

Full Length Research Paper

Assessment of factors affecting the farmer demand for seed potato in Nakuru District, Kenya

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The potato sector in Kenya has been hampered by inadequate use of certified seed mainly due to inefficient delivery of quality seed in the right quantities. This study aimed at estimating the farmer demand for seed as well as analysing the structure, conduct and performance of the seed market. A total of 250 farmers and 36 fertiliser traders were interviewed between February and April 2001, using systematic and simple random sampling procedures, respectively. Three models namely: the structure-conduct-performance model, the seed requirement model and the potato input demand analysis model, were used to analyse the market performance, estimate the total seed requirement for a given variety and to estimate the seed demand, respectively. The results indicated that the seed demand had a significant positive relationship with producer price and that producer price was the major determinant of the potato seed demand. Also, the study revealed that there was unregulated informal seed marketing and distribution system. These results clearly showed that producer price incentives are critical in enhancing potato production in a particular region in Kenya and that the informal seed system needs to be regulated to ensure supply of certified seed in the right quantities.

Key words: Market structure-conduct-performance, potato production, producer price, seed requirement, seed demand.

INTRODUCTION

Horticulture is one of the leading sub-sectors of Kenya's agriculture. Among the horticultural crops gaining prominence lately is the potato (*Solanum tuberosum*). Although it accounts for only 1.9% of the agricultural gross domestic product (GDP) in Kenya (Gitu, 2004), potatoes is an important food and cash crop for many farmers, whose increased production can enormously contribute to the national objective of diversification and food security. Most potato farmers in Kenya are small-scale, owning an average land size of about 2 hectares. With these small land sizes, the only feasible option to enhance production lies in increased productivity through intensified input use. This requires adequate availability of, and access to quality inputs (for example, seed and fertiliser). Moreover,

understanding the input market may lead to proper targeting of production and marketing, which may in turn, lead to increased consumption.

A number of studies on potato production and marketing have been conducted in Kenya (Durr and Lorenzl, 1980; Crissman, 1989; Walingo et al., 1997), but little attention has been given to the seed potato marketing. Crissman et al. (1993) reported that only a small percentage of farmers use certified seed and that high prices of certified seed, poor distribution, inadequate information (about certified seed), and the lack of certified seed of preferred varieties are limiting factors to the use of these seeds. Indeed, other studies (e.g. Gildemacher et al., 2006; FAO, 2004) show that the production of potatoes in Kenya is constrained by lack of high quality seed. Earlier, Durr and Lorenzl (1980) found that most farmers growing potatoes for home consumption generally applied little or no purchased inputs and that the use of improved varieties was not common in any of the

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producing areas. This was mainly because farmers perceived the improved varieties as being late maturing, expensive, difficult to obtain in good time for planting, and less popular with consumers. Indeed, they found that consumers of fresh potatoes prefer red-skinned potato varieties, which are thus often better priced than white-skinned ones. However, consumer preference for processed potato may be different from that of fresh potato. Walingo et al. (1997) reported that 85% of chips producers in Nairobi prefer white-skinned varieties, while 70% of crisp manufacturers prefer the red-skinned varieties.

Moreover, although seed is an important link between cropping seasons, is a costly input and key to increasing productivity, little attempts have been made to estimate the demand for seed (KARI, 1999a). Indeed, there is currently no reliable information on the quantity of potato seed produced in Kenya annually. For example, the estimated annual requirement of potato seed is around 240, 000 tonnes (Lung'aho et al., 2010; Gildemacher et al., 2009) but the effective demand is approximately 36, 000 tonnes (Lung'aho et al., 2010). Also, the formal seed potato supply has not been efficient in delivery of significant quantities of good quality seeds (Ayieko and Tschirley, 2006; Lung'aho, 1996).

However, with high yielding varieties of potatoes, significant production can only be realised with use of good quality seeds at recommended rates. Thus, with no demand estimates for seed potato, it becomes difficult to target production. Therefore, the objectives of this study were: (i) to estimate the farmer demand for seed potato and (ii) to analyse the structure, conduct and performance of the seed potato market in Nakuru district, Kenya.

MATERIALS AND METHODS

Study area

This survey was conducted in Nakuru District, Rift Valley Province, 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 purposes of this study, the potato growing areas in Nakuru were divided into three divisions: Mau Narok, Bahati and Molo. Four locations were subsequently selected from each division. These divisions are characterised by highly fertile, deep, well-drained soils (mollic andosols in Bahati and Mau Narok, and vitric andosols in Molo), cool temperatures (annual average of 14.5 to 16.7°C in Bahati and Mau Narok and 10.6 to 14.5°C in Molo) and high rainfall (1200 - 1400 mm, 1000-1100 mm and 1000 - 1200 mm p.a. in Bahati, Mau Narok and Molo, respectively) that are suitable for potato production (Jaetzold and Schmidt, 1982).

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, three 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; the seed requirement model to estimate the total seed requirement for a given variety (percent (%) of total seed requirement); and the potato input demand analysis model to estimate the seed demand. The market performance was estimated using the farm-retail share and the farm-retail margin (Ogola et al., 2011). The total seed requirement for a single variety was estimated using Monares' Seed Demand model (Vedora and Brieve, 1995) as shown in Equation 1:

$$S_a = A * T_s * T_r * P_j \quad (1)$$

Where S_a is the seed demand (in sacks or kg); A is the potato area planted in a particular location (ha); T_s is the amount of seed (sacks per hectare); T_r is the seed renewal rate (%); P_j is the area planted to variety j (% of total area). Furthermore, the potato-input demand was estimated from the production function. A production function is generally stated as shown in Equation 2 (Varian, 1984):

$$Y = f(X_1, X_2, X_3, \dots, X_n) \quad (2)$$

Where Y is the quantity of output that can be produced by applying the major factors of production, and X_1, X_2, \dots, X_n are the major factors of production. Moreover, it was assumed that the potato production function took the form of a Cobb-Douglas production function as stated in Equation 3:

$$Y = f(X_{ji}) = A X_{1i}^\alpha X_{2i}^\beta \quad \alpha + \beta = 1 \quad (3)$$

Where X_1 and X_2 were variable factors used in the production of potato. It was assumed that X_{1i} was 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 3, the profit function of the farmer was stated as:

$$\pi(X; p, r) = p_i f(X_{ji}) - \sum_{j=1}^2 r_{ji} X_{ji} \quad (4)$$

Where r is the input price and p is the farm-gate producer price of potato. Taking the first derivatives of the variables with regard to the respective inputs gives the necessary conditions for maximising profits:

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

$$\frac{d\pi}{dX_{2i}} = p_i A \beta X_{1i}^\alpha X_{2i}^{\beta-1} - r_{2i} = 0 \quad (5)$$

Solving for X_{1i} and X_{2i} in Equation 5, and stating the models implicitly gave the fertiliser and seed demand functions, stated in Equation 6:

$$\begin{aligned} X_{1i} &= f(p, r_{1i}, r_{2i}) \\ X_{2i} &= f(p, r_{1i}, r_{2i}) \end{aligned} \quad (6)$$

These two equations were thus used to estimate the demand for fertiliser and seed. An estimate of the farmer demand for fertiliser has been reported elsewhere (Ogola et al., 2011). The estimated empirical form of the demand for seed can now be stated explicitly as follows:

$$Seed_{ki} = g(p_{ki}, r_{ji}^f, r_{ki}^s) \quad (7)$$

Where $Seed_{ki}$ is the amount of seed, j of variety k , used by farmer i to produce potatoes and; r_{ji}^f and r_{ki}^s are fertiliser and seed prices, respectively. The function was estimated using least square regression method.

RESULTS AND DISCUSSION

Potato seed system

The current study found that most of the seed used in potato production was farmer-based (57 and 90% for Tigoni and Nyayo, respectively, which are the most widely grown varieties) with only a small proportion coming from research institutions and other sources. The farmer-based seeds were either farmers' own seeds (preserved from previous harvest) or those purchased from neighbours. Similarly, Ayieko and Tschirley (2006) reported that only 1% of potato farmers in Kenya use certified seed. More recently, Gildemacher et al. (2009) found that less than 1% of potato farmers in Kenya sourced their seed from seed growers while the corresponding figure was 4% in Uganda.

According to 46% of the farmers interviewed in the current study, the main reason why they produced their own seed was because they considered seed from other sources to be comparatively more expensive and their fear of the likelihood of seed unavailability at the time of planting. This is consistent with findings from other studies (Ayieko and Tschirley, 2006). Farmers who buy seed (or exchange with neighbours) do so when their crop was infested with disease, or when the neighbours' crop appeared to be doing well. Thus, the seed supply market in this region of Kenya, as indeed in other parts of Kenya, is basically an informal one with little control from the government (Kwambai and Komen, 2010; Gildemacher et al., 2009; Ayieko and Tschirley, 2006; KARI, 2001; Lung'aho, 1996; Kinyae et al., 1994). Therefore, it has been difficult to establish the seed demand and supply functions.

In the current study, farmers growing local landraces reported that the main problems with seed included low

quality (43%), susceptibility to diseases (18%), rotting (9%) and nematode attack (1%). Seed renewal rates varied greatly amongst farmers in this region. For example, 21% of the farmers growing local landraces never renewed their seed, 29% renewed after every season, 41% yearly (after 2 seasons) and 9% after three to four seasons. In contrast, 44% of those growing improved varieties did not renew their seeds, 10% renewed every season, 12% every year while the rest (34%) renewed after three to four seasons. This is consistent with recent findings (Gildemacher et al., 2009) that 41 and 26%, respectively of potato farmers in Kenya and Uganda renewed their seed periodically and that majority of these farmers did so after eight seasons (4 years). Our results and those of Gildemacher et al. (2009) compare favourably with the current recommendation that potato seed should be renewed after every 2 to 3 years (Kabira et al., 2006).

The most prevalent mode of storage for seed potato in the current study was wooden granary (51%). Others included holes dug in the field (30%), sacks (15%), etc. This is in line with recent findings that most potato farmers in Kenya store their seed in dark stores (51%) and underground pits (21%) (Gildemacher et al., 2009). Since the potato sector is characterized by price instability and the fact that potato is highly perishable, suitable storage facilities would be important in stabilizing the market prices and in making seed available at the right time. Indeed, most (45%) farmers in the current study reported that poor storage was a major factor contributing to deterioration in seed quality as it leads to weight loss, sprouting and pest infestation. Furthermore, Gitu (2004) reported that poor storage was one of the major factors leading to massive post-harvest losses in potatoes. Therefore, supportive policies are needed to not only enhance seed production, but also to improve post-harvest activities like storage. Previous studies show that countries with well-established storage facilities tend to realise increased potato output (FAO, 1995).

Market structure-conduct-performance of the input market

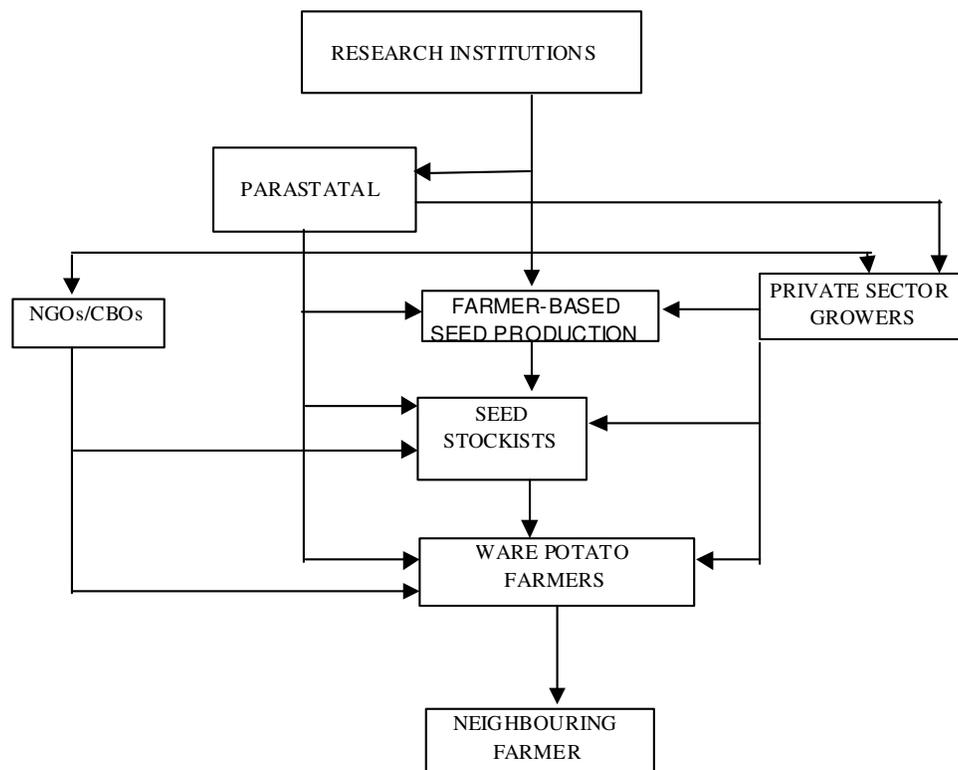
Structure

There were no formal seed traders in the study region (Table 1). Also, the study found that there were some restrictive practices in the seed potato trade. This could be due to the unavailability of a formal market for seed, the high cost of certified seed, the nature of the seed (highly perishable), flexibility in use (can also be used as ware potato), and the seasonal nature of the seed demand (Tilburg et al., 1992). 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

Table 1. Distribution of seed potato traders in the study area.

Division	Major trading centre	Number of formal seed sellers
Molo	Molo	Nil
	Elburgon	Nil
	Turi	Nil
	Mau Summit	Nil
Bahati	Bahati	Nil
	Kabazi	2 ^a
	Kabatini	Nil
	Dundori	Nil
Mau Narok	Likia	Nil
	Mau Narok	1 ^a
	Sururu	Nil

^a The trader is a farmer who also stocks fertiliser.

**Figure 1.** Distribution channel for potato seed.

and poor transport system.

Conduct

There was no well-established formal market or distribution

channel for seed potato, but the general distribution channel for seed potato is given in Figure 1. Indeed, it was difficult to distinguish the seed potato market from the ware potato market because the potato tuber is often used both for food and propagation (Horton, 1987; FAO, 1995). However, there have been attempts by Kenya

Table 2. Potato seed requirement per variety (% of total seed requirement).

Division	Variety				Total
	Tigoni	Nyayo	D. Robjin	Asante	
Molo	47.4	18.3	12.9	21.4	100
Mau Narok	8.1	91.4	0.5	0.0	100
Bahati	1.8	97.3	0	0.9	100
Total	35.1	40.7	9.1	15.1	100

Agricultural Research Institute (KARI) in collaboration with the International Potato Centre (CIP) to strengthen and streamline potato seed production and distribution through the promotion of Farmer-Based Seed Production [FBSP] (Kwambai and Komen, 2010; CIP, 2000; Lung'aho 1996). Whereas this has been a positive step in enhancing production and distribution of seed, it still does not meet the producers' demand. For example, CIP (2000) estimated the informal seed production for Nakuru district at 12,000 (50 kg) bags which was much lower than the estimated seed requirement for this area (Ogola et al., 2002). Moreover, although FBSP has resulted in increased availability of seed, the high prices leads to continued use of low quality recycled seed by most farmers in the north Rift region of Kenya (Kwambai and Komen, 2010). Therefore, there is need to explore cheaper seed multiplication and delivery technologies that would ensure fair seed pricing and hence sustainability of FBSP.

In addition, this study found that seed potato was sold in bags [extended (130 kg), normal (90 kg or 50 kg)] or in tins (2, 10 or 20 kg). However, these weights were rarely verified, thus often leading to underweight or overweight packages. As seed often represents the most expensive input (FAO, 1995), it is important to determine the appropriate quantities to be used. The use of correct units of measurement is likely to facilitate the estimation of the seed demand, lead to correct pricing, and eliminate wastage and/or shortages. Therefore, there is need to have clear guidelines on the units of measurements of seed potato. Moreover, seed price in this study was found to range from Kshs 300 to 3000 (US\$ 3.5 to 35) per 50 kg bag, with an average of Kshs 673 (US\$ 7.9); seed from formal sources tended to be more expensive than seed from informal sources. These prices are comparable to those of good quality seed in the north Rift region (Kwambai and Komen, 2010) as well as prices from the informal seed system nationally (Ayieko and Tschirley, 2006). The low average prices in the current study could be due to the fact that most farmers used seed from informal sources.

The physical location of the market did not appear to affect seed prices in this study. This was probably because most seed used in potato production in this region was obtained from the immediate neighbourhood. Similarly, the informal seed sector (which includes growers

and suppliers of seed mainly in their immediate localities) has been reported to account for 99% of the total annual potato seed requirement in Kenya (Ayieko and Tschirley, 2006; KARI, 2001).

Potato seed requirement

The average seed rates for the study region was found to be 43, 25 and 28 bags (50 kg) ha⁻¹ for Molo, Mau Narok and Bahati, respectively. The seed rates in Molo compared favourably with the current recommendation of 40 to 48 bags (50 kg) ha⁻¹ (KARI, 1999b). In contrast, the seed rates in Bahati and Mau Narok are comparable to the prevailing rates in Meru central and Nyandarua (Gildemacher et al., 2009). Using the seed rates from the current study, potato seed requirement was determined for the most widely grown varieties for each division. The most preferred variety in Molo was Tigoni (47.4%), followed by Asante (21.4%) and Nyayo (18.3%). In Mau Narok and Bahati in contrast, Nyayo was the most preferred variety (accounting for 91.4 and 97.3% of the total seed requirement in these divisions, respectively). Overall, in the study area, Nyayo (40.7%) and Tigoni (35.1%) seeds were the most preferred (Table 2). Yields (42%), marketability (33%) and resistance to disease (10%) were the main reasons for preference of the two varieties. Therefore, any seed programme in the study area should lay emphasis on these two varieties. More recently, Kwambai and Komen (2010) found that Tigoni was the most (70%) preferred variety in the north Rift region mainly due to its high marketability and yield.

Potato seed demand

Results from a regression of seed, fertiliser and output prices against seed demand showed that the demand for seed potato (all varieties) was negatively related (but non-significant) to both seed and fertiliser price and positively related to output price (Table 3). These results imply that the farmers react more to the price of the output rather than inputs in determining how much seed to use. This is in line with earlier findings that marketing of potatoes may be more critical than production, because a sharp drop in price can cancel out all the

Table 3. Factors affecting total seed demand for all varieties combined.

Model	Coefficient			Significance
	β	S.E.	t	
Constant	5.555	1.965	2.827	0.005
Seed price	-8.888e-04	0.001	-1.584	0.114
Fertilizer price	-1.692e-03	0.002	-1.092	0.276
Output price	3.188e-03	0.002	1.721	0.086
N	253			
R ²	0.012			
F-value	2.038			

Table 4. Factors affecting total seed demand for the most widely grown variety, Nyayo.

Model	Coefficient			Significance
	β	S.E.	t	
Constant	14.597	5.841	2.499	0.014
Seed Price	-1.405e-02	0.002	-6.648	0.000
Fertilizer Price	-3.027e-03	0.004	-0.699	0.486
Output Price	1.269e-02	0.003	4.161	0.000
N	150			
R ²	0.27			
F-value	18.90			

potential benefits of a bumper crop (Horton, 1987). Given that potato production in the study area is mainly rain-fed, the crop matures at the same time and therefore during harvest, the supply outstrips the demand (mainly at the farm-level) and the price is at its lowest. After the harvest, the market supply of potato contracts and the price rises again.

Meanwhile, when the analysis was restricted to the most widely grown variety, Nyayo (with seed, fertiliser and output prices as regressands), the seed demand had a significant negative relationship with seed price and a significant (more significant than for all varieties combined) positive relationship with output price (Table 4). These results are comparable to the findings of Ayieko and Tschirley (2006) who reported that the demand for improved seed of a number of crops, including potatoes, in Kenya is influenced by output markets. The effect of potato output price on fertilizer demand has also been reported (Ogola et al., 2011). Similarly, Mose et al. (2007) found that maize farmers in Trans-Nzoia District, Kenya responded positively to producer price incentives. Changes in price levels (seed and output) therefore strongly influence the decisions of potato farmers. For instance, an increase in seed potato price will lead to a fall in the seed demand and a resultant lower output, and vice versa. On the other hand, an increase in the output price will lead to an increase in seed demand, thereby resulting in increased output.

Indeed, Gildemacher et al. (2009) suggests that high prices of ware potato or high potato yields may render regular investment in expensive but high quality seeds economically feasible.

CONCLUSION AND RECOMMENDATION

This study revealed that potato farmers in one particular region of Kenya rely mainly on unregulated informal seed system and that producer price of potato is the major determinant of seed use. Therefore, there is need to regulate this informal seed sector and develop an efficient distribution system if adequate production of preferred varieties is to be realised. Moreover, to ensure that the producer prices received provide adequate incentives, the government should improve the working of a free market through the development of appropriate legal and institutional frameworks and provision of physical infrastructure.

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