

POLICY BRIEF

TEGEMEO INSTITUTE FOR AGRICULTURAL DEVELOPMENT AND POLICY

No 6 Downloadable at: <http://www.tegemo.org>

July 2005

Technical Efficiency in Kenya's Maize Production:
The Stochastic Frontier Approach

Betty Kibaara

**TEGEMEO INSTITUTE FOR AGRICULTURAL
POLICY AND DEVELOPMENT**
July 2005

Technical Efficiency in Kenya's Maize Production:
The Stochastic Frontier Approach

Betty Kibaara

Background

Maize is a very important staple food in Kenya and accounts for about 40 percent of daily calories. Maize has per capita consumption of 98 kilograms, which translates to, between 30 and 34 million bags of annual maize consumption. Over the last 10 years, domestic production has stagnated to between 24 and 28 million bags. The quantity of imported maize has increased from 2.9 percent between 1970 and 1991 to an average of 12 percent in the last 10 years. However, the percentage of imports is highly underestimated because there is massive unreported cross-border maize trade from Uganda and Tanzania.

Maize yields have declined from 1.85 metric tonnes per hectare in the period 1985-89 to the current yield of 1.57 metric tonnes per hectare. Compared to other neighboring countries such as Tanzania, Uganda and South Africa, Kenya is the only country that has had declining yield in that past 10 years. Shortage of maize in Kenya results in famine among the poor urban and rural households. Since most of the arable land is under cultivation future increase in maize production will heavily depend on yield improvement rather than expansion in area under production.

Some of the reasons for the dwindling performance in maize production have been: poor access to credit, inadequate use of recommended technologies and high costs of inputs. In addition, lack of agricultural extension services, poor flow of information from the research stations to farmers and imitations in the development of infrastructure, have further contributed to this poor show. Low prices from the maize market reforms resulting in lower input use, a general decline in performance of the economy, high level of technical and allocative

inefficiency, all have been cited as causes of the abysmal performance. One way of reducing the cost of production is to increase farm output by increasing technical efficiency. In this regard, it is necessary to quantify current levels of technical efficiency to estimate losses in production, which could be attributed to inefficiency due to differences in socio-economic characteristics and management practices.

Objectives, Data and Methodology

The main objective is to determine levels of technical efficiency among the maize producing farms in Kenya. Secondly, we identify some socio-economic characteristics and management practices which influence technical efficiency in maize production. These include: access to credit, years of school, age of the household head, off-farm income, gender of the household head, quality of maize seed, and use of machines. The quality of maize seed is a proxy for good management practice. Thirdly, the level of responsiveness of yield to the main factors of production namely, seed, labor and fertilizer is estimated. Finally, the study suggests appropriate policies given the empirical results. The study uses a subset of the data from the rural household survey for the 2003/2004 main harvest-cropping seasons from the 24 districts in Kenya. The study applies the recent developments in the Stochastic Frontier Modeling.

Technical efficiency of an individual farm is defined in terms of the ratio of the observed output to the corresponding frontier output, conditioned on the level of inputs used by the farm.

Results

Maize yield is responsive to levels of input use. From this study, an additional kilogram of fertilizer increases maize yield by 2.7 kilograms. Increase of seed by one kilogram increases maize yield by 52 kilograms. On the other hand, an increase in one person-day improves maize yield by 5.4 kilograms.

Low responsiveness of yield to fertilizer was unexpected. This could probably be explained partly by the tendency by some maize farmers in the tea-growing region to use tea fertilizer (such as NPK) on maize. Such fertilizer does not benefit maize plants since the nutritional requirement is different. In addition, incorrect timing of the top-dressing fertilizer may reduce the effectiveness of the applied fertilizer. Use of top-dressing fertilizer as a basal fertilizer may be another problem.

From this study, labor is used optimally due to its abundance. On the other hand, fertilizer is not used optimally due to budgetary constraints experienced by the producers. It is important to note that labor use by the least efficient producers is greater than that of the most efficient producers, an indication of input substitution among the least technically efficient producers. Further analysis shows that there is insignificant difference in the size of the households among the clusters. However, the inefficient cluster source 72 percent of labor from family as compared to the most efficient group that uses only 39 percent of total labor from family. Family labor is therefore cheaper than fertilizer. Another explanation could be due to low access to credit.

The minimum estimated efficiency is 8.04% percent, the maximum 98.30 percent and the mean is 49 percent with a standard deviation of 19.71 percent. This is interpreted as follows: in the short run: there is a scope for increasing maize production by 51 percent by adopting technologies and techniques used by the best practice maize farms. This suggests that, on average; about 51.30 percent of maize yield is lost due to inefficiency. However, each region has a different estimated mean technical efficiency., Disaggregating data by region reveals that there exists-regional variations in technical efficiency. The high potential regions have the highest technical efficiency of 64 %, the medium potential has a mean of 45% while the low potential regions have the lowest mean of 37%. However, a few producers in the high potential maize zones are also classified among the least technically efficient cluster. Moreover, input use of the least efficient producers in the high potential region is relatively

higher than their counterparts in the same cluster in the medium and low regions.

Table 1.0 Range of Technical Efficiency by Region

Range of TE in Percent	Low ^a	Medium ^b	High ^c	Total
Less than 20	13.1	7.2	1.7	7.2
20 - 39	45.9	32.3	9.3	29.3
40 - 59	31.0	39.4	27.1	33.5
60 - 79	10.0	20.1	39.3	23.0
80 - 98.3		1.0	22.5	7.0
Total	100	100	100.0	100

Source: Tegemeo Institute, Kenya, 2004 rural household survey

^a Low potential refers to coastal lowlands, Eastern lowlands, Western Lowlands, Marginal rain shadow

^b Medium potential refers to the Central Highlands, Western Transition, Western Highlands

^c High potential region

The potential yields are approximated using the estimated farm specific technical efficiency. The high potential region has an actual mean of 13.32 bags per acre. Furthermore, there exists a mean potential yield of 25 bags. On the other hand, the mean actual yield for the medium potential is 7.38 bags per acre. If the productive inefficiencies were reduced, then the most efficient producers could achieve a yield of 19 bags. Finally, the low potential region has the lowest mean yield of four bags, although there exist a potential of 10 bags per acre.

Why the differences in farm specific technical efficiency?

The above can be explained partly by use of inputs. The most-efficient producers with technical efficiency of 80 to 98 % produce 21 bags, by using a combination of inputs: 65 kg fertilizer; 9.63kgs of seed; 61 person-days. While the least technically efficient producers, with less than 20% technical efficiency, use 23 kg of fertilizer; 10 kg of seed and 68 person-days and obtain 1.5 bags of output. Since most maize producers use the recommended seed rate, inefficiency could be because of the quality of seed rather than the seed rate.

In addition, results show that the mono-cropped maize fields have higher technical efficiency than the intercropped fields. For example, in the high potential regions, producers who practice mono-cropping system attain 74% technical efficiency as compared to those who intercrop, 64%.

Differences in technical efficiency can also be explained by selected socio-economic characteristics and management practices. Technical efficiency is increased by use of hybrid, tractors, presence of a male-head in household, young farmers (less than 50 years), credit, the number of years in formal school, (although the increase with the years of school is not linear but quadratic). Thus, technical efficiency begins to reduce after five years of school. In addition, producers in the high potential regions have high technical efficiency. Technical efficiency decreases by participation of the household in off-farm income earning activities and illness of the household head.

The following section discusses the marginal effects for the proposed variables determining inefficiency.

Table 2.0 Marginal Effects of the Efficiency Measuring Variables

Variable	Change in TE in %	Change in bags per acre
Purchased hybrid***	36.32	6.14
Tractor use***	26.12	4.41
School years*	0.84	0.14
School years squared***	-0.17	-0.03
Male- headed household	9.18	1.55
Ill head	-8.47	-1.43
Age	0.05	0.01
Off-farm income	-1.45	-0.24

Source: Tegemeo Institute, Kenya, 2004 rural household survey

Use of hybrid maize increases TE by 36% (6.4bags), use of tractors increase TE by 26% (4.4 bags), an additional year of school increase TE by 0.84% (0.14bags) but quadratically reduces TE by 0.17% after 5 years of school. Male-headed households are 9.18% (1.55 bags) more TE than the female-headed households. Illness of the household

head reduces TE by 8.47% (1.4 bags). In addition, younger producers are 0.05% technically more efficient than the older producers. Finally, participation in off-farm income reduces TE by 1.45%.

Recommendations

Results have shown that fertilizer is not used optimally. To ensure increase use of recommended inputs, the amount of money allocated to credit through AFC should be increased from 0.003 % (Ksh 1.5 billion) to at least Ksh 60 billion. In addition, the government should promote the mushrooming microfinance institutions and village banks by streamlining the policy under which they work.

As seen in this study, formal education increases technical efficiency. The government should ensure sustainability of the newly implemented policy on free elementary education. Currently, there is a political will; budget allocation to education is 19% of the total budget. However, since the benefits of education are not instantaneous, in the short run, non-formal agricultural education is needed.

The male-headed households are technically more efficient than the female-headed households are. Agricultural training programs should target women who handle 80% of the work even though they are allocated only 5% of the resources through extension.