International Journal of Applied and Pure Science and Agriculture
ISSN Online - 2394-5532 Impact Factor : 5.295 by SJIF ISSN Print - 2394-823X

Determinants of Smallholder Farmers Demand for Inputs: A Case of Paddy Growers in Kilombero Districts Morogoro

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Abstract

Demand for input is derived from the production process and demand for the product being produced, and when the demand for product increases the most notable outcome is the increase in price and demand of the inputs until the equilibrium price and production number are met. Thus, the demand for all factors of production, including labor is derived demand as the demand for the factors of production is dependent on the demand for the outputs they produce. A farmer as rational producer they are theorized to maximize financial returns thus they would demand the amount of inputs that maximizes return, and the profit maximization occurs when the marginal costs of the last unit of input applied is equal to the value of the marginal return. In Kilombero district; Agriculture is one of the most important economic activity employing about 75% of the labor force, the district is one of the most important productive districts for paddy in Tanzania as it is one of the largest paddy producers in the region although the yield is persistently observed to be lower (average to 2 ton/ha) compared to other major rice producers in other districts, the low yield is said to be attributed by dependence on rain-fed agriculture and the use of local tools such as hand hoe and traditional practice. The study employed a cross-sectional survey designs and is built around the Neoclassical theory under the perfect competition model and the theory of the firm, where a farmer (firm) is assumed to be a rational producer that seeks to maximize profit from its production activities. The derivate of translog function concerning a factor input was obtained and the results in the cost share of purchased factor input in total cost was established and reported. Results show that both prices of pesticides and fertilizers portray a positive relationship with the share of fertilizer and a negative relationship with the share pesticides, Household size portrays a positive relationship with both share of fertilizer and pesticides. There is also a positive relationship between an income of the and amount of fertilizer purchased as one percentage increase on the income of the producer will increase the cost-share allocated for fertilizer while reducing the cost share for pesticides by the same amount. Policy measures such as intervention on the output and input market by the state that will increase the availability of inputs for farmers production are expected under situation and also land reform that encourages farm to increase the purchase for fertilizer should be adopted to improve the productivity of paddy in Kilombero districts

Keywords: Derived Demand, Cost-Share, Translog-Cost Functions, Duality, Production function

I. INTRODUCTION

The demand for all factors of production, including labor, is a derived demand, as the demand for the factors of production is dependent on the demand for the outputs that they produce. The demand for input is derived from the production process and demand for the product being produced. If the demand for the product increases two things will probably transpire; the price will increase and the demand for inputs will increase until the equilibrium price and production numbers are met (Derbetin, 2009).

Rice is one of the most important food grains widely produced and consumed in Tanzania, it falls under the category of preferred crop staples which comprises maize and wheat, other categories include drought staples (sorghum, millet, and cassava), pulses (including beans and pigeon peas) and oils seed (comprising of sunflower, groundnuts, and sesame). Rural Livelihood Development Company (RLDC) in 2015 reported that the total area under paddy cultivation in Tanzania was 681,000 ha, representing 18% of Tanzanian's cultivated land the average yield is low around 1.5t-2.93t per ha, and mainly of paddy produced in Tanzania is produced by smallholders' farmers approximately 230,000 in number, however, there are few larger-scale producers in the country and are owned by the National agriculture and food corporation (NAFCO). The bulk of the national paddy is produced from five regions of Morogoro, Mbeya, Shinyanga, Tabora, and Mwanza which account for 70% to 80% of the national paddy production.

In Kilombero district; Agriculture is one of the most important economic activity employing about 75% of the labor force, the district is one of the most important productive districts for paddy in Tanzania as it is one of the largest paddy producers in the region although the yield is persistently observed to be lower (average to 2 ton/ha) compared to other major rice producers in other districts (SAGCOT, 2013). The major reason identified for the low yield level was dependence on rain-fed agriculture and the use of local tools such as hand hoe and traditional practice.

In a world of perfect information and well-functioning markets, a farmer would demand the amount of input that maximizes financial returns; profit maximization occurs when the marginal cost of the last unit of input applied is equal to the value of the marginal returns. However is not certain whether the rice producers in the Kilombero district are making a profit by maximizing inputs decisions because they face a significant lack of information, liquidity, and risk constraints that limit effective demand for input; technical constraints that make it difficult to use inputs in combination with recommended crop management practices; and institutional constraints that limit the development of human capital and the performance of input and output markets**;** Thus authors developed an idea on trying to understand what are the factors influence the decision making of rice producers when undertaking the rice production activities with the assumption that they have a goal of making a profit as rational producers; The paper comes out intending to determine the factors that influence the demand for agricultural inputs among rice producers in Kilombero district. Specifically, the paper determines how do farmers respond to change in input prices as well as how are they allocating different combinations of inputs in rice production.

II. LITERATURE REVIEW

Demand for inputs in the agricultural production process is a derived demand since the input demand function is derived from the demand by buyers of the output from the farm. In general, the demand for inputs or factors of production depends on (a) the price of the output or outputs being produced, (b) the price of the input, (c) the prices of other inputs that substitute for or complement the input, and (d) the parameters of the production function that describes the technical transformation of the input into an output. In some instances, the demand for input might also depend on the availability of money (dollars or shillings) needed to purchase the input. For example, the demand by a farmer for seed, fertilizer, machinery, chemicals, and other inputs is derived from the demand by users for the corn produced by the farmer. The demand for each of these inputs is a function not only of their respective prices but also the price of other products in the marketplace. The demand by a dairy farmer for grain and forage is dependent not only on the respective prices of grain and forage but also on the price of the milk being produced (Derbetin 2006).

A. *Production function, Functional Form and measurement issues*

1) *Production function*

The simplest and most common way to describe the technology of a firm is the production function, which summarizes the production possibilities of the firm, depicting combinations of inputs and outputs that are technologically feasible. The simple production function can be simply defined as: $Y = f (w, k, z)$. Hence, the firm's output of a particular good produced at a particular time (Y) is a function of input (w) used in the production, capital usage (K), and other variables affecting the production process (z). In general, a production function shows the maximum amount of output that can be produced using alternative combinations of inputs.

Likoya and Mangisoni (2008) estimated the demand for fertilizers by small holder farmers in Malawi and they adopted a general dynamic model of demand by considering the basic demand function for fertilizers (linear demand function) where they showed that prices, loan, index of food, farm size and lagged quantity of fertilizers are factors affecting the quantity of fertilizers demanded in the study period. They also showed that the demand for fertilizers were inelastic in both short run and long run, however the absolute value for long run elasticity were large than those in the short run.

2) *Functional form and properties*

Preferred functional form depends on a variety of things, including theory, underlying technology, research objectives and data (Anderson *et al.,* 1996). More importantly, functional forms are both data and model specific; the empirical estimates, including own-price elasticity, elasticity of substitution and returns to scale, are very sensitive to the choice of the functional form, it is fundamental to consider different functional forms and test their validity. However, since there is no absolute best functional form dominating the others, a priori knowledge of the production process under analysis may be helpful in selecting the most suitable form for the specific research objective.

Maganga and Mahire (2011), carried out an empirical study to determine the factors that affects smallholders demand for purchased fertilizer and seed; they adopt a translog cost function on their study and identified that education, field size and household size have significant negative relationship with fertilizer purchased but positive relationship with seed, whereas price of output, seed, fertilizer and household income have found to be significant and positively related to share of fertilizer and negative related with share of purchased seed.

3) *Duality: Specifying Cost and profit function*

Essentially a cost function can be simply defined as: C = f (y, w) where cost (C) is a function of output (Y), which is predetermined, and of input prices (w), the advantages of specifying the cost function are that: the factor levels are now endogenous; the input demand functions for the factors of production can be easily derived as the partial derivatives of the total-cost function with respect to the factor prices. Because the output produced enters the total-cost function, input demand is dependent on output produced and this is why we refer as 'contingent' demand functions (Nicholson, 2005). Dividing these functions by the output level yields the input demand functions per unit of output, or the input-output coefficient functions. Hence, the demand equations do not represent a complete picture of input demand since they still depend on a variable that is under the firm's control. An alternative approach consists of specifying a profit function; $\pi = f(p, w)$, where the firm's profits (Π) depend only on the prices that the firm faces for inputs (w) and for output (p).

In the process of profit maximization, the firm chooses levels of both output and inputs in order to maximize profits, subject to the exogenous prices of the inputs and the market price of the output produced. Since the profit maximizing equations also imply cost minimization, the first-order conditions in a profit-maximizing process can be used to yield input demand functions (Hotelling's lemma), so that the demand for a particular input (as well as output supply) depends on the prices faced by the firm. In this sense, these input demand functions are 'unconditional' as they allow the firm to adjust its output to changes in prices (Nicholson, 2005). Researchers in their studies have investigated on effects of change in price of an input on demand for other input; example if the price for labor falls there will also be changes on the amount of capital as rationale requires a cost minimizing combination of inputs must be chosen

B. *Determinants of inputs demand by the farmers*

Rational farmers in the world of perfect information and a well-functioning market would demand the number of inputs that maximizes the financial return; as known from the theory that profit is always observed when the marginal cost of inputs equals the value of the marginal return, i.e., $MC = VMP$.

But for the context of farmers in Tanzania and a large part of Sub Saharan Africa, it is very unlike that they maximize the inputs decision because of various constraints they are facing, such as poor information regarding the product and factor prices also risks associated with production such as drought that has limited the effectiveness of the demand for inputs (such as demand for fertilizers or labor). Farmers also are faced with the technical constraints that make it difficult to use the available inputs in combination with agronomic practices (Kelly 2005).

For rationale farmer before purchasing any inputs for production will always be driven by two factors; Incentives management factors which allow the analysis of whether the inputs used in production will be profitable compared to alternative expenditure such as education or, health and the capacity utilization factor which address the analysis of the possibility of acquiring the desired number of inputs and use it efficiently.

C. *Demand for inputs: Economic perspective*

The consumption level of inputs in agricultural production can be viewed as forces that bring an intersection between the demand for inputs and the supply of those inputs. Consumption can be extended further as the conversion of inputs economic potential into farmer's effective demand, and the satisfaction of this demand is through input supply and distribution system (Kelly 2005). Inputs demand function is always referred to as derived demand because it is determined to large extent by the final demand for the crop being produced, in the hypothetical production process with a single variable input maximum profit will be obtained at the point where the marginal physical product of the output times price of the product equals to the price of the input. ($MPPx * Py = Px$).

D. *Drivers of farm-level input Demand*

Factors that drive farmers to purchase a certain level of inputs are directly known by the farmers before commence of the production activities, those factors are such as output and input price and also the yielding response of the input being purchased. Farmers' perception and prior knowledge or experience about the inputs have a significant impact on the output and productivity by the farmers as they are deciding production based on the prior knowledge they have about the previous season; thus, a farmer may perceive a yielding response of certain inputs at a lower or higher level. Relatives return of inputs and risks of expenditure are other factors that may influence the purchase of inputs by a farmer, this is because of the variability in the yielding response of output also risks in the inputs and outputs market. The risks in agricultural production have been observed to be higher in Africa than elsewhere (Kelly, 2005).

Output prices are easily influenced by the change in the aggregate demand as there is a change in the market. Many agricultural markets in sub-Saharan countries including Tanzania they are very thin thus a small change in total production can result in a large proportion change in marketed surplus, thus causing volatile price in output and increases risks. Byre (1994) Observed that in Ghana for instance, if maize production increases due to the introduction of seed/fertilizer technology the output/input ratios fluctuated as much as 100% compared to less than 10% in Punjab India, indicating a very elastic market.

III. METHODOLOGY

The paper employed a cross-sectional survey design where data were collected at a single point in time from Paddy Growers in the Kilombero district using structured questionnaire. Data collected were used for simple description purposes as well as determining relationships between variables.

E. *Theoretical and Empirical model*

The study is built around the Neoclassical theory under the perfect competition model and the theory of the firm, where a farmer (firm) is assumed to be a rational producer that seeks to maximize profit from its production activities. Farm households to a large extent they are faced with a market that is not perfectly competitive but for this paper, we will assume that farmers are faced with a competitive market for farm input such as fertilizers, seeds, labor, and pesticides. For most smallholder farmers who operate in 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 (Maganga and Mahere, 2011). 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

Production function specified

$Y = f(x, g, k)$……………………………………………………………..(1)

Whereby Y=household farm output (paddy harvested), x represents the vectors of purchased input quantity, g represents the household fixed factors, and k is household characteristics. The production function in (i) is a concave production function and it is twice differentiable.

$$\frac{\partial y}{\partial x} > 0 \ and \ \frac{\partial 2y}{\partial x2} < 0$$

The cost function for the purchased input can be stipulated as

$C = Xp$………………………………………………………………………………(2)

X is the quantity of input purchased while P is the vector of input prices

We assume that farmers are rational and minimize the level of cost of production subject to the respective level of output:

Min: $C = Xp$…………………………………………………………… (3)

Subject to: $Y = f(x, g, k)$

$\mathcal{L} = Xp - \lambda\{Y - f(x, g, k)\}$…………………………………………………(4)

Then if we find the First Order condition for equation (5) then,

$X *= x(p, y, g, k)$……………………………………………………………(5)

Substituting (5) into (2) to get corresponding minimum cost function

$C *= c(p, y, g, k)$……………………………………………………………(6)

The cost-share can be derived from equation (6), and we opted to use the translog cost function which is more flexible compared to other functions and does not impose prior restrictions on scale economies and substitution factors (Green, 2000). Transforming equation (6) into natural logarithm, the cost function C* can be written as:

lnC*=c (lnP, lnY, Ing, lnk)……………………………………………(7)

then because we wanted to estimate the coefficient of interest from the total cost function in (7), we imposed a constant return to scale condition and then omit the output term in the equation so that we specify the cost function as average cost function C*. The cost-share equation is derived and estimated, directly using the seemingly unrelated regression technique as described by Greene (2000).

The derivate of translog function concerning a factor input (i.e., shepherd lemma) will be obtained and it will result in the cost share of purchased factor input in total cost, the derivate is;

$Si = \frac{\delta \ln C**}{\delta lnPj} = \beta + \sum_{j=1}^{J} \alpha lnPj + \sum_{m=1}^{M} \mu lng + \sum_{l=1}^{L} \gamma \ln K + \varepsilon$ ………………………..(8)

Where Si is the cost share of factors in production. The cost-share for purchased input can be calculated as $Si = \frac{Pixi}{I}$ where I=$\sum PiXi$. ……………………………………………..(9)

The cost shares are estimated for fertilizer (Sf), and pesticides (Sp) after adding some dummy variable they can be represented as:

$$Sf = \beta i + afPf + aplnPp + \gamma lnA + \gamma glng + \gamma slnH + hDi \ldots\ldots(10)$$
$$Sp = \beta i + afPf + aplnPp + \gamma lnA + \gamma glng + \gamma slnHs + hDi \ldots\ldots(11)$$

Whereby βi, α, and γ are estimate coefficients, Pf, Pp are prices of fertilizers and pesticides respectively, A, g, Hs, are household land area, household income, household size, and, Di is the dummy for access to irrigation. The estimates under this paper are the system of cost-share equation for inputs using their prices and farm household (socio-economic) characteristics.

IV. RESULTS AND DISCUSSIONS

Table 1: Coefficient Estimates for share of Pesticides

Sp(Cost-Share Pesticides)	Coefficients
Intercept	-0.3091012
Price of fertilizer	0.0015806*
ln price pesticides'	-0.0409138**
Use of Irrigation	0.0023482*
Price for Rice	0.0010894*
Income	-0.0047905**
Household Size	0.0028171*
Area	0.0015531*
*Significant at 5%	** Significant at 10%

Table 2: Coefficient Estimates for the Share of Fertilizer

Sf (Cost-Share fertilizer)	Coefficients
Intercept	-1.517431
Price_ fertilizer	0.0181479*
Price_ pesticides	-0.0032598
Use of Irrigation	0.0003664
Price of Rice	0.1222409
Income	0.0001016
Household Size	0.0035611
Area	0.0022042
*Significant at 5%	** Significant at 10%

Results show that both prices of pesticides and fertilizers portray a positive relationship with the share of fertilizer and a negative relationship with the share pesticides, as 1% the increase in the price of fertilizer will increase its cost-share by 0.01% thus the prices of these two inputs are significantly affecting the demand for farmers in purchasing of inputs, and the two inputs can substitute on another, as the cost share for one input increases significantly with the increase in the price of the input the cost share of the other input (pesticides) will be observed to decrease. The result for the price of rice was positively related with both share of fertilizer and with the share of pesticides, and 1 percent increase in the price of rice will increase the share of fertilizer by 0.12 percent, this indicates that farmers also consider the price of output before purchasing any input as to whether with the expected price level is there will be profitable to purchase a certain amount of input. The result also shows that if the price of rice were to increase farmers will also use the resource available to purchase pesticides and fertilizer. The insignificant parameter estimates at 5% implies that the prices that farmers receive for the output produced are comparatively low and thus it becomes difficult to cover some of their cost for production.

Household size portrays a positive relationship with both share of fertilizer and pesticides; household size can be used as the proxy for labor and they can be great complementarity between the fertilizer and labor as observed by Olwande J *et al* (2009) in their study were by they found substitutability between family labor and fertilizer, family labor is the cheapest form of labor that smallholder farmers can have, thus with the increase on the family means more cheap labor is available thus resources for the purchase of fertilizer may be used for family labor uses. There is also a positive relationship between an income of the producer and amount of fertilizer purchased as one percentage increase on the income of the producer will increase the cost-share allocated for fertilizer while reducing the cost share for pesticides by the same amount, that means an improvement in income will move a farmer along the same demand curve to a higher quantity of fertilizer used; this means that the purchase of fertilizer is more important for a farmer than a purchase of pesticides as a share of pesticides have shown to be negatively related with the income that a farmer obtains from selling of his/her output.

There is a negative relationship depicted between land size and cost-share for pesticides because a one percent increase in the land area allocated for paddy production will reduce the cost-share going for purchasing of pesticides implies that as a farmer increase the land size, the usage of pesticides input is reduced significantly, and it is consistency with the process of agricultural (intensification) transformation; Akwasi (2010). From the result, it can be observed that farmers can substitute the usage of pesticides with an increase in area for cultivating paddy. The use of irrigation was observed to be positive related with a share of fertilizer used as an increase in the application of irrigation by farmers will also increase the cost-share for fertilizer by 0.00364 implying that farmers will use both fertilizer and irrigation for the increase in paddy productivity.

V. CONCLUSION

The knowledge about the demand for inputs by smallholder farmers is important and it's a clear starting point for coming up with a policy that will enhance the production and productivity of farmers. The results reveal that the land size, prices of output, the income of farmer from paddy production, and usage of irrigation have a significant negative relationship with the share of pesticides while household size, price of pesticides, prices of seed, and price of fertilizer have a significant and positive relationship with the share of pesticides, on the other hand, price of fertilizer, price of seed, price of pesticide, output price, income level from paddy production and use of irrigation portrays a positive significant relationship with the share of fertilizer.

The policy measures such as intervention on the output and input market by the state that will increase the availability of inputs for farmers production are expected under situation and also land reform that encourages farm to increase the purchase for fertilizer should be adopted to improve the productivity of paddy in Kilombero districts.

Farmers know their demand before the purchase of input as they base their decision on previous seasons so it is a challenge to many researchers, policymakers, and non-governmental organizations who advise the framers to use a certain combination of input based on the study as they are required also to consider farmers responses to demand of those inputs, as it has shown from this paper that farmer responds in various ways towards a certain combination of inputs usage for paddy production. The government also should try to ensure the availability of those inputs that farmers are considering as critical for production, as well as the market for products produced, have to be improved so that farmers can realize the returns from the farm output by getting encouraged output price for their product. Then since the direction of a relationship between fertilizer and pesticides are opposite by how much the factors affect the demand either of fertilizer or pesticides depend on the elasticities of the two factors.

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