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Full Length Research Paper

Analysis of fertiliser use in potato production in Nakuru district, Kenya

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This study aimed at estimating the farmers' demand for fertiliser in the production of potatoes, and analysing the structure, conduct and performance of the fertiliser market in Nakuru district, Kenya. 250 farmers and 36 fertiliser traders selected using systematic and simple random sampling procedures, respectively, were interviewed between February and April 2001. Two models (the Structure-Conduct-Performance Model, and the Potato Input Demand Analysis model) were used to assess fertiliser use in potato production in Nakuru district, Kenya. The results indicated that it was mainly the producer price that affected the fertiliser demands. The fertiliser prices were generally high and were mainly influenced by the relatively low usage of fertiliser in potato production. Also, the study revealed that there was formal marketing and distribution channel for fertiliser and that fertiliser trade depicted oligopolistic tendencies. Therefore it is clear that producer price of ware potato is critical in determining fertiliser use in the study area and that there is need to streamline the distribution and marketing of fertiliser.

Key words: Potato, fertiliser demand, policy reforms, productivity, input utilisation, market structure-conduct-performance.

INTRODUCTION

Potatoes (*Solanum tuberosum*) are an important food and cash crop in many parts of Kenya; thus increase in potato production can enormously contribute to the national objective of diversification and food security. However, most potato farmers in Kenya are small-scale, owning an average land size of about 2 hectares. Thus, the most likely option to enhance production lies in increased productivity, which can be achieved through intensified input use. This requires adequate availability of, and access to quality inputs (mainly fertiliser and seed) as well as a thorough understanding of the input market.

Understanding the input market may be necessary for proper targeting of production and marketing, which may in turn lead to increased fertiliser consumption. Several attempts have been made to encourage fertiliser use in Kenya. For example, between 1964 and 1990, the government controlled fertiliser prices with the objective of making fertiliser affordable to small-scale farmers. However, the controls had unforeseen bottlenecks such as delays in fixing and announcing input prices and late deliveries of fertiliser to farmers. Moreover, the fixed fertiliser prices could neither compensate for the marketing costs nor provide reasonable profit incentive to promote the distribution of the input by private traders (Mulagoli and Karuri, 2001). Consequently, key changes in the fertiliser sub-sector were instituted between 1983 and 1990. These included, amongst others, fertiliser market reform programs to liberalise fertiliser imports and set realistic margins, with the aim of increasing private

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Abbreviations: DAP, Di-ammonium phosphate; **TSP,** triple super phosphate; **MAP,** mono-ammonium phosphate; **CAN,** calcium ammonium nitrate.

sector involvement in fertiliser trade (Mulagoli and Karuri, 2001). Despite these initiatives and several studies conducted in the fertiliser industry in the last two decades, there is still a dearth of information in a number of areas of the fertiliser sub-sector in Kenya. Therefore this study aimed at estimating the farmers' demand for fertiliser in the production of potatoes, and analysing the structure, conduct and performance of the fertiliser market in Nakuru district.

MATERIALS AND METHODS

Study area

A survey was conducted in Nakuru district, Kenya (35°28´ and 36´E, 0°3´N and 1°10´S) between February and April 2001. Nakuru district was chosen because it is one of the major potato-growing areas in Kenya. For the purpose of this study, the potato growing areas in Nakuru were divided into three main divisions, namely Mau Narok, Bahati and Molo. Four locations were subsequently selected from each division.

Data collection

Both primary and secondary data were used in the study. A total of 250 farmers and 36 fertiliser traders were selected using systematic and simple random sampling procedures, respectively. The selected farmers and traders were interviewed using both structured and non-structured questionnaires.

Data analysis

Data analysis was both descriptive (means, percentages, and frequencies) and quantitative (regression of the key variables). In addition two models were used: the Market Structure-Conduct-Performance (SCP) Model (Sosnick, 1958; Clodius and Mueller, 1961; Tilburg et al., 1992) to analyse the market performance; and the Potato Input Demand Analysis Model to estimate the fertiliser demand.

The market performance was estimated using the farm-retail share and the farm-retail margin which were calculated as follows:

$$FRS = \frac{P_f}{P_r} * 100\% \quad (1)$$

$$FRM = \frac{P_f - P_r}{P_r} * 100\% \quad (2)$$

Where, *FRS* is the Farm-retail price share, *FRM* is the farm-retail margin, P_f is the farm-gate price and P_r is the retail price.

The potato-input demand was estimated from the production function. A production function is generally stated as shown in Equation 3 (Varian, 1984):

$$Y = f(X_1, X_2, X_3, ..., X_n) \quad (3)$$

Where *Y* is the quantity of output that can be produced by applying the major factors of production, and $X_1, X_2, ..., X_n$ are the major factors of production.

It was assumed that the potato production function took the form of a Cobb-Douglas production function as stated below:

$$Y = f(X_{ji}) = AX_{1i}^{\alpha} X_{2i}^{\beta} \qquad \alpha+\beta=1 \quad (4)$$

Where X_1 and X_2 are variable factors used in the production of potato. More specifically, it was assumed that X_{1i} is the amount of fertiliser and X_{2i} the amount of seed demanded by farmer ***i*** to produce ***Y*** tonnes of potato and that the land size was fixed in the short-run.

Furthermore, agricultural producers were assumed to pursue profit maximisation as a key objective. Therefore using equation 4, the profit function of the farmer was stated as:

$$\pi(X; p, r) = p_i f(X_{ji}) - \sum_{j=1}^{2} r_{ji} X_{ji} \quad (5)$$

Where, ***r*** is the input price and ***p*** is the farm-gate produce price of potato.

Taking the first derivatives of the variables with regard to the respective inputs gives the necessary conditions for maximising profits:

$$\frac{d\pi}{dX_{1i}} = pA\alpha X_{1i}^{\alpha-1} X_{2i}^{\beta} - r_{1i} = 0$$

$$\frac{d\pi}{dX_{2i}} = p_i A\beta X_{1i}^{\alpha} X_{2i}^{\beta-1} - r_{2i} = 0 \quad (6)$$

Solving for X_{1i} and X_{2i} in equation 6, and stating the models implicitly gave the fertiliser and seed demand functions, stated in Equation 7:

$X_{1i}=f(p, r_{1i}, r_{2i})$
$X_{2i}=f(p, r_{1i}, r_{2i})$

(7)

These two equations were thus used to estimate the demand for fertiliser and seed. An estimate of the farmers' demand for seed has been reported elsewhere (Ogola et al., 2002a). The estimated empirical form of the demand for fertiliser can now be stated explicitly as follows:

$$Fert_{ji} = f(p_{ki}, r_{ji}^{f}, r_{ki}^{s}) \quad (8)$$

Where, $Fert_j$ is the amount of fertiliser j, used by farmer i to produce potatoes and; r^f_{ji} and r^s_{ki} are fertiliser and seed prices, respectively. The function was estimated using least square regression method. Since farmers interviewed mainly used one fertiliser type (Di-ammonium phosphate, DAP) and one potato variety at a time, fertiliser demand was estimated using equation 9 below:

$$Fertj = \alpha + \beta_1 r^s + \beta_2 r^f + \beta_3 p_k \quad (9)$$

Where α is a constant, β_1 is a coefficient for seed price, β_2 is a coefficient for fertiliser price, and β_3 is a coefficient for output price of the previous harvest . Equation 9 was estimated in two ways:

Table 1. Distribution of fertiliser traders in the study area.

Fertiliser Division	Major trading centre	Number of trader
Molo	Molo	4
	Elburgon	5
	Turi	3
	Mau summit	6
	Total	18
Bahati	Bahati	2
	Kabazi	4
	Kabatini	2
	Dundori	Nil*
	Total	8
Mau Narok	Likia	3
	Mau Narok	6
	Sururu	1
	Total	10

*The potato producers in this trading centre buy fertiliser from Nakuru municipality.

generalising potato output for all varieties; and estimating the output for the most widely used varieties.

RESULTS AND DISCUSSION

Fertiliser trade and use

Most fertiliser traders (58%) in Nakuru district stocked a combination of various fertilizer types; di-ammonium phosphate (DAP), triple super phosphate (TSP), mono-ammonium phosphate (MAP), calcium ammonium nitrate (CAN), and urea. Decision to stock a particular type of fertiliser was influenced mainly by demand (94%), while fertiliser stock levels were influenced by demand (78%) and affordability (21%). This implies that the forces of demand and supply are the most critical factors in determining availability and affordability of fertilizer.

Only 10% to 15% of the farmers used recommended rates of fertiliser in potato production; the rest used either less than the recommended rates or no fertiliser at all. Use of less-than-recommended rates was attributed to factors such as the high cost of fertiliser, lack of soil testing facilities, farmers' educational levels etc. The high fertilizer prices could be due to oligopolistic tendencies and/or built-in costs in the marketing system within the fertiliser industry. Higher fertilizer prices in rural centres compared with major urban centres have also been reported by Argwings-Kodhek (1996). Thus, the government should undertake reforms to ease restrict-tions on business entry and operations while putting in place appropriate safeguards against anti-competitive behaviour. This can be achieved by rationalisation, and reduction in the number of local fees and licences required.

Also, the study revealed that 94% of farmers obtained fertilisers from stockists, 4% from distributors (within major urban centres in the growing areas) and the rest from other sources (e.g., Kiosks, hardware shops etc). Most farmers (80%) reported that the fertiliser stockists were accessible. About 70% and 88% of the farmers, who purchase fertiliser from distributors and stockists, respectively reported that the supply was always reliable. Therefore to enhance fertiliser use, a lot of emphasis should be laid at the stockist level. For example, the physical infrastructure between the rural centres and major towns should be improved. Also, stockists could be encouraged to have contractual arrangement with their suppliers on one hand, and farmers on the other.

The average price (per 50 kg bag) of the most widely used fertiliser type (i.e., DAP) was found to be US $19.1 (Molo), US $19.4 (Mau Narok) and US $19.0 (Bahati). These prices were found to be influenced by market forces of demand and supply (62%), fertiliser type (26%), and quality (8%).

Market structure-Conduct-Performance of the Input Market structure

There were few fertiliser traders controlling the market at the retail level; there were 18 stockists in Molo, 10 in Mau Narok, and 8 in Bahati division (Table 1). Moreover, most of the fertiliser stockists were engaged in other businesses such as hardware trade, chemists/ pharmacies, and other agro-chemicals. The traders were concentrated in the market centres within the production areas. These traders stock fertilisers only during the start of the production season. In contrast, fertiliser consump-tion was characterised by a large number of consumers

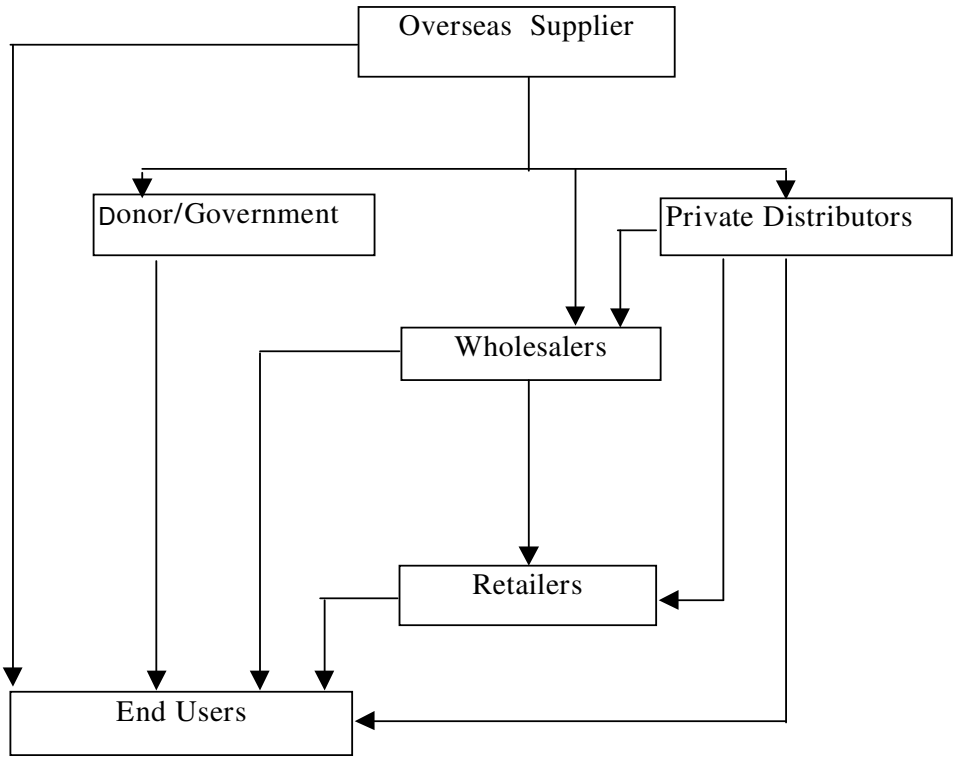

Figure 1. Fertilizer marketing channel in Kenya.

(9,000, 8000 and 4,500 potato farmers in Molo, Bahati and Mau Narok, respectively). The few number of fertiliser traders could be due to some restrictive practices. This is because the effect of market concentration is manifested in its ability to highlight barriers to entry that might exist in the trade. The barriers to entry probably included the high capital requirement (compounded by inaccessibility to credit) and the seasonal nature of demand for the commodity (Tilburg et al., 1992). Indeed Ogola et al. (2002b) reported that none of the farmers in the study region used credit to finance the purchase of farm input, mainly due to unfavourable repayment terms. In contrast, Jones (1972) concluded that African marketing systems were reasonably efficient and competitive in the face of numerous obstacles such as lack of market intelligence and poor transport system.

Conduct

The study found that there was a formal market and distribution channel for fertiliser; this involved importers, processors (or bulkers), wholesalers and retailers (or stockists) (Figure 1). The selling and buying practices depended on the level within the distribution channel. At the retail level, most farmers were not able to buy fertiliser in bulk and often demanded smaller quantities. However, the commodity was packaged in larger quantities (25 and 50 kg). Therefore the traders were often forced to repackage the fertiliser into smaller packets (1, 2, 5 or 10 kg), which could lead to inaccuracy in weights and possibly give room for unethical practices such as adulteration, mis-packaging, and misleading price quotations.

Performance

The farm-gate prices of ware potato were very low compared to market prices (Table 2), and these differences could not be explained by the normal marketing costs. In support of this, the producer share (the ratio of the producer price to consumer price) of the ware potato price in the three divisions were 32%, 25% and 30% for Molo, Mau Narok and Bahati, respectively, while the overall producer share was 29% (Table 2). The low producer share may suggest that there exist large marketing margins that, however, accrue to the middlemen. Indeed, Ogola et al. (2002b) reported that middlemen in the marketing chain of ware potato exploited potato growers by paying very low farm-gate prices. Similarly, (Horton, 1987) attributed low producer prices, high consumer prices and price instability to

Table 2. Farm retail Price share and margin in the study area.

Division	Farm retail price share (%)	Farm retail margin (%)
Molo	32	68
Bahati	30	70
Mau Narok	25	75
Overall	29	71

Table 3. Factors affecting total fertiliser demand for DAP, the most widely used fertiliser type.

Model	Coefficient β	S.E.	t	Significance
A				
Constant	1.051e-02	1.912	0.005	0.996
Seed price	-6.748e-04	0.000	-1.411	0.160
Fertilizer price	-6.748e-04	0.001	-0.120	0.905
Output price	5.435e-03	0.002	2.585	0.010
N	194			
R^2	0.032			
F-value	3.107			
B				
Constant	-1.993	2.014	-0.990	0.324
Seed Price	-5.35e-04	0.000	-1.217	0.226
Fert. Price	1.109e-03	0.001	0.772	0.441
Output Price	4.633e-03	0.002	2.332	0.021
Town centre	-1.25e-02	0.033	-0.375	0.708
Municipality	-8.11e-03	0.007	-1.096	0.275
Experience	3.764e-02	0.017	2.155	0.033
Education	-3.15e-02	0.105	-0.300	0.765
Acreage	0.742	0.093	7.937	0.000
N	152			
R^2	0.365			
F-value	10.646			

inefficient and/or exploitative marketing practices. In general, potato prices are highly affected by price instability and uncertainty (associated with supply and demand), and the perishability of the crop. Moreover, the output is extremely vulnerable to changing weather conditions. The inelastic demand in some cases, and the narrowness of the market in others, often create conditions of high price volatility (FAO, 1995).

Fertiliser demand

Results from regression of seed, fertiliser and potato output prices against fertiliser demand showed that the demand for DAP (the most widely used fertiliser) was negatively related (but not significant) to seed price and fertiliser price, but positively related to output price (Table 3 model A). For example, a 10% increase in farm-gate price of ware potato was found to lead to a similar increase in fertiliser demand (Ogola et al., 2002b). When other variables were included (Table 3, model B), output price, farmer's experience (proxied by number of years in potato farming) and potato acreage were found to be significantly related to fertiliser demand. This implies that although fertiliser use may be affected by input (seed and fertiliser) prices, the most significant factor determining use was the expected output prices. Therefore the importance of producer price incentives in enhancing production cannot be gainsaid.

CONCLUSIONS AND RECOMMENDATIONS

The study has clearly shown that the producer price of potato was the major determinant of fertiliser use in potato in Nakuru district, Kenya and that the performance

of the potato sub-sector was inefficient. Therefore the government should improve the working of a free market through the development of appropriate legal and institutional frameworks and provision of physical infrastructure before leaving the market to perform allocative functions. Also, selective interventions to provide an enabling environment are necessary if market-based reforms are to be effective.

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