# DETERMINANTS OF INPUT USE ON SMALLHOLDER FARMS IN THE FORMER LEBOWA.

M. Chikanda and J.F. Kirsten
*Department of Agricultural Economics, Extension and Rural Development, University of Pretoria*

This paper presents evidence from the former Lebowa to evaluate the impact of liquidity, input supply and distribution infrastructure, extension and training services on the quantities of inputs purchased and used by individual small farm-households. Secondly, it assesses the impact of various inputs used on smallholder farm productivity. The results from this study reveal that the key determinants of the main inputs purchased and used by smallholder farmers in the former Lebowa namely fertiliser, seed and other inputs (chemicals, veterinary services and feeds) are; credit, non-farm incomes, extension services and location. Productivity is in turn determined by the application of fertiliser, use of other inputs, training and location. It concludes that farmers with access to credit, incomes and training and located in districts with higher potential natural resources, use more inputs and produce more than their counterparts without access and located in poor agro-ecological zones.

## 1. INTRODUCTION

The main problem in promoting the use of modern farming inputs among smallholder farmers is lack of information about individual farm household constraints, limitations of the existing resources, infrastructure and incentives needed by suppliers to operate in rural areas. Accurate estimation of factors affecting/undermining smallholder input demand is not only important to the input suppliers but the Departments of Agriculture responsible for meeting the development needs of the resource poor smallholder farmers. This study examines how accurate information on factors influencing input demand can be used as a strategy to minimise input procurement constraints, transaction costs for the empowerment of the previously neglected smallholder farmers. More specifically this paper investigates the key determinants of purchased inputs and services with the view of establishing how their improved supply and access can be used to foster smallholder agricultural productivity.

Existing literature shows that the adoption of modern technology by smallholder farmers is influenced by personal attributes of the farmer, farming systems and resource characteristics, institutional, infrastructural and environmental factors (Desai, 1988; Jha & Hojjati, 1994). Personal attributes of the farmer include age, level of education and sex. Farming systems and resource characteristics comprise cultivated area, family size, availability of appropriate inputs such as fertiliser, seed, machinery, equipment and the liquidity position of the farmer. Institutional and infrastructural factors cover laws and regulations governing the supply and accessibility of credit, extension advice, training and input markets. Environmental factors, basically agro-ecological potential and capacities, give farmers and input suppliers incentives to participate subject to expected gains.

This paper hypothesizes that the use of purchased inputs and services vary across households and is a function of prices, liquidity, extension and training services, access to markets and distribution infrastructure while yield is a function of quantity of inputs and services used. Farmers with access to financial resources, access to cost effective input markets, extension and training services use more purchased inputs and have better productivity enhancing management skills relative to their counterparts without.

Data from the former Lebowa are analyzed to evaluate the impact of liquidity, input supply and distribution infrastructure, extension and training services on the quantities of inputs purchased and used by individual farm-

households. It assesses the impact of various inputs used on smallholder farm productivity. The research results are then used as the basis for recommending resource policy reforms that would improve the entrepreneurial ability and productivity of smallholder farmers.

## 2. RESEARCH METHODS

A quantitative approach that employs econometric techniques is used to analyze cross-sectional data collected during October 1995 for the 1994/95 crop year from survey sites in Nebo, Sekhukhune, Seshego and Bochum districts of the former Lebowa in the Northern Province. Apart from input and output figures of the main crops (maize, beans, sorghum and vegetables), institutional and infrastructural data pertaining to the availability of extension, training, number of suppliers of farm inputs and distance of farmers to the input suppliers, credit for purchasing agricultural inputs and related services are used in the analysis.

Due to poor record keeping among farm households, data was aggregated by input type and total crop production. This facilitated whole farm rather than individual enterprise analysis. Output prices were held constant for all farmers to fully capture the variation in household productivity.

## 3. ESTIMATION FRAMEWORK

The primary data collection survey yielded data on input use and access to services by individual households which can be expressed by equation 1.

$$Qi = a_0 + B_1L_i + e_i \qquad (1)$$

Qi is the quantity of inputs used by the household that purchase modern inputs, Li is the liquidity position of the farm household and ei is the error term that represents all other variables which influence the overall input use level. However, the distribution of ei implies that Qi can attain all real values, while in reality input use is non-negative. Since the use of modern inputs and services is beyond the means of numerous smallholder farm households, zero observations occur, and their incidence vary systematically with the liquidity level L. Kmenta (1990) pointed out that analysing such data using ordinary least squares method result in the lower tail of the distribution of Qi and ei being cut and pilled at the cut-off point. This causes the means of ei to be non zero and to vary between purchased input and non-input users (equations 2 and 3).

$$Qi \text{ is} > 0; \ ei = Qi - (a_0 + B_1 x_i) \qquad (2)$$

$$Qi \text{ is} = 0; ei = -(a_0 + B_1 xi) \tag{3}$$

The limitation of the range of values of the dependent variables, causes non-zero mean of the error terms biased and inconsistent least squares estimators.

The Tobit method named after Tobin's work in 1958 best accounts for this phenomenon. The Tobit method basically takes into account the probability of Qi being equal or greater than zero and uses the likelihood estimation technique that recognise the fact that the sample consist of two data sets with characteristics illustrated by equations 2 and 3 (Amemiya 1984). The first data set consists of zero Qi values that indicate the number or frequency (but not position) of observations beyond the cut off point and the second data set comprises figures for which Qi values are greater than zero. The probability weighting make the random Qi values in each data set to approximate a normal distribution as they vary across households $Qi \approx N(a_0 + B_1 Li, 6_2)$ and Qi & Qj (ij) are independent. Equation 4 shows the likelihood function combining the two data sets.

$$L = \tilde{O}_0 F(Qi) \tilde{O}_1 f(Qi) \tag{4}$$

F and f are the cumulative distribution and probability density functions respectively, $\tilde{O}_0$ is the product over those i for which Qi = 0 and $\tilde{O}_1$ is the product over those i for which Qi > 0.

Estimation of model 1 using maximum likelihood function (Equation 4) gives estimators that are efficient, consistent and asymptotically normal (Kmenta 1990). Function 4 is capable of handling multi-variable equations such as 5 and 6 comprising additional factors believed to influence smallholder farm input use and productivity in selected districts of the former Lebowa.

$$Qi = a_0 + B_1 Ci + B_2 Ii + B_3 Pi + B_4 NSi + B_5 STi + B_6 EXTi + B_7 TRNi + B_8 D_1 + B_9 D_2 + B_{10} D_3 + ei \tag{5}$$

Where:

| | |
|---|---|
| Qi | is the quantity of input purchased and used by each farm-household (kg); |
| Ii | is non-farm income available to the farm-household (R); |
| Ci | is the credit available to the farm-household (R); |
| Pi | is the unit price of input (R/unit); |
| NSi | is the number of input suppliers in the area |
| DSTi | is the distance to the nearest accessible input supplier (km) |
| Exti | is the extension dummy variable = 1 for farmers with access to extension services and 0 for those without. |
| TRNi | is the training dummy variable = 1 for farmers with access to training services and 0 for those without. |
| $D_1$ | is the district dummy variable = 1 for Sekhukhune and 0 otherwise. |
| $D_2$ | is the district dummy variable = 1 for Bochum and 0 otherwise. |
| $D_3$ | is the district dummy variable = 1 for Seshego and 0 otherwise |

Quadratic equation 6 is used to estimate the effects of various inputs and services on crop production because of its theoretical and practical flexibility and usefulness in allowing for varying marginal returns to factors in the various stages of production and solving optimisation problems.

$$Yi = a_0 + B_1 Fi + B_2 Fi^2 + B_3 Si + B_4 Si^2 + B_5 Pi + B_6 Oi + B_7 Oi^2 + B_8 Li + B_9 Ei + B_{10} Ti + B_{11} D_1 + B_{12} D_2 + B_{13} D_3 + ei \tag{6}$$

Where:

| | |
|---|---|
| Yi | crop production value (Rands) |
| Fi | fertiliser quantity used (kg) |
| Si | seed quantity used (kg) |
| Pi | Ploughing service costs (R) |
| Oi | total value of other inputs (R) |
| Li | number of labour hours available |
| Ti | training dummy variable = 1 if the farmer attended a course during 1994/95 season and 0 otherwise. |
| Ei | extension dummy variable = 1 if farmer was personally visited by extension officer during the 1994/95 production season and 0 otherwise; |
| Di | district dummy variable = 1 for Sekhukhune and 0 otherwise; |
| Di | district dummy variable = 1 for Seshego and 0 otherwise; |
| Di | district dummy variable = 1 for Bochum and 0 otherwise; |

## 4. PRESENTATION AND DISCUSSION OF RESULTS

The estimators for the various factors are presented in Tables 1 and 2. Many of the estimators have the expected signs and are significantly different from zero at p-value less than 0.1.

### 4.1 Prices of Inputs

The use of seed and ploughing services decreases with increase in prices. The increase in fertiliser use with a price increase is a confusing outcome that may be explained by the fact that the majority of fertiliser users are farmers operating under an irrigation scheme who were borrowing inputs from the former Lebowa Agricultural Company which was more expensive compared to alternative sources. The input supply arrangement was not flexible to allow farmers opportunities to obtain inputs from alternative sources thus giving the impression that more fertiliser purchases took place as prices increased. The farmers on the irrigation scheme use more of the relatively more expensive fertiliser and other inputs compared to dryland farmers in other sub-regions who had access to flexible and cheaper markets but used less inputs.

### 4.2 Infrastructure

The use of all inputs increases with increase in number of suppliers as evidenced by positive estimators for fertiliser, seed and other inputs. The use of inputs declines with increase in distance to the input markets. This indicates that accessibility of inputs improves as the supply increases leading to farmers nearer the market purchasing and using more inputs than their counterparts staying far from the markets.

### 4.3 Liquidity

The use of fertiliser, seed and other inputs increases significantly as credit increases at p value less than 0.05

**Table 1: Estimators of factors influencing inputs used**

| Factor | Fertiliser Used | Seed Used | Ploughing Service | Other Inputs |
|---|---|---|---|---|
| Constant | -930.20 (-3.52)*** | 3.60 (0.70) | 2.706 (3.94)** | -255.20 (-1.45) |
| Price (R/unit) | 18.46 (4.62)*** | -0.0626 (-0.080) | -0.0074 (-2.880)** | |
| Number of suppliers | 6.44 (1.70)* | 0.134 (1.74)* | 0.114 (1.263) | 1.691 (0.712)* |
| Distance (Km) | -63.47 (-0.68) | -10.187 (-7.058)*** | -0.0088 (-0.049) | -18.78 (-0.361) |
| Credit | 0.43 (2.62)** | 0.0098 (2.433)** | -0.00063 (-1.058) | 0.6284 (4.695)*** |
| Non-Farm Income | 0.94 (0.52) | 0.00625 (1.510)* | 0.00012 (0.211) | -0.0039 (-0.0039) |
| Extension Services | 61.10 (0.38) | 4.505 (1.504)* | 0.2876 (0.767) | -106.89 (-0.028) |
| Training | 142.91 (0.83) | -1.471 (-0.383) | 0.0698 (0.133) | -191.66 (-1.236)*** |
| Sekhukhune | -148.30 (-0.63) | -19.427 (-3.968)*** | 0.880 (1.368)* | -354.53 (-1.819)*** |
| Bochum | -590.89 (-1.29)* | -26.128 (-4.348)* | -0.6117 (-0.862) | -212.25 (-.0987) |
| Seshego | -37.33 (-0.173) | -23.657 (-5.135)*** | -0.364 (-0.586) | -113.74 (-0.693) |
| $R^2$ | 24% | 56.6% | 47.8% | 44.3% |

n = 149 and figures in parenthesis are the calculated t ratios.
*** Significantly different from zero with a p-value < 0.01
** Significantly different from zero with a p-value < 0.05
* Significantly different from zero with a p-value < 0.1

This is consistent with the view that liquidity is the main limiting factor to use of purchased inputs. However, the decline in use of ploughing services with increase in availability of credit is again a confusing result, that could be attributed to the argument where majority of farmers with access to credit but extremely limited land were on an irrigation scheme.

The use of fertiliser, seed and ploughing services also increases with increased non-farm income. However, the fact that only the increase in use of seed is significant at p value less than 0.1, indicates that a very small proportion of non farm income is invested in agricultural inputs. This is explained by immediate consumption needs of households using a high proportion of non-farm incomes for consumption purposes. It can be alternatively argued that farm households are investing in non-farm income into less risky non-farming activities.

### 4.4 Services

The use of fertiliser, seed and ploughing services increases with access to extension services. The decline in the use of other inputs with increase in extension service possibly suggests extension service bias against activities which use other inputs. Although not significant, the use of fertiliser and ploughing services increased with training. The decline in use of purchased seed with increase in training possibly indicates that the training induces farmers to become sensitive to seed varieties used. The more knowledgable farmers become selective in terms of seed used which may lead to the decline when appropriate varieties are not available. Again the decline in the use of other inputs with training possibly suggests that trainers were biased against activities that use other inputs.

### 4.5 Variation of Input use by District

The negative intercepts for almost all inputs in the four districts show that the threshold level of purchased input use is beyond the reach of majority of most farmers. Such farmers will only start to use purchased inputs when the combined effect of liquidity, supply, accessibility, extension and training services has improved by a magnitude large enough to offset the negative intercepts. The use of purchased fertiliser is highest in Nebo and declines as one moves to Seshego, Sekhukhune and Bochum respectively. The use of purchased seed is highest in Nebo and it declines as one moves to Sekhukhune, Seshego to Bochum district. The variations in use of both purchased fertiliser and seed are perhaps in line with rainfall distribution patterns. The use of ploughing services declines from Sekhukhune to Nebo, Seshego and Bochum with all districts having positive intercepts indicating that if a farmer is producing, he/she is forced to plough or make use of ploughing services regardless of their liquidity status and supply of the other services. Finally, the use of other inputs declines from a highest level in Nebo, Seshego, Bochum to Sekhukhune.

### 4.6 Impact of various inputs on productivity

Table 2 shows the impact of various inputs and services in descending order on productivity. An increase in the use of fertiliser, other inputs, and training service has positive impact on crop production that is significantly different from zero at a p-value less than 0.1 (Table 2). Although increased use of seed, ploughing services and extension also lead to increase in production, their respective contributions are not significantly different from zero at p values of less than 0.1.

The positive but insignificant contributions of seed and

**Table 2:   Estimators of the Various Inputs on Crop Production.**

| Input | Estimator | t-ratio |
|---|---|---|
| Constant | 37.580 | 0.208 |
| Fertiliser Quantity (kg) | 2.920 | 8.012*** |
| Fertiliser Quantity squared(kg$^2$) | -0.0004 | -3.900*** |
| Other Inputs Value (Rands) | 1.380 | 3.175*** |
| Other Input value squared (R$^2$) | -0.641 | -0.028 |
| Ploughing Costs (Rands) | 0.0083 | 0.045 |
| Seed Quantity (kg) | 6.240 | 0.769 |
| Seed Quantity Squared (Kg$^2$) | -0.1060 | -0.819 |
| Labour (Labhrs) | -0.278 | -1.364* |
| Training | 285.340 | 2.346** |
| Extension | 76.340 | 0.930 |
| Sekhukhune | 14.160 | 0.091 |
| Seshego | -10.640 | -0.710 |
| Bochum | -118.310 | -0.672 |

n = 149 and R$^2$ = 80.24%
*** Significantly different from zero with a p-value < 0.01
** Significantly different from zero with a p-value < 0.05
* Significantly different from zero with a p-value < 0.1

ploughing services possibly reflects the inappropriateness of the available seed, ploughing and extension services given that agricultural climate and location in the former Lebowa are characterised by land shortages, low rainfall, poor soils, and extremely variable cropping outcomes. Lack of breakthrough in seed varieties more suited to the environment possibly undermines the contribution of seed and other purchased inputs and services to smallholder productivity. Arable land shortages relative to labour could possibly explain why from the outset, increase in labour leads to significant decline of crop production.

The insignificant increase in crop production with increased access to extension services, suggests that extension is not making significant contribution to smallholder production possibly due to lack of meaningful advice and technology delivered to smallholder farmers since research activities were previously focused on large scale commercial farmers only. This is consistent with allegations that some of the extension officers are still playing the role of law enforcement agents. It is alleged that many extension officers are still preoccupied with ensuring that farmers adhere to the stipulated soil conservation requirements at the expense of providing new strategies that would increase productivity.

The impact of specific training courses were much more effective since an increase in training services result in a significant increase in crop production as evidenced by a positive estimator that is significant at p value less than 0.05. Crop productivity declined from highest level in Sekhukhune, Nebo, Seshego to Bochum as evidenced by the values of the intercepts.

## 5.      CONCLUSIONS AND RECOMMENDA- TIONS

The results from this study reveal that the key determinants of the main purchased inputs used by smallholder farmers in the former Lebowa namely fertiliser, seed and other inputs (chemicals, veterinary services and feeds) are; availability of markets, credit, non-farm incomes, extension services and location. The variation in agro-ecological potential in districts surveyed influence the use of various inputs and services indirectly through yield gain expectations.

Productivity is in turn determined by the fertiliser and other inputs used, training accessed and location. It is therefore concluded that farmers with access to input and credit markets, incomes and training and located in districts with higher potential natural resources, use more inputs and produce more than their counterparts without access to markets and located in poor agro-ecological zones. The economics of the innovation process result in modern farming techniques being supplied to and accepted in high potential areas earlier and faster than the lower potential areas. Taking uncertainty and the fact that the spread of knowledge is not instantaneous, it shows that input suppliers and smallholder farmers in the former Lebowa behave in a fashion consistent with profit maximisation objectives.

This implies that if the supply of inputs and services in the former homelands are left to markets forces alone, it aggravates the already serious problem of sector, district and regional disparities in access to technology, credit and input markets, productivity and growth. Substantial investments infrastructure in the former homelands and self governing states will enable smallholder farmers to overcome barriers and achieve significant improvements in access to modern inputs and services for sustainable productivity and income.

Agricultural input policy thrust should therefore be directed towards reforming research activities, input markets and distribution channels, extension, training, institutions, and infrastructure to accommodate smallholder needs. This requires Government to forge a long term partnership with the private sector for sustainability. Focus should therefore be geared towards developing appropriate technology especially seed, fertiliser, machinery and equipment, technical support services and infrastructure to promote linkages between smallholder farmers in remote areas and urban input suppliers. More accessible input markets could be fostered through empowering locally based input traders and transporters through improved access to finance, better business advice and other non-financial support measures. Such catalytic measures will go a long way to enhance the private sector participation in providing inputs and services in the appropriate form, time and place convenient to smallholder farmers. This leaves Government and non governmental organisations to concentrate their limited

resources towards bridging the gap between commercial input and service supply in more marginal areas and the development needs of smallholder farmers.

## 6.      FURTHER RESEARCH

Although majority of the results are statistically significant and consistent with a priori conjecture, caution must be exercised in interpreting the results given that the model used assumes that the error terms are normally distributed and the analysis was based on one season data. Given the well-known sensitivity of Tobit method results to distributional assumptions, this is certainly one of the areas deserving further investigation. In fact, further analyses using time series data is recommended.

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