grams available for household consumption were converted to kcal using the FAO (1997) recommended conversions (Appendix 1, i.e., 100g of white maize = 357kcal). Thus, total kcal available for household consumption per year was determined using the following equation:

$$C_i = {}^{G}/_{100} * 357 \qquad \text{.. (1)}$$

where:

C_i = total kcal available for household consumption per year, and;

G = amount of grams available for each household consumption per year. Next step involved calculating the annual kcal requirement per individual in the household based on the FAO (1997) (Appendix 2) recommendation and summing them up to obtain the total kcal required per household (Z_i) per year. Using the results above the food security index was calculated as;

$$y_i = {}^{C_i}/_{Z_i} \qquad \text{.. (2)}$$

where:

y_i = food security status of i^{th} households (1= food secure household, 0 = food insecure household);
C_i = total kcal available for household consumption per year;
Z_i = required annual kcal intake per i^{th} households per year;
y_i = 1 for C_i greater or equal to Z_i; and
y_i = 0 for C_i less than Z_i.

Model estimation

Based on the household food index y_i, the logit model was estimated in SPSS to identify the determinants of food security status among farm households including the output market transaction cost aspects (proxied by expected price). The logit model assumes that there is an underlying response variable y_i defined by regression relationship

$$y_i = \beta' X_i + u_i \qquad \text{………………….................... (3)}$$

where:

y_i = food security status of i^{th} household;
X_i = vector of explanatory variables;
β = vector of the parameter estimates; and
u = the error term.

RESULTS AND DISCUSSION

Descriptive statistics: On the basis of the recommended daily calories intake (see Appendix 1), as converted to annual requirements, it was found out that slightly above half (54% of the households were food secure. The mean kcalorie intake available for each household per year was 5.5955E6 kcal (Table 3). This is higher than the recommended mean of 4.1229E6 kcal. The overall mean household size was 5.1. Average household size for food secure household was 4.9 and for food insecure household was 5.3. Correlation analysis indicates that the explanatory variables used in the logit model do not correlate justifying the absence of multicollinearity problem.

Determinants of household food security: The study used a logit model (equation 3) to identify determinants of farm household food security. Expected maize farm-gate price was included as one of the explanatory variables as it is influenced by transaction costs. The dependent variable was household food security status (1 = food secure, 0 = food insecure). The results show that the model predicted 63.6% variability in food security (Table 4). The chi-squared test result also shows that the model was adequate in explaining the determinants of the food security status of farm households.

Maize farm-gate price: The results on maize farm-gate price show that farm-gate price has a negative significant effect (at 10% significance level) on household food security. This finding suggests that the lower the producer price the higher the likelihood of food security.

Table 1. Importance of staple foods in diet (averages of 2005 – 2007)

Commodity	Quantity consumed[a] (kg/person/year)	Daily caloric intake (kcal/person/day)	Share of caloric intake (%)
Maize	73	655	33
Cassava	157	298	15
Rice	16	154	8
Wheat	10	79	4
Sorghum	9	79	4
Other		730	37
Total		1,995	100

a.Apparent consumption is production plus imports minus exports and non-food uses.
Source: Rashid and Minot (2010)

Table 2. Expected signs of the explanatory variables for logit model

Variable	Description	Expected sign
Hsize	Household size (persons)	Negative
Agehead	Age of household head (years)	Negative/positive
Edu	Education level of household head (number of years spent in school)	Positive
Ttsland	Total land owned by head of household (acres)	Positive
mzpro2010	Quantity of maize produced in 2010 (100kg bags)	Positive
Infgp	Natural log of farm-gate price (TZS/100 kg bag)	Positive/negative
Transcoop	Cooperative in maize transportation(dummy)	Positive

Table 3. Summary of descriptive statistics related to household food security

Variable	N	Minimum	Maximum	Mean	Standard deviation
Calorie available per household (kcal/annum)	409	142800	40983600	5.5955E6	5.2E6
Calorie recommended per household (kcal/annum)	409	668865	11195996	4.1229E6	1.7E6
Age of head of household (years)	409	19	85	43.89	13.3
Household size (persons)	409	1	13	5.10	2.0
Land for maize production (acres)	409	0	50	1.3094	2.9
Amount of maize produced in 2010 (100kg bags)	409	0	500	29.888	34.9
Number of years head of household spent in school	409	0	14	6.88	2.2
Maize farm-gate price (TZS/100kg bag)	409	10000	35000	1854.09	5058
Farmer Cooperative in maize transportation	286				0.2

Source: Field survey data and own computations

Table 4. Logit model estimates of determinants of household food security status

Variables	Coefficients	Standard error	Wald/t-statistics
Hhsize	-0.31	0.081	14.26***
Agehead	0.027	0.012	5.25**
Edu	0.128	0.076	2.85*
Ttsland	-0.060	0.014	19.65***
mzpro2010	0.040	0.008	26.00***
lnpr2010	-0.996	0.603	2.73*
Transcoop	-0.621	0.620	1.00
Constant	8.746	5.957	2.16
Chi^2	50.47		
Prob>Chi^2	0.00		
Percentage of correct prediction	57.8		
-2Log likelihood value	324.012		
Number of observation	409		

Dependent variable: Food security status
* = significant at 10%; ** = significant at 5%; and *** = significant at 1%.
Source: Field Survey data and Own Computations

The result looks strange but the possibility is that once the price of output is high, the farmer tends to sell all produce and vice versa. So, while high price motivating more production, there should be measures/policies to ensure that households are selling the only surplus.

Household size: The results show that household size had a negative coefficient which was significant at 1% level. This result suggests that the probability of a household being food secure decreases by 0.31 if household size increases by one person. In other words, the larger the household size, the more likely household would be food insecure. This result was expected because among other things, the requirement of calories at household level increases with its size. So, if production of food (maize in this case) does not increase in accordance with the size of household, the household becomes food insecure. The finding is consistent with that of Amani (2004) who found out that the large households in Tanzania are likely to be food insecure and Aidoo *et al.* (2013) who revealed that the household size had a negative influence on household food security in Ghana. This implies that fertility control policies can have a significant impact on food security at household level.

Age of household head: The result shows that age of the household head had a positive coefficient that was significant at 5% level. This suggests that an increase in household's head age by one year above mean age increases the likelihood of household being food secure. This finding supports previous research into this brain area (e.g. Aidoo *et al.* 2013) which shows that the age of the farmer had a positive and significant influence on food security in Ghana.

Education level of the household head: For the case of the level of education, the findings suggest that the number of years the household head spent in school exerted a positive and statistically significant effect on food security (i.e., at 10%). These results have the implication that households with educated heads are more likely to be food secure than the one with uneducated heads. The positive correlation could imply that educated household heads are likely to be able to cope with new technologies and training from agricultural extension officers and hence, increase production. Blessing and Theresa (2013) came up with the same findings when they revealed that education level is among of the major causal factors that impacted food security positively and significantly in Nigeria.

Total land size owned by household head: The size of land owned by the household head was negative and statistically significant at 1% probability level. The negative coefficient is contrary to the expectations. The study by Babatunde *et al.* (2007) came up with the same unexpected negative sign and insignificant findings for the land size in Nigeria. The unexpected sign could be due to the fact that farmers expand the size of their land when the output price is high and therefore, there is a possibility of being motivated by the price and selling all produce and remain food insecure. The findings, however, is consistent with that of Haile *et al.* (2005) which revealed that land size was significantly influenced the probability of a household being food secure in Ethiopia.

Maize production in current season: The coefficient of the quantity of maize produced by household is positive and statistically significant at 1% test level. This suggests that the higher the amount of maize obtained from own production, the higher the likelihood of the household being food secure. The result suggests that an increase of maize production by one 100kg bag will increase the probability of a household being food secured by 0.06. This result was expected since rural households largely depend on their own produce for food. The findings are consistent with that of Haile *et al.* (2005) who found out that per capita aggregate crop production had a positive and significant influence on food security in Ethiopia.

Conclusion and policy Recommendation

Based on the findings and discussion of the study, it can be concluded that *household size, total land size owned by household head, maize production in the current season*, **and** *expected maize farm-gate price are significant factors for farm household security. The study recommends the policies that will lead to increased farm-gate price but monitoring behaviour of farmers so that they do not sell above surplus. The study also recommends* fertility control policies to maintain manageable household size**.**

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APPENDICES

Appendix 1: Comparative energy and protein content of some cereals, tubers, legumes and oilseeds (per 100 g)

Food	Energy *(kcal)*	Protein *(g)*
Maize, white	357	9.4
Rice, brown hulled	357	8.1
Fonio meal	343	10.5
Millets	345	10.4
Sorghum	345	10.7
Cowpeas	342	23.1
Beans *(Phaseolus spp.)*	336	23.0
Groundnuts	549	23.2
Sesame	558	17.9
Soybeans	405	33.7
Cassava flour	340	1.5
Cassava, fresh	153	0.7
Yam flour	317	3.5
Yam, fresh	104	2.0
Sweet potato	114	1.5
Taro	113	2.0
Plantain	128	1.0

Source: FAO/United States Department of Health. Education and Welfare, 1968.

Appendix 2. Daily requirements for energy and protein

Group/age (years)	Energy (kcal)	Protein (g)	
		Diet Aa	Diet Bb
Children (both sexes)			
0-6 months	585	10	-c
6-12months	960	14	-
1-3 years	1250	14	23
3-5	1510	18	26
5-7	1710	20	30
7-10	1880	26	38
Boys			
10-12	2170	34	50
12-14	2360	43	64
14-16	2620	52	75
16-18	2820	57	84
Girls			
10-12	1925	35	52
12-14	2040	42	62
1416	2135	46	69
16-18	2150	45	66
If pregnant	+200	+6	+7
Men, active			
1 8-60	2 944	49	57
>60	2 060	49	57

Continue…………

Women, active			
Child-bearing age	2140	41	48
Pregnant	2 240	47	55
Lactating	2 640	59	68
>60	1830	41	48

Source: WHO. 1985.

Appendix 2: Outputs for logit model

Classification Table[a,b]

Observed			Predicted		
			food security status in year 2010		Percentage Correct
			food unsecured	food secured	
Step 0	food security status in year 2010	food unsecured	0	116	.0
		food secured	0	159	100.0
	Overall Percentage				57.8

a. Constant is included in the model.

b. The cut value is .500

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	50.468	7	.000
	Block	50.468	7	.000
	Model	50.468	7	.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	324.012[a]	.168	.225

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	hhsize	-.305	.081	14.256	1	.000	.737
	agehead	.027	.012	5.250	1	.022	1.028
	edu	.128	.076	2.849	1	.091	1.136
	ttsland	-.060	.014	19.645	1	.000	.941
	mzpro2010	.040	.008	25.996	1	.000	1.041
	lnpr2010	-.996	.603	2.728	1	.099	.369
	transcoop	-.621	.620	1.003	1	.317	.537
	Constant	8.746	5.957	2.155	1	.142	6283.205

a. Variable(s) entered on step 1: hhsize, agehead, edu, ttsland, mzpro2010, lnpr2010, transcoop.

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