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The response of maize production in Kenya to economic incentives

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Abstract

Agricultural development policy in Kenya has emphasised the use of incentives towards increased production and therefore self-sufficiency in maize which is a basic staple for most households. The channels used to provide incentives to maize farmers over the years include setting higher producer prices; subsidisation of inputs; provision of agricultural credit, research and extension services; construction and maintenance of roads, development of irrigation and water systems; legislative, institutional and macroeconomic reforms. Despite these efforts output of maize has remained below domestic requirements in most years and the country continues to rely on imports to meet the deficits. Studies have assessed the responsiveness of maize to output price and reported inelastic responses and have recommended policies targeting non-price incentives to complement prices for the required increased production of maize. The studies, however, did not analyse the influence of the non-price incentives on the production of the crop. The findings of those studies are therefore deficient in explaining the relative importance of different non-price incentives and how they complement prices in influencing maize production in Kenya. This study investigated the response of maize production to both price and non-price incentives. The aim of this study was to ascertain the relative importance of non-price factors in influencing production of the crops as well as complementarity between price and non-price incentives. The findings show that maize production responds positively to its output price, development expenditures in agriculture, maize sales to marketing boards, growth in per capita GDP, liberalisation and governance reforms. However, maize production responds negatively to fertiliser price and unfavourable weather conditions. The response of maize output to its price is lower with rising inflation and grain market liberalisation.

Keywords: Maize production response, Price Incentives, Non-price incentives

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1. Introduction

1.1. Maize consumption and production in Kenya

Maize is the main staple in the diet of over 85 per cent of the population in Kenya. The per capita consumption ranges between 98 to 100 kilograms which translates to at least 2700 thousand metric tonnes, per year (Nyoro et al., 2004). Over 38 per cent of the food crop producers in Kenya grow the crop (Republic of Kenya, 2003a). Small scale production accounts for about 70 per cent of the overall production. The remaining 30 per cent of the output is from large scale commercial producers (Export Processing Zone Authority, 2005). Small scale producers mainly grow the crop for subsistence, retaining up to about 58 per cent of their total output for household consumption (Mbithi, 2000). The trend in total maize output in Kenya for the period 1972 to 2008, shown in figure 1.1, reveals that output has fluctuated over the years.

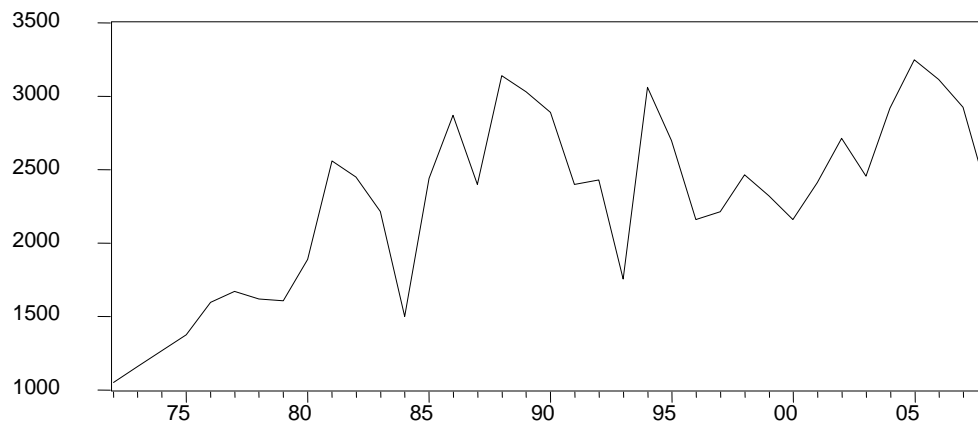


Figure 1.1. Production of maize ('000' MT) in Kenya (1972 - 2008)

Data source: Republic of Kenya. Economic Surveys (various issues). Nairobi: Government Printer

Given an average consumption requirement of at least 2700 thousand MT per year, the trend shows deficits in most of the years. These deficits are met through imports. Poor weather is blamed for the low output of maize in some years. However, yields have also remained at an average of 2 tonnes per hectare below the possible 6 tonnes per hectare a situation attributed to inadequate absorption of modern production technologies such as high yielding maize varieties and fertilisers because of high input costs, lack of access to credit and inadequate extension services to small scale producers (Republic of Kenya, 1997; 2004; Kang'ethe, 2004). Other constraints include poor rural infrastructure, insufficient budgetary allocations to agricultural development and the private sector's weakness in maize marketing in liberalised markets (Republic of Kenya, 1997; 2008).

2. Incentives for maize production in Kenya and the problem

During the first two decades after Kenya's independence in 1963, public policy singled out maize as the major food staple. Its production and marketing received budgetary support through government controlled marketing board (Nyangito and Kimenye, 1995). Policies focussing on subsidising producer and input prices, credit, research and extension activities were also implemented. The resettlement programmes and increased small holder production in the late 1960s and early 1970s remarkably expanded maize production to the extent that large surplus production were realised (Republic of Kenya, 1974; 1981; Nyangito and Kimenye, 1995).

From mid 1970s, rapid population growth and shortage of unexploited arable land in the high and medium potential areas prevented any marked improvement in maize production and in food production in general. Per capita nutritional intake reduced and some sections of the population remained food insecure (Nyangito and Kimenye, 1995; Republic of Kenya, 1981). Coupled with the drought of 1979, a potential imbalance between national supply of and demand for food became evident. This led to the development of the country's first comprehensive national food policy in 1981 (Republic of Kenya, 1981). The national food policy of 1981, set up guidelines for decision making on all major issues related to food production and distribution including marketing, trade, pricing, research and extension, agricultural credit, inputs, land use, food security and nutrition (Republic of Kenya, 1981). The thrust of food security policy was to increase production and distribution of food to all areas, expand production of sorghum and millet in the semi-arid areas, and accumulation of a multi-commodity strategic food reserves from domestic surpluses for use during periods of crop failure (Republic of Kenya, 1981). These objectives remain central in the country's food security policy as emphasised in later policy documents (Republic of Kenya, 1986; 2004).

From early 1980s, it was believed that the intensive state controls had turned the terms of trade against agriculture and the country began to gradually adopt structural adjustment programmes (SAPs). The complete liberalisation of the production and marketing of maize in the country was realised in 1993. Liberalisation was to break the structural rigidities, broaden the role of market signals and align relative prices more closely with those in world markets, so as to improve agricultural terms of trade for increased agricultural production and economic performance (Republic of Kenya; 1986; 1997; Nyangito and Kimenye, 1995; Nyangito and Okello, 1998). Upon liberalisation, all price controls, import licensing, and foreign exchange controls were abolished. Agricultural prices were left to market forces and marketing to private traders. The role of the National Cereals and Produce Board (NCPB) was to be restricted to maintenance of strategic reserves and buyer and seller of last resort (Republic of Kenya, 1986; 1994, 1997). Provision of government services also changed from the supply oriented approach to demand driven approach. While the government continued to disseminate relevant information to farmers and to support agricultural education, beneficiaries of research and extension services were required to support the activities through levies. The private sector was to undertake research in commodities that competitive markets could handle so that direct government involvement could focus on problems of national importance and constraints facing small scale farmers (Republic of Kenya, 1986; 1997; Nyangito and Kimenye, 1995).

Agricultural TOT improved following full liberalisation but production of maize was lower in the second half of the 1990s than in the late 1980s and economic performance also worsened (Republic of Kenya, 1997; Nyangito and Okello, 1998). This was blamed on inadequate complementary policy measures in rural infrastructure and institutions, and unfavourable weather conditions which are thought to have weakened the price incentives (Nyangito and Okello, 1998). Public investments in roads, research and extension, fertiliser supply and water control systems are considered to be complementary to the pricing system in influencing private investment in agriculture (Delgado, 1995). Budgetary allocations towards agricultural research and extension, road construction and maintenance, development of irrigation and water systems aimed at improving access to rural areas and increasing productive capacity of agricultural land are therefore considered important. Research and extension services enhance provision of new technologies and the information needed for increased productivity in agriculture (Nyangito and Kimenyi, 1995; Republic of Kenya, 2009c). The role of the government in the provision of these services is critical because of their public good's nature.

From 2003, the government of Kenya initiated, macroeconomic, legislative and institutional reforms, infrastructure development to help revitalise the agricultural sector towards the country's economic recovery, creation of wealth and employment, eradication of poverty and achieving food security (Republic of Kenya, 2003b; 2004). The reforms alongside macroeconomic stability and human development were considered necessary for providing an enabling environment for achieving the goals of Kenya vision 2030, which aims to transform subsistence agriculture to a commercial, market oriented activity, towards sustainable national food security (Republic of Kenya, 2008). Low levels of inflation, limited public sector deficits, stable exchange rate, and low interest rates are also envisaged as important to instil confidence in investors in all economic activities in the country (Republic of Kenya, 2007b; 2008).

It is significant to note however, that despite all these government efforts to provide incentives with a view of enhancing maize production, maize output has remained below domestic requirements in most of the years and the country continues to rely on imports to meet the deficits. This leads us to question the responsiveness of maize production to economic incentives.

Earlier studies on the responsiveness of maize production to producer prices in Kenya revealed inelastic responses to producer prices (Mbithi, 2000; Mose et al., 2007; Olwande et al., 2009). This suggests ineffectiveness of pricing policies in raising maize production. Mbithi (2000) analysed the influence of output prices, rainfall, liberalisation, fertiliser prices, and time trend on maize production in Kenya using data for the period 1970 to 1998 in order to ascertain the determinants of maize production in the country and the impact of liberalisation of maize market. Results of the estimated double log function specified according to the Nerlove (1958) model, showed that 1 per cent increase in the ratio of fertiliser to maize prices reduced maize output by 0.18 per cent. The low response was attributed to a large proportion of maize production among small scale subsistence farmers being retained for home consumption. The conclusion was that producer price strategy would benefit the large scale producers more than small scale producers and therefore could not lead to significant expansion of maize production.

Mose et al. (2007) found no significant difference between maize production supply response before and after market liberalisation. The study applied cointegration analysis and error correction model (ECM) using data on small holder maize production for Trans Nzoia district in the period 1980 – 2003. The results showed that high maize and low fertiliser prices positively influenced aggregate maize supply response. Past prices were shown to estimate the observed supply response better than contemporaneous prices. The study recommended that besides price incentives, other complementary interventions such as good infrastructure, household access to information, extension and credit in addition to improved technology were necessary for the desired supply response.

Olwande et al. (2009) assessed how responsive maize output, fertilizer and labour demand were to price and non-price factors using cross sectional farm-level data for 334 maize producing households in the high potential maize zone of Kenya during the main crop season of 2003/2004. The study employed the use of normalized restricted trans-log profit function from which output and factor shares functions were obtained. The study found a positive own-price supply elasticity of maize which indicated that a 10 percent increase in the price of maize would result into a 1.1 per cent increase in the supply of maize, other factors held constant. The inelasticity of maize supply to maize price implied that making the price of maize favourable would not increase production substantially. The study suggested that making public investment in rural infrastructure and efficient port facilities to reduce fertiliser prices and promoting standards of commerce that provide incentives for commercial agents to invest in fertilizer importation, wholesaling and retailing would be desirable. Although response to land was the largest, the fact that land had been subdivided into small uneconomical parcels meant that intensive use of other productivity enhancing inputs in addition to fertilizer would be the means towards increasing output.

This study was carried out to investigate the relative influence of price and non-price incentives in maize production in Kenya and to analyse the complementarity between them in influencing the crop's production. The study specifically investigated the relative influence of maize output price, input prices, development expenditures on agriculture, development expenditure on roads, transport and communication; maize sales to marketing boards; macroeconomic environment; governance and institutional reforms, on the production of maize in Kenya

3. Methodology

3.1. Conceptual framework

Most producers of maize in Kenya cultivate it for subsistence, but sell surpluses for income to enable purchase of other consumer goods from the market. In this way, the producing households exhibit the dual character of being producers and consumers at the same time. An appropriate analysis of their production behaviour was based on the utility maximisation theory (Singh et al., 1986), but with the model extended according to Key et al. (2000), to incorporate other constraints and government interventions, in production of the food crop. Assuming that the farmer pursues utility maximisation from a consumption basket

comprising home produced goods, market purchased goods, and leisure, subject to the full income constraint and that cultivation involves more than one crop, where all markets exist in which the farmer is a price taker, the production and consumption decisions are recursive. Solution to the farmer’s problem yields output supply functions that are dependent on the farm’s production technology, producer prices for all crops cultivated ($P_{1,...,n}$), prices of variable inputs including the market wage rate $P_{v(1,...,m)}$, and the quantities of fixed inputs of land and capital ($A_{1,...,k}$). The output supply function for crop i can therefore be expressed as:

$$Q_i = f(P_{1,...,n}; P_{v(1,...,m)}; A_{1,...,k}) \text{-----} 3.1$$

According to the arguments of Key et al. (2000), transaction costs reduce the prices farmers receive when they sell but increase the prices they pay when they buy. The basic household model was extended to accommodate effects of transaction costs on the prices producers receive when they sell their produce or the prices they pay when they purchase inputs, the prices being expressed as:

$$P_i^* = P_i - t^s(z_{it}^s) \text{-----} (3.2)$$

$$V_i^* = V_i + t^b(z_{it}^b) \text{-----} (3.3)$$

where: P_i^* and V_i^* are the net output and input prices realised by farmers; P_i and V_i are the market prices of the output and inputs, respectively; t^s and t^b are transaction costs associated with marketing output and purchase and use of inputs by farmers. The transaction costs are expressed as functions of a factor z, which is a vector of all those factors that may influence the level of transaction costs. Such factors include rural infrastructure, level of extension services received by farmers and macroeconomic conditions. Incorporating the conditions 3.2 and 3.3 into the output supply function (3.1) implies that agricultural production is influenced by all these factors.

The government of Kenya intervenes to reduce the implicit costs imposed on farmers by the various sources of production constraints in agriculture through financing construction of roads, research and extension. Government policy also aims at macroeconomic stability, human development, institutional and governance reforms, as ways of providing a favourable environment for private investment in economic activities. Farmers’ production decisions can therefore be conceptualised as dependent not only on producer prices, input prices, quantities of fixed inputs and farm technology, but also on public investment on transport, road construction, agricultural research and extension, macroeconomic environment, institutional reforms and governance.

3.2. The empirical model

Following the theoretical argument, the models estimated in this study were expressed as:

$$Y_{(t)} = f(Y_{(t-i)}, P_{y(t-i)}, P_{yi(t-i)}, V_{f(t)}, V_{s(t)}, W_t, Z) \text{-----} (3.4)$$

where: $Y_{(t)}$ and $Y_{(t-i)}$ were outputs of maize in metric tonnes in periods t and $t - i$, respectively; $P_{y(t-i)}$ was the output price in Kenya shillings per bag of maize in period $t - i$; $P_{yi(t-i)}$ was the output price per unit of another crop i in period $t - i$. $V_{f(t)}$ and $V_{s(t)}$ were the price of fertiliser in and the price of certified seed for the respective crop in period t , respectively. These were measured by the price indexes.

W_t was the average agricultural wage in Kenya shillings for period t ; and Z was a vector comprising other exogenous factors that could influence production and marketing of crop j as indicated in equation 3.5:

$$Z = [G_R; G_A; GDPCT; R; INF; MKTBD; D_i] \text{-----} \quad (3.5)$$

where: G_R represented government expenditures on road construction and maintenance and the improvement of transport and communication; G_A government expenditures on agricultural development, $GDPCT$ was per capita GDP; R , the lending rate; INF , inflation rate and $MKTBD$ was maize purchases by marketing boards. D_i was a dummy variable which captured the effects of liberalisation, changes in governance, or other unique occurrences that affected production of the crops.

3.3. Data type, sources and analysis

The study used published data on all the variables under consideration for the period 1972-2008. Information on the output of each crop was compiled from Food and Agricultural Organisation production statistics (FAO, 2011) and Republic of Kenya Economic surveys. Data on output and input prices were obtained from the Republic of Kenya statistical abstracts and other records obtained from the Kenya National Bureau of Statistics (KNBS). Data on macroeconomic variables including GDP, population, and lending rates, were obtained both from the statistical abstracts and International Financial Statistics (CD-ROM). Information on government expenditures, inflation and the annual weighted average index were obtained from Statistical abstracts, Economic Surveys and the KNBS.

To answer the research questions regression analysis was done but to avoid spurious results, stationarity and cointegration tests were conducted on the time series used in the study. The output response function was fitted using autoregressive Distributed lag model (ARDL), and estimated by least squares method. The logs of variables were used in the models, except for the dummies. Interaction terms between output and input prices with the non-price variables, were introduced in the models to investigate effect of non-price incentives on output response to the prices. Further, dummies were used to capture shocks due to unusual occurrences in the system.

The estimated response equation satisfied the normality assumption for residuals, no autocorrelation and heteroskedasticity as well as stability tests. It was transformed into its distributed lag form to enable computation of elasticity estimates and effects of different independent variables on current production. Where an independent variable had an effect on the dependent variable distributed over different periods, a distinction was made between short run and long run elasticity estimates. The short run elasticity estimate was computed based on the coefficients of non-lagged explanatory variable, while long run elasticity

estimate was computed based on the sum of coefficients of the respective independent variable (Christiaan et al., 2004).

4. Findings and discussion

The response of maize production in Kenya to the price and non-price incentives are discussed in the following sections

4.1. Maize production response to output and input prices

Table 4.1 presents the estimated coefficients for output and input prices from the estimated response equation.

Table 4.1. Coefficient Estimates of Output and Input Prices

Dependent Variable: Log Maize output		
Independent Variable	Coefficient	t-Statistic
Log maize price	0.0326	0.5313
First lag of Log maize price	0.4286***	13.582
Log agricultural wage	0.2109	2.2061
Log fertilizer price	-0.4350***	-6.8869
Log seed price	0.1073	2.2685

Source: Extracted Estimated output response equation.

The asterisk (***) indicates that the coefficient is significant at 1%

The coefficient for log maize price is statistically insignificant as expected. The output in a current period is not influenced by the price prevailing in the particular period. The biological lags characterising agricultural production prevents changes in output following a price increase not be realised immediately. Output in the current period is usually as a result of decisions made in earlier periods, based on what producers expected prices would be when the output is ready for sale. The expectations are therefore formed in the previous period based on past prices and all other information available at the disposal of producers (Nerlove, 1958; McKay et al., 1999; 1998; Madala, 2001; Muchapondwa, 2008).

Coefficient of the first lag of log maize price is positive and significant, showing that maize production increases with output price, but the response is realised with a lag. From the estimated coefficient, the calculated elasticity value of 0.3649 was obtained which implies that a 10 per cent increase in maize output price, would raise production of the crop by only 3.6 per cent. Thus maize output responds less proportionately to a price increase. However, the elasticity estimate is higher than those reported in earlier studies (Mbithi, 2000; Mose et al., 2007 and Olwande et al., 2009). Farther lag values of log maize price had coefficients that were statistically insignificant. This suggests that expectations formation by maize

producers in Kenya follow an adaptive scheme where producers attach more weight to the most recent prices when forecasting future prices. The finding supports arguments in Nerlove (1958), Madala (2001), McKay et al. (1999) and Mbithi (2000).

Coefficient of the log agricultural wage is statistically insignificant. This could be attributed to the fact that most of the maize growing households depend on family labour for maize production activities. The coefficient of log fertiliser price is negative and statistically significant. The computed elasticity estimate shows that in the long run, other factors held constant, an increase in the average fertiliser price by 10 per cent would reduce maize output by 3.7 per cent. Maize requires heavy intake of nitrogen and phosphorus for a good crop. Continuous cropping heavily depletes soils of these nutrients, so that if replenishment through application of fertilisers is not possible, then yields would fall. The consequence is reduced output. The negative response could therefore be due to lower yields in the crop as a result of reduced use of fertilisers as prices go up. It could also be due to reduced acreages cultivated as profit margins on commercial production narrow down with increased costs of fertilisers. The inelastic response of maize output to fertiliser price is due to low intensity of fertilizers use by large proportion of maize growers in Kenya (Export Processing Zone Authority, 2005, Republic of Kenya, 1997; 2004; 2005; 2009c; Mbithi, 2000).

Coefficient of log seed price is statistically insignificant showing that maize production is not sensitive to changes in average price of purchased seed. The use of purchased seed among small scale producers of maize in Kenya is low due to high costs of hybrid seeds (Republic of Kenya, 2009c). Occasionally, seeds supplied in the market are poor quality counterfeit seeds, as was experienced in the years 1993 and 2002 (Republic of Kenya, 1994; 2003a) and sometimes the seeds are unavailable as was the case in 2000 (Republic of Kenya, 2001). Because of the uncertainties surrounding availability and quality of seeds, some farmers rely on seeds selected and prepared from own production. The use of purchased seed in production of maize therefore remains quite low and hence the lack of any significant response of its output to purchased seed prices.

4.2. Maize output response to non-price incentives

Non-price policy avenues used for increased food production in Kenya include, enhanced research and extension, processing and marketing, access to credit and infrastructure development (Republic of Kenya, 1981; 2004; 2009c; Nyangito and Kimenye, 1995). These are realised through allocation of resources to agricultural development, infrastructural development and the establishment and management of parastatals which are directly involved in marketing of commodities. Macroeconomic stability, institutional and governance reforms have also been considered to provide a favourable environment for economic activities, including investment in food crops production. This study analysed the response of maize production to the non-price and the results are presented in table 4.2.

The coefficient of the log of development expenditure in agriculture is negative and statistically significant while the coefficients of the first, second and third lag values of log development expenditure in agriculture are all positive and significant with those for the second and third lags larger in magnitude than that of the first lag. The results suggest that production of maize increases with increased spending by the central government on agricultural development. The positive and larger lagged responses indicate that investment

in agricultural development take time to increase maize output. This is because investment activities such as research, training of extension staff, and development of irrigation infrastructure, involve heavy initial costs, but take a long time to yield the required outputs. The elasticity estimates computed from the coefficients show that over time, an increase in agricultural development expenditure by 10 per cent would raise maize output by 3.8 per cent. The inelastic response to development expenditure in agriculture implies that allocation of more resources to agricultural development, as stipulated in the Comprehensive African Agricultural Development Programme (CAADP) proposals (Africa Union, 2003) is not on its own sufficient to raise production to levels required to reduce food insecurity in Kenya. The reasons for the inelastic responses must also be addressed.

Table 4.2. Coefficient Estimates for Non-Price Variables

Dependent Variable: Log Maize output		
Independent Variable	Coefficient	t-Statistic
Log development expenditure in agriculture	-0.0622**	-2.5825
First lag of log development expenditure in agriculture	0.0924**	3.0883
Second lag of log development expenditure in agriculture	0.2360***	10.657
Third lag of log development expenditure in agriculture	0.1839***	7.0973
Log development expenditure on roads, transport and communication	0.0380	2.3115
Log maize purchases by marketing boards	0.1300***	6.5812
Log lending rate	-0.1220	-1.7404
Log inflation rate	2.1113***	18.588
First lag of log inflation rate	0.0213	1.9544
Log per capita GDP	2.1678***	14.970
Change in governance 1 D ₁ =1 for 1972 - 1978: 0 otherwise	-22.820***	-9.9090
Change in governance 2 D ₂ =1 for 1979 - 2002: 0 otherwise	-0.3636***	-5.4819
Market liberalization	7.5458***	15.507
Drought (1980, 1984) and Coup attempt (1982): D=1 and 0 otherwise	-0.1253***	-7.0805
Favourable weather (1986, 1994, 2005) availability of cheap fertilizers (1994): D= 1 and 0 otherwise	0.1058***	5.4876

Source: Extracted Estimated output response equation.

The asterisk (***) and (**) indicates that the coefficient is significant at 1% and 5%, respectively

The coefficient of log development expenditure on roads, transport and communication is not statistically significant. This shows that increased government spending on infrastructural development has no significant influence on maize production. This could be because expenditures by the central government for such infrastructure development are mainly used in improving highways connecting major urban centres and not rural infrastructure. The coefficient of the log of maize sales to marketing boards is positive. The derived elasticity estimate shows that a 10 per cent increase in the quantity of maize marketed centrally by

the boards raises maize output by 1.1 per cent. However, the inelastic response shows that maize production in Kenya is not very sensitive to central marketing activities of the National Cereals and Produce board suggesting that many farmers do not utilise such opportunities. The lack of transport services by small scale farmers to enable them deliver their output to buying points and delayed payments has left such opportunities to the advantage of middlemen who purchase produce from farmers at lower prices.

The coefficient for the log of per capita GDP is positive. This implies that in the process of economic growth, maize production increases. The response is elastic showing that maize production increases more than proportionately to economic growth. The finding suggests that maize production increases with increased food demand in the country. The coefficient of log lending rate is statistically insignificant. The lack of response to changes in lending rates implies that producers of maize in Kenya do not rely heavily on bank loans to finance their activities. The coefficient of log of inflation rate is positive and statistically significant. This indicates that over time, persistent increases in the general price level would lead to increased production of maize in Kenya. The computed elasticity estimates show that in the long run, an increase in inflation rate by 1 per cent, other factors held constant, would lead to 1.8 per cent increase in maize production. High inflation reduces the value of money hence a loss of purchasing power. Further, with rising inflation, future prices become less predictable and people increasingly fear that their purchasing power will decline more and their standards of living would fall. To prevent such eventualities, food crops producing households may increase production of important crops in their diet so as to guarantee their nutritional security.

The effect of changes in governance was based on the coefficients of the dummy variables for governance for the specified period in comparison to that for the period 2003-2008. The coefficients of these dummies were interpreted as differences in production in the defined period compared to production in the period 2003-2008, which was used as the reference. The negative coefficients for dummy variables for governance in the period 1972-1978 and that for the period 1979-2002, imply that maize production was on average lower for the two periods than it was in the period 2003-2008. The results seem to confirm the arguments that poor governance in the period 1979-2002 discouraged food producers in Kenya (Nyangito and Okello, 1998; Republic of Kenya, 2003b). The governance reforms initiated by the government as specified in the strategy for economic recovery and employment creation of 2003 and strategy to revitalise agriculture in 2004 seem to have instilled confidence in people on government's commitments towards proper management of the economy.

The coefficient of the dummy variable capturing market liberalisation is positive and statistically significant. This indicates that maize production was on average higher in the liberalisation era than in the period before liberalisation. This finding differs with that of Mbithi (2000) and Olwande et al. (2009) that reported negative effects of liberalisation on maize production in Kenya, and that of Mose et al. (2007) which reported insignificant effect of liberalisation on maize output in trans-Nzoia district in Kenya. The negative effect of liberalisation on maize production reported by Mbithi (2000) and Olwande et al. (2009) as well as lack of response by Mose et al. (2007) could probably be attributed to the short period after liberalisation that the studies covered. Unlike in the earlier studies, this study covered a longer span of time in the liberalisation era, and possibly this enabled it to fully capture the effects of a liberalised grain market.

The findings suggest that over time, a liberalised grain market creates a better environment for increased production than a heavily controlled one.

Production of maize was also shown to respond to shocks associated with some unusual occurrences as those experienced in Kenya in certain years. The unusual occurrences that favoured production of the crops the very favourable weather in years 1975, 1977, 1978, 1986, 1994, 2001, 2005 and 2006; advent of gradual liberalisation of cereal markets in 1988 and full liberalisation in 1993, which allowed maize sales across district borders, and availability of cheap fertilisers in 1994. Those that had adverse effects on production were the severe droughts of 1980 and 1984, the coup *d'état* attempt of 1982, declines in seasonal credit in 1987 and the ethnic clashes of 1992.

5. Summary, conclusions and policy implications

This study was carried out to investigate the response of maize production to both price and various non-price incentives with a view to determine the relative influence of each on the crop's production. The findings show that maize production respond positively to its output price, development expenditures in agriculture, maize sales to marketing boards,, inflation, growth in per capita GDP, liberalisation, governance reforms of 2003-2008, favourable weather and availability of cheap fertilisers. Output of the crop respond negatively to increase in average fertiliser price, unfavourable weather, shocks of the failed coup *d'état* attempt of 1982.

The elasticity estimates show inelastic responses to maize output price, fertiliser price, development expenditure in agriculture, and maize purchases by marketing board while responses to inflation and real per capita GDP are elastic. Output of the crop is not responsive to changes in development expenditure on roads, transport and communication and the lending rate. The inelastic response for most of the variables show that a comprehensive policy combining both price and non-price incentives is required to raise maize production in Kenya. Further the elastic responses to macroeconomic variables show that a volatile macroeconomic environment would be devastative to food production in the country.

To encourage increased production of maize, the government should put in place strategies that keep fertiliser prices low such as subsidising the input whenever possible, provision of information on cheap sources of fertilisers and waiving import duties on fertiliser imports. The Ministry of Agriculture should ensure that the extension services offered to small scale producers are effective and adequate to enable increased use of improved farming technologies. Operations of the National Cereals and Produce Board should be re-evaluated and redefined so that the benefits of centralised marketing of maize accrue to majority of small scale producers. The government should ensure that more resources on infrastructure development are directed to improving rural infrastructure. Effective macroeconomic management leading to economic growth with low inflation and lending interest rates should be pursued to create a favourable environment for production of the crop. Governance reforms that keep producers optimistic on commitments by the government, such as those seen immediately following the take-over of power by the government of 2003-2008 from that of 1979-2002, must continually be pursued. Public institutions must be seen to be professionally run, and service delivery to farmers improved.

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