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Socio-Economic Factors Influencing Farmers' Participation in Grain Warehouse Receipt System and the Extent of Participation in Nakuru District, Kenya

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Abstract
Post harvest losses in Sub-Saharan Africa (excluding South Africa) are generally high, arising from handling, transportation, storage, processing and packaging and marketing. In Kenya, it is estimated that 21.1% of total annual maize production is lost through poor post harvest handling techniques. As an effort to mitigate post-harvest losses, the Government together with development partners introduced the Grain Warehousing Receipt System (GWRS). Under this system, farmers store their marketable surplus in parastatal storage capacity or private grain handling service providers. The farmers are charged for storage service. As certification of their deposition, farmers are issued with receipts from the warehouses. The receipts can be used to access credit facilities from cooperating financial institutions up to 80% of the prevailing maize market prices. After waiting for prices to rise over the storage season, the farmers market the produce and payment made through respective financial institutions.
Methods: The study was carried out in Nakuru District, Kenya. Double Hurdle model was used to estimate factors influencing farmers' participation in GWRS and the extent of participation. The sample size was 178 farmers using multistage sampling technique where two divisions, Mauche and Gilgil were chosen to represent zones where maize farming is commercialized. Each of these divisions had 89 farmers randomly selected.The determination of sample size was through the approach based on the precision rate and confidence level.
Results: Six explanatory variables were found to significantly influence participation in GWRS. Gender and distance to warehouse negatively influenced participation in GWRS while gender land size under maize production, off farm income, group membership positively influenced participation in GWRS. On the extent of participation in GWRS, five dependent variables were found to significantly influence participation in GWRS. Gender, household size and distance to warehouse negatively influenced while land size under maize production, group membership positively influenced the extent of participation. From the study the following recommendations are made; Strengthening of farmer owned organizations is highly recommended. This is achievable through capacity building and training on organizational development. Empowering women in agricultural activities is desirable. Offline diversification should be promoted to enhance household income. Grain driers and collection points should be made available at distance which farmers access them with ease to counter quality and transport challenges experienced by farmers. Storage costs charged by warehouses, interest on loan and loan arrangement fees should be brought down through research for farmers to optimize profit. This can be achieved by approving more warehouses, involving more cooperating financial institutions, warehouses diversifying to offer farm inputs and financial services and offer contract farming.
Keywords: Socio-economic characteristics, Participation, Marginal effects

1.0 Introduction

Maize is the foundation in Kenyan diet with per capita consumption of 98 kilograms which translates to a national total of 30 to 34 million tonnes (2.7 to 3.1 million metric tonnes) making the price of commodity in the country to be among the highest in Eastern and Southern Africa. The lowest quartile of Kenyan population spends 28% of its income on maize (Guantai *et al*. 2007). From the maize producers' point of view, increased productivity, more efficient markets and rational government policies could dramatically alter the economic contribution of maize sub-sector from being a drag in the economy to becoming a key element in accelerated growth and poverty reduction (Kalunda *et al.* 2003). However, poor post harvest handling and storage of the harvested maize often results in reduced value of stored grain, negating the benefits of improved productivity as

it poses challenges in value chain. The significant costs incurred in maize storage are reflected in the production cost. By international standards, post harvest losses in Sub-Saharan Africa (excluding South Africa) are generally high, arising from handling, transportation, storage, processing and packaging and marketing. In Kenya, it is estimated that 21.1% of total annual maize production is lost through poor post harvest handling techniques (post harvest information system, 2007).

As an effort to mitigate post-harvest losses, the Government together with development partners introduced the Grain Warehousing Receipt System (GWRS). Under this system, farmers store their marketable surplus in parastatal storage capacity or private grain handling service providers. The farmers are charged for storage service. As certification of their deposition, farmers are issued with receipts from the warehouses. The receipts can be used to access credit facilities from cooperating financial institutions up to 80% of the current maize market prices. After waiting for prices to rise over the storage season, the farmers market the produce and payment made through respective financial institutions**.** Grain warehousing offers growers options to capitalize on post-harvest price increases.

Collateralized financing is quite new in Africa, and the most common model has been developed around local subsidiaries of international inspection companies. The inspection companies set up tripartite collateral management agreements (CMAs) involving a bank, the borrower and the collateral manager (i.e. the inspection company acting as warehouse operator), which allow depositors to secure bank credit. The warehouse receipts are issued directly to the financing bank and not to the depositor, and they are non-negotiable and non-transferable. Depositors who do not borrow against the stocks will be entitled to the full proceeds from the sale. However, all depositors have to pay storage costs and collateral management fees. Depositors are also responsible for the cost of transporting the crop to the designated storage site.

1.1 Methodology

1.1.1The study area

The study was carried out in Nakuru district, which covers an area of 7,242.3 km^2 of which 5,274 km^2 is arable and 283 km^2 is water mass. It is located between longitudes 35^0 28 and 35^0 36' East and latitude 0^0 13 and 1^0 10' South. The four main livelihoods in the district are mixed farming: Food Crops/Livestock, Marginal Mixed Farming, Formal Employment/Business/Trade and Casual Waged labour. Annual rainfall in the district ranges from 719mm to 1282mm in two rainy seasons. The average small scale farm size is 2.5 acres and 1100 acres for large scale farmers while the total population is approximately 1,187,039 million people. The district has 69,881 hectares under maize and produces 1,886,307 bags of maize per production season.

The main crops grown in the district include maize, beans, Irish potatoes, pyrethrum, cut flowers, wheat and fresh fruits and vegetables. Main livestock enterprises include dairy cattle, beef cattle, sheep, goats, poultry, pigs, rabbits, and bee keeping. The district was selected for the study because it is one of the districts that grain warehouse receipt system has been initiated under Kenya maize development programme (KMDP).

1.1.2 Sampling procedure and sample size

A multistage sampling technique with Nakuru district as the universe was adopted in the study. Two divisions, Mauche and Gilgil were chosen to represent zones where maize farming is commercialized. Each of these divisions had 89 farmers randomly selected.

The determination of sample size was through the approach based on the precision rate and confidence level and since the population is finite, the following formula was used (Cochran1963);

$$n = \frac{Z^2 pq}{e^2} \quad \ldots \ldots \ldots \ldots \ldots (1)$$

Where;

n = optimum sample size,

Z= Normal variant associated with levels of significant.

e = probability of error

p=the estimated proportion maize farmers in the district, and q is 1-p

In the study, p=0.865, Confidence interval is 95% therefore, $z_{\alpha/2} = 1.96$, e = 5 %(at 95% confidence level).The sample size thus becomes 178 households.

1.1.3 Data types and collection

Both primary and secondary data were used. Primary data was obtained from farmers and secondary data was obtained from Ministry of Agriculture (MOA), Nakuru district, Kenya maize development programme (KMDP) and Eastern Africa Grain Council (EAGC) offices. Interview schedules were used in collection of data. Data on the following were collected: farmers experience in maize business, number of acres under maize production, capital invested in maize business, transport costs, quantity of maize stored, educational level of the farmers, age of farmers, gender, number of members of the household, purpose of maize production, quantity of maize deposited in GWRS, storage costs, interest charged on loan, maize price movements.

1.1.4 Analytical Model

When statistically modeling farmers' participation in GWRS, two important and distinct issues must be addressed: how to model farmers' decision to participate in GWRS and how to model farmers' decision about the proportion of marketable surplus allocated for GWRS, conditional on the participation decision. Therefore double hurdle model was appropriate for the study because it allows for the observable and unobservable factors that affect participation to differ from the factors that affect extent of participation unlike tobit model which forces the participation decision to be identical to the extent decision.

The participation decision is typically addressed by a simple "Yes"/"No" question in the collection of data. If a farmer participates in GWRS (answering "Yes" to the participation question), a second question is asked, eliciting some measure of the respondent's extent of participation, the proportion of marketable surplus allocated for GWRS. Decisions about to participate can be motivated by a latent variable model linking unobserved utility derived from participation. Formally, an individual's decision to participate in GWRS can be represented by an indicator function;

$$I_i^* = \propto Z_i + v_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Equation (1) is often referred to as "first hurdle" in the two step process, where I_i^* is an unobservable indicator variable that determines whether or not individual *i* participated in GWRS (I_i^*=1) or not (I_i^*=0). $\propto$ is a vector of unobserved parameters to be estimated, Z_i is a vector of observed independent covariates that explain individual *I's* decision to participate in GWRS, and v_i is an unobserved random variable capturing all factors other than Z_i that influence the decision to participate in GWRS. Formally, Equation (1) implies that individual *i* will participate in GWRS if $v_i > - \alpha' Z_i$, and the probability of observing individual *i* participating in GWRS is P ($v_i > - \alpha' Z_i$).$\propto$

An individual's decision about extent of participation can be represented by a function

$$g_i^* = \beta' X_i + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where g^*_i is a latent variable reflecting proportion of marketable surplus allocated for GWRS — where β is a vector of unobserved parameters to be estimated, X_i is a vector of independent covariates that explain individual *I's* decision about extent of participation, and ε_i is an unobserved random variable capturing all factors other than *Xi* that influence the decision about extent of participation. Equation (2) is often called the "second hurdle" in the two-step process.

The double hurdle model simply relaxes the assumption that the participation decision is irrelevant. It includes the possibility that P ($v_i > - \alpha' Z_i$) <= 1. If both ε_i and v_i are normally distributed and independent random variable with zero mean and constant variance, the likelihood function for the double hurdle model is

$$L_{DH} = \Pi_1 P(v_i > -\propto' Z_i) P(\varepsilon_i > -\beta' X_i) f(g_i \mid \varepsilon_i > -\beta' X_i) \cdot \Pi_0 [1 - P(v_i > -\propto' Z_i) P(\varepsilon_i > -\beta' X_i)] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The double hurdle model allows for the observable and unobservable factors that affect participation (v_i, $\alpha' Z_i$) to differ from the factors that affect extent of participation (ε_i, $\beta' X_i$). Since Z_i can contain variables not in X_i, the double hurdle model also allows for some factors to affect only participation in GWRS, and not the extent. The inclusion of Π_1P (v_i>- $\alpha' Z_i$) Π_0 (1- P (v_i>- $\alpha' Z_i$) in the double hurdle model is a probit model for the participation

decision. Because the Tobit model is nested in the double hurdle model, the restrictions placed on the double hurdle model can be tested, using a likelihood ratio test. If L_T is the maximum value of the log-likelihood function for the Tobit model and L_{DH} the maximum value of the log-likelihood function for the double hurdle model, then the likelihood ratio LR = -2 (L_{DH} - L_T) is distributed as a $\chi 2$ random variable with degrees of freedom equal to the number of parameter restrictions that must be placed on the double hurdle model to produce the Tobit model.

2.0 Results and Discussion

Maximum likelihood estimates for probit model was used to estimate factors influencing farmers' participation in GWRS (first hurdle). The results presented in Table 1. To calculate elasticities for the continuous variables of the model, Marginal effects of the explanatory variables and their associated standard errors were also evaluated. Dependent variable is farmer's participation (0=does not participate, 1=participates) and explanatory variables were those associated with farmer's socio-economic characteristics. The Log likelihood for the fitted model was -22.7966 and the $\chi 2$ value of 161.93 indicating that all parameters are jointly significant at 5%. Pseudo R^2 of 0.7803 is well above the statistical threshold of 20% indicating that participation in GWRS was attributed to the covariates considered in the model.

The results indicate that six variables were significantly related to the dependent variable and were according to *apriori* expectations except the Gender variable. Gender, land under maize production, off farm income and group membership were statistically significant at 1% while distance to warehouse was statistically significant at 5%.Level of education of household head was significant at 10%.The probability of female headed household participating in GWRS was 35% higher than male headed households. This differed with results of Adele *at al.* 2006 which showed that female headed households are more susceptible to instant crop sales than male headed ones. They argued that fewer options are available for female headed households in terms of resorting to other sources of incomes. The most likely explanation for the results obtained is that farming activities are mainly done by women .Moreover, they are more cohesive than their men counterparts as shown that 44% of female headed household interviewed is attached to farmer owned organizations compared to 32% of male headed ones. This enhances participation in GWRS in that women would like to optimise returns as they also benefit from economies of scale that arises from group membership.

Level of education of household head was significant at 10%.An increase in the level of education of household head increased the probability of a household participating in GWRS by 7%.Though household size is not a significant determinant in household decision on whether to participate in GWRS or not, it has a negative effect. It can be inferred that an increase in the number of household member decreases the probability of participation by 2 %.

Land size under maize production positively influence participation in GWRS. The combined marginal effect of the size shows that the probability of a farmer to participate increases by 4% for each acre that the size is larger than the sample average. This implies that the more the lands size under maize production, the more the total marketable surplus hence enhancing participation in GWRS. Off farm income has a positive and significant effect on participation in GWRS. This establishes that as household off farm income increases, the pressure to sell maize soon after harvest to meet family obligations decreases. Membership to farmer owned organizations increased the probability of participation in GWRS by 32% at 5% significant level. This reveals that farmer groups are channels of agricultural information through interaction and interconnectedness in a society, act as collaterals in accessing credit and members benefit from economies of scale. Masuki *et al*. (2002) also experienced similar findings.

Distance away from warehouse reduced the likelihood of a household participation in GWRS. As the distance from warehouse increased, farmers were less likely to participate, all other factors constant. The combined marginal effect showed that the probability that a household participate in GWRS decreases by 0.6% (at 5% significant level) for each kilometre that the sample's average farm was located away from the warehouse. The effects of household size and access to credit on the decision to participate in GWRS were statistically weak but had the expected signs. . The pressure on households triggered by larger family size to meet other consumption needs tends to induce farmers to instant maize produce sales. Access to credit catalyzed participation in GWRS. This may be attributed to the fact that a farmer who access credit would optimize output to service loan and associated costs. The findings showed that age of household head correlated with participation in GWRS. This implies that as the farmer gets older he/she tends to participate. The variable is attributable to the experience of the farmer and that older household heads are ascribed to more sources of income options than their younger counterparts. However, this contrast with the findings of Musara *et al*.(2010) who argued out that young farmers are usually pioneers and the elderly are laggards when it comes to innovation take-up. See table 1

2.1.0 Factors influencing extent of participation in Grain Warehouse Receipt System.

Table 2 shows the results of maximum likelihood estimations of extent of participation in GWRS, proportion of maize marketable surplus allocated for GWRS being the dependent variable. Results of the Tobit run show that five out of ten estimated coefficients of explanatory variables exhibited positive sign and were significant at 5% or better. The coefficients of land size under maize production, distance to warehouse and membership to farmer group ($P \leq 0.01$) were found to be most important determinants of extent of participation, followed by coefficients of gender and household size ($P \leq 0.05$). However, off farm income did not significantly influence the extent of participation in GWRS though it exhibited a positive sign. (Table 2).

3.0 Conclusions and Recommendations

The study concludes the following; six explanatory variables were found to significantly influence participation in GWRS. Gender and distance to warehouse negatively influenced participation in GWRS while gender land size under maize production, off farm income, group membership positively influenced participation in GWRS. On the extent of participation in GWRS, five dependent variables were found to significantly influence participation in GWRS. Gender, household size and distance to warehouse negatively influenced while land size under maize production, group membership positively influenced the extent of participation.

From the study the following recommendations are made; Strengthening of farmer owned organizations is highly recommended. This is achievable through capacity building and training on organizational development. Empowering women in agricultural activities is desirable. Offline diversification should be promoted to enhance household income. Grain driers and collection points should be made available at distance which farmers access them with ease to counter quality and transport challenges experienced by farmers. Storage costs charged by warehouses, interest on loan and loan arrangement fees should be brought down through research for farmers to optimize profit. This can be achieved by approving more warehouses, involving more cooperating financial institutions, warehouses diversifying to offer farm inputs and financial services and offer contract farming

TABLES

Table 1: Factors influencing farmers' participation in Grain Warehouse Receipt System.

Variable	co-efficient estimates	Standard error	P>|z|	marginal effects
Gender	-1.7538	0.6215	0.005**S	-0.3479
Age	0.0158	0.0263	0.549	0.0019
Education level	0.5604	0.3350	0.094*	0.0668
Household size	-0.1248	0.1376	0.364	-0.0149
Land size under maize Production	0.3377	0.0936	0.000***	0.0402
Total marketable surplus	0.0009	0.0010	0.334	0.0001
Off farm income	0.0000	0.0000	0.000***	4.98e-06
Access to credit	0.0789	0.4784	0.869	0.0097
Group membership	1.7266	0.5899	0.003***	0.3151
Distance to warehouse	-0.0496	0.0217	0.022**	-0.0059
Constant	-2.7285	1.3730	0.047	

Log likelihood = -22.7966; $\chi 2$ = 161.93; Pseudo R^2=0.7803; ***, **, * significant at 1%, 5% and 10% probability respectively.

Table 2: Factors influencing extent of participation in Grain Warehouse Receipt System.

Variable	co-efficient estimates	Standard error	P>|t|	marginal effects
Gender	-0.3435	0.1558	0.029**	-0.3435
Age	0.0023	0.0078	0.765	0.0023
Education level	0.0503	0.1143	0.661	0.0503
Household size	-0.0934	0.0455	0.042**	-0.0934
Land size under maize Production	0.1045	0.0276	0.000***	0.1045
Total marketable surplus	-0.0001	0.0010	0.919	0.0001
Off farm income	0.0000	0.0000	0.106	0.0000
Access to credit	0.1319	0.1602	0.412	0.1319
Group membership	0.5518	0.1678	0.001***	0.5518
Distance to warehouse	-0.0270	0.0079	0.001***	-0.0270
Constant	0.3686	0.4437	0.407	

Log likelihood = -81.908074; $\chi 2$ = 110.54; Pseudo R^2=0.4029; ***, **, significant at 1%, and 5% probability respectively.

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