Determinants of smallholder farmers' demand for purchased inputs in Lilongwe District, Malawi: evidence from Mitundu extension planning area

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Determinants of Smallholder Farmers' Demand for Purchased Inputs in Lilongwe District, Malawi: Evidence from Mitundu Extension Planning Area

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ABSTRACT

The aim of this study was to empirically determine the factors that affect smallholder farmers' demand for purchased fertilizer and seed using cross section data from 160 farmers. Model solutions, which were created by using Translog Cost Function were carried out by Seemingly Unrelated Regression (SUR). To this end this study revealed that education, field size (plot of land cultivated) and household size have significant negative relationship with the share of fertilizer purchased and positively related with share of seed. Whereas price of output, seed, fertilizer and income of the household are found to be significant and positively related to share of fertilizer and negatively related with share of purchased seed.

Key Words: Translog, Cost, Purchase inputs, Demand

INTRODUCTION

It is widely accepted that increased use of purchased inputs (seeds, chemicals and fertilizers) has a critical place, alongside organic soil fertility enhancement practices, in the technical change needed for sustained smallholder agricultural growth in Africa. However, purchased input use is very low amongst the farmers especially from Sub-Saharan Africa and has remained largely static over the last 20 years or so, with particularly low usage in smallholder food-crop production where constraints on expanded purchased inputs (seed and fertilizer) use exists on both the supply and demand sides.

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Hybrid seed and chemical fertilizer utilization of the smallholder farmers ought to improve over time and space. Just as there is strong correlation between crop yield and the volume of purchase input utilization, so there ought to exist a relationship between the purchased input consumption of the farmer and selected socio – economic factors (Nwagbo and Achoja, 2001) which are at play in the micro environment in which the farmer operates. But it is difficult to generalize about the economic variables that are responsible for the growth in purchased inputs demand. For instance, variables which may correlate with purchase input consumption may relate to price of farm produce, market access conditions, fertilizer price per bag, farm size, farm income to mention but a few and each could have its own set of assumption (Abott, 1993; Akinola and Young, 1991; Nwagbo and Achoja, 2001).

In Malawi, the most fundamental input that may be purchased is seed (i.e. improved) and as farmers intensify, fertilizer is the next most crucial input to be purchased. However, most of agricultural inputs have been subject to dramatic price increases (FAO, 2009), as a result, farmers are scarcely able to afford purchased inputs especially those not included in the government sponsored scheme (i.e. subsidy; which targets 50% of the total smallholder population)because they have limited purchasing power as their average annual income per household MK50,000 (NSO, 2005). As such, purchased agricultural inputs represent a major expenditure. Even when farmers can afford to purchase the inputs, they may be unavailable. Despite large numbers of farmers i.e. over 85% of the rural population (GoM, 2007), they represent very small markets for agricultural inputs, largely because of low purchasing power. Therefore, they must generally travel some distance to locate inputs with no guarantee of success. As such distance, plays a negative effect on the use of purchased inputs (Chianu *et al*., 2008).

The farmers are also constrained by the lack of information on, for example, prices, appropriate time to apply inputs, yield responses, appropriate inputs etc. Even assuming that the information exists, it may not be within easy reach of farmers because extension services within the country have been severely affected by public sector budgetary constraints leaving many workers with their salaries paid but without funds to visit farmers (Siyanda, 2008). The decision on the use of purchased inputs requires information on prices, and in thin markets (i.e. those with low and uneven volumes of transactions over time), prices can be particularly uncertain and variable. Lastly, farmer willingness to purchase inputs is also affected by risk and uncertainty. Low and uncertain rainfall is closely linked to low use of purchased inputs, since it creates additional yield risk and due to the volatility of output prices, farmers are unwilling to apply inputs for fear that they may not cover costs (Gordon, 2000).

This paper builds on previous studies done by Reardon (1994) on fertilizer use in Africa, Kelly (2005) on farmer demand for fertilizer in Sub Saharan Africa, Adesina (1996), Marenya (2009) on factors affecting fertilizer adoption and demand and Langyinthuo (undated) on factors affecting improved seed demand. Thus, the objective of this paper is to determine the factors that affect smallholder farmers' demand for purchased inputs. The paper will utilize data which is an area representative obtained from the Lilongwe Agricultural Development Division that was collected during a survey in 2008. The survey sampled 160 households, of which more than 80% had agricultural activities as their main source of livelihood.

METHODOLOGY

Theoretical and Emperical Model

The study assumes that a farm household to a large extent faces more effective markets (though not perfectly competitive) for other farm inputs like fertilizer and seed. Differences in transaction costs in different rural locations, affects the return to individual smallholder farm households from the purchase of fertilizer from urban markets and the value of product which is normally sold at the farm level (Lopez, 1986).

For most small holder farmer households who operate in the imperfect market environments their utility and profit maximizing decisions are jointly determined, where the optimal production and consumption levels are determined within an integrated framework (Lopez, 1986). But given the desired level of output that gives the maximum utility or profit level, these farmers (producers) would want to minimize their respective cost of production, notably costs of purchased inputs. Hence, producers will minimize their production cost, given their respective level of output.

Therefore, let the production function of a farm be given as:

(1) $q = q(X, Z, H)$

Where; q, represents the household's farm output (i.e. maize harvested), whilst X, Z and H present vectors of purchased input quantity (fertilizer and seed), household fixed factor and household characteristics, respectively (i.e. all the variables have been mentioned above). The production function (equation 1) is assumed to be a concave function: it is twice differentiable where $\partial q(*) / \partial X > 0$ and $\partial^2 q(*) / \partial X^2 < 0$.

The cost of purchased input is given by:

(2) $C = Xp$

Where, **p** is vector of input prices (which also reflects the differences in transaction costs for input at various locations). We assume that farmers minimize their cost of production subject to their respective level of output.

(3) $\min C = Xp$

Subject to; $q = q(X, Z, H)$

Setting up the Lagrange function:

(4) $L = Xp + \lambda(q - q(X, Z, H))$

Solving the first order conditions and adding vectors of household fixed factors and other characteristics of the farm household give a vector of purchased factor input function of the form:

(5) $X^* = x(p, q, Z, H)$

Substituting equation 5 into equation 2, the corresponding minimum cost function is derived as:

(6) $C^* = c(p, q, Z, H)$

Christensen et al., (1973) derived factor cost share equations by transloging the cost function. The translog cost function is flexible and does not impose priori restrictions on scale economies and substitution of factors. The translog cost function is the most particularly useful function for estimating the factor demand functions (Binswanger, 1974; Greene, 2000).

Rewriting equation 6 in natural logarithm, the cost function C* takes the form,

(7) $\ln C^* = c(\ln p, \ln q, \ln Z, \ln H)$

Where; p, q, z and h are defined above.

We impose the symmetry and constant returns to scale conditions, and then some of the coefficients (coefficients of interest) of the total cost function are estimated. With the constant returns to scale condition imposed, the output term (*lnq*) is omitted from equation 7 and the cost function is specified as an average cost function (*C***). With this approach cost share equations are derived and estimated, directly using the seemingly unrelated regression technique as described by Greene (2000). The derivative of translog cost function with respect to a factor price (i.e. Shephard Lemma), which gives the cost share of the purchased factor input in total cost, is:

$$(8) \qquad s_i = \frac{\partial \ln C^{**}}{\partial \ln p_i} = \beta_i + \sum_j \alpha_{ij} \ln p_j + \sum_m \pi_{im} \ln Z_m + \sum_k \pi_{ik} \ln H_k$$

Where; s_i is the cost share of the "i^{th}" factor in total farm cost. The cost shares for the purchased inputs are calculated as:

$$(9) \qquad s_i = \frac{p_i x_i}{I}$$

Where $I=\sum p_i x_i$

The cost shares equations are estimated for fertilizer (S_F) and Seed (S_S). They are expressed from equation 13 and after adding some dummy variables they can be represented as:

$$(15) \qquad S_F=\beta_F+ \alpha_{FF}P_F+\alpha_{FS}\ln P_S +\pi_{FL}\ln Z_L+\pi_{FI}\ln H_I+\pi_{FP}\ln H_P+\pi_{FE}\ln H_E+ \pi_{FA}\ln H_A +\pi_{FD}\ln H_D+\pi_{FX}D_X$$

$$(16) \qquad S_S=\beta_s+ \alpha_{SF}P_F+\alpha_{SS}\ln P_S +\pi_{SL}\ln Z_L+\pi_{SI}\ln H_I+\pi_{SP}\ln H_P+\pi_{SE}\ln H_E+ \pi_{SA}\ln H_A +\pi_{SD}\ln H_D+\pi_{SX}D_X$$

Where; β_i, α_{ij} and π_{im} are coefficients, P_F and P_S are prices of fertilizer and seed, Z_L, H_I, H_P, $H_{F,}$ H_A and H_D are household's landholding (fixed factor), household income level, household size, education, age of household head, distance to the input market respectively. D_X is Dummy for access to extension service.

This study estimates the system of cost share equation for fertilizer and seed using their prices and farm household (socio-economic) characteristics. Obare et al. (2003) and Dalton et al. (1997) have followed similar approach to describe production structure of agriculture in Kenya and Zimbabwe, respectively.

RESULTS AND DISCUSSION

The results show that the land area allocated to Maize was small at an average of 0.43 hectares. The average age of the sample farmers was 41.7 years with a minimum of 22 and maximum of 75 years. Mean household head's farming experience was 10 years and 4 years of formal education. The farm size in the sample was between 0.52 to 2.35 ha with a mean of 0.75 ha and a standard deviation of 0.56 ha. On average, the sampled farms reported a mean yield of 1475kg/ha while the yields vary between a low of 375kgs/ha and a high 4447kgs/ha, suggesting considerable room for improving Maize yields. The results reported that there are 20% households headed by females. This ratio is much deviated from the literature by GoM (2002) who estimated that the majority of households (about 70%) in the country are headed by males. The lowest income level was found to be MK200 and the highest was MK8 000 with mean of MK1996.98 and standard deviation of MK1 784.47.

In order to control for data reliability and validity; a number of measurements were effected. The test for homoskedasticity of variance was conducted using Breusch-Pagan test for heteroskedasticity as explained by Breusch et tal. (1979) under the null hypothesis of constant variances of the residuals. The p-value for Breusch-Pagan test is 0.102241, which is greater than the 10% level of significance. This leads to the decision of failing to reject the null hypothesis of homoskedasticity of residues. Thus, for all practical purposes, we conclude that there is no heteroscedasticity. The Variance Inflation Factor (VIF) method was used to detect multicollinearity and was preferred over the correlation coefficient method which does not give conclusive results (Pindyck and Rubinfield, 1981). VIF registered a value of 3.98 which according to Edriss (2003) is within the acceptable range on a scale of 1 to 10.

Table 1: Parameter Estimates for Seemingly Unrelated Regression Model

	Purchased Inputs	
Regressors	**Share of Fertilizer**	**Share of Seed**
	Parameter (Std Err)	**Parameter (Std Err)**
Intercept	-16.296 (4.168)***	17.296 (4.168)***
LnEdu	-0.119 (0.014)***	0.119 (0.014)***
lnFieldSize	-0.115 (0.018)***	0.115 (0.018)***
LnIncome	0.067 (0.021)***	-0.067 (0.021)***
InPrice	0.102 (0.040)**	-0.102 (0.040)**
InHHsize	-0.140 (0.037)***	0.140 (0.037)***
LnAge	0.006 (0.021)	-0.006 (0.021)
LnSeedPrice	2.806 (0.776)***	-2.806 (0.776)***
LnFertPrice	0.189 (0.017)***	-0.189 (0.017)***
Extension	-0.007 (0.014)	0.007 (0.014)

R Squared = 0.749 (Adjusted R Squared = 0.703)
Breusch-Pagan test of independence: $\chi^2 = 27.432$, P-value = 0.102241
VIF = 3.98

Source: Computed from Field Survey Data, 2009

****indicates variables that are significant at 1% level. **indicates variables that are significant at 5% level. *indicates variables that are significant at 10% level. Values in parenthesis are standard errors. Ln means logarithm.*

The results from the above table denote that both price of seed and fertilizer are significant at 1% with a positive association on share of fertilizer and negative association on share of seed, showing that the price of this inputs significantly affect farmers demand for purchased inputs. the results are similar with findings of other studies like Njiwa (2007) who found a positive relationship between price of fertilizer and intensity of its use.

On the other hand, the price of output is positive and significant. This suggests that farmers base their decision to use fertilizer not only on the fertilizer price, rather also on the price of output in question. This suggests that, if the price of output were to be increased, farmers would increase purchases of fertilizer using even the resources meant for seed purchases.

Household Size and share of fertilizer portrayed an inverse relationship whilst having a positive relationship with share of seed. Croppenstedt et tal. (1996) used household size as a proxy for labour. Obare et tal. (2003) and John Olwande et tal. (2009) reported highest substitutability between fertilizer and labour. Family labour is the cheapest form of labour form smallholder farmer and relatively very cheap compared to fertilizer. Thus, the negative relationship between household size and share of fertilizer might be substantiated by Obare's findings. With this fertilizer labour substitutability, it can be inferred that, with big household size which means more cheap labour, resources for purchasing fertilizer are reallocated to family labour and seed purchase.

From the econometric estimation results, it is shown that extension has insignificant negative relationship with the share of fertilizer and positive with share of seed. The sign of the relationship can be due to the fact that extension service will enhance the use of modern inputs with alternative applications and substitutes. The insignificancy of the parameter estimate implies there is very limited extension service in the area which is consistence with the 'shortage extension workers in Malawi' as reported by GOM, 2007.

Age is one of the household characteristics that are deemed to influence demand for purchased inputs in this study. The results indicate insignificant positive relationship with share of fertilizer. Studies by Mwangi et al., 1998 and Doss, 2003 found that age positively affects the demand for purchased inputs. The reasoning is that with age, farmers gain more experience and acquaintance with new technologies and hence are expected to have higher ability to demand new technologies more efficiently. On the other hand, there is a negative relationship between age and share of seed as with age farmers become more conservative and less amenable to change.

The results reported a mean of 4 years of formal education of the household head which showed a negative relationship with the share of fertiliser. As reported by Kelly (2009), only secondary and higher education has a significant effect on the likelihood to use fertilizer. However the results showed a positive relationship between the education of household head and the share of seed. This could be attributed to the likelihood that education would improve the perceptions of farmers on the agro-economic potential of improved seed hence increase their effective demand.

The household income level showed a positive relation with the share of fertiliser. It is postulated that improvements in income will move a farmer along the same demand curve to a higher quantity of fertilizer used. However a negative relationship was showed between the share of seed and household income level. This suggests that the purchase of fertiliser is relatively more important to the farmers than the purchase of improved seed.

The estimated positive and negative effects of household's land size on cost shares of seed and fertilizer respectively, were consistent with processes for agricultural intensification (transformation). This implies as land size increases farmers use large quantity of seed and relatively small amount of fertilizer. The sign indicated that demand of seed is positively related with field size and the vice versa is true for demand of fertilize. These results are similar to findings of other studies like Akwasi (2010).

CONCLUSION

It is unquestionable that empirical knowledge about the demand of seed and fertilizer by small scale farmers is a key to come up with appropriate policy to enhance production and productivity of the farmers. To this end this study revealed that education, field size (plot of land cultivated) and household size have significant negative relationship with the share of fertilizer purchased and positively related with share of seed. Whereas price of output, seed, fertilizer and income of the household are found to be significant and positively related to share of fertilizer and negatively related with share of purchased seed. From this we can conclude that policy measures such as: intervention via the input and output market, family planning, land reform influence usage of fertilizer and seed. Moreover, since the direction of relationship between seed and fertilizer for different factors is opposite, the extent to which a factor affects the demand either seed or fertilizer depends on the sensitivities (elasticises) of both factors for the factor in question.

REFERENCES

Abott, J.C. (1993). *Financing Fertilizer Distribution Network.* In Abott, J.C. (ed) Agricultural and Food marketing in Developing Countries, Selected Reading, U.K. CTA International Publication.

Akinola, A.A and Young, T. (1991). *Application of the Tobit Model in the Analysis of Agricultural Innovations Adopted Process*: A Study of the Use of Cocoa Spraying Chemical Among Cocoa Farmers: In *Agricultural Systems*, 36: 36 – 26 – 51.

Binswanger, H.P. (1974). *A Cost Function Approach to the Measurement of Elasticities of Factor Demand and Elasticities of Substitution*. Amer. J. Agric. Econ. 56: 377 – 386.

Breusch, T. S., and A. R. Pagan (1979), *A Simple Test for Heteroskedasticity and Random Coefficient Variation*, Econometrica 50, 987–1007.

Croppenstedt, A. and M. Demeke. (1996). *Determinants of adoption and Levels of Demand for Fertilizer for Cereal Growing Farmers in Ethiopia*. Working Paper No. 96-3. Centre for the Study of African Economies, Oxford University. Oxford.

Dalton, T.J., Masters W.A. and Foster, K.A. (1997). Production Costs and Input Substitution in Zimbabwe's Smallholder Agriculture, Agric. Econ. 17: 201 – 209.

Edriss, A.K. (2003). *A Passport to Research Methods*. Las Vegas; International Publishers and Press.

Government of Malawi. (2002). *Poverty Reduction Strategy Paper.* Ministy of Finance and Economic Planning. Lilongwe, Malawi.

Greene, W.H. (2000). Econometric Analysis, 4th ed., Prentice Hall, pp.640 – 642.

Kelly V.(2005). *Farmers' Demand for Fertilizer in Sub-Saharan Africa.* Michgan State University, East Lansing.

Lopez, R.E. (1986). Structural Models of the Farm Household that Allow for Interdependent Utility and Profit Maximization Decisions, In: Singh, L., Squire L, Strauss J (ed). Agricultural Household Models", Johns Hopkins University Press, Baltimore, pp. 306 – 325.

Nwagbo, E.C. and Achoja, F.O. (2001). *Correlates of Sustainable Fertilizer ConsumptionAmong Smallholder Farmers*: An Econometric Approach". A paper presented at theAnnual conference of Nigeria Association of Agricultural Economists at the University of Nigeria Nsukka 11 – 13th June.

Njiwa, D. (2007). *Assessment of Socio-Economic Factors Affecting Investments in Soil Fertility Improvement in Smallholder Flood Plane Rice Value Chains*. The Case of Bua and Kasitu Rice Schemes in Nkhotakota Rural Development projects in Malawi. Univeristy of Malawi. Unpublished M.Sc.Thesis. Malawi.

Obare, G.A., Omamo, S.W. and Williams, J.C. (2003). *Smallholder Production Structure and Rural Roads in Africa*: The Case of Nakuru District, Kenya, Agric. Econ. 28: 245 – 254.

Olwande, J. Ngigi, M. and Nguyo, W. (2009). *Supply Responsiveness of Maize Farmers In Kenya:* A Farm-Level Analysis. Kenya.

Pindyck, R.S. and Rubinfield, D. (1981) *Econometric models and economic forecasts*. New York:McGraw Hill.