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Abstract (223 words)

Maize is the staple food for most Kenyan households, and grown in almost all the farming systems. Due to diminishing farm sizes in Kakamega District, crop productivity and the efficiency of farming systems are of great concern. This paper aims to provide empirical evidence on the links between efficiency in maize production and access to soil-related agricultural information services. Using cluster sampling, a total of 154 farmers in Kakamega District were interviewed. A 2–step estimation technique (Data Envelopment Analysis (DEA) and Tobit model) were used to evaluate the technical efficiencies among the farmers and the factors explaining the estimated efficiency scores. Data was disaggregated into farmers with and those without access to soil-related agricultural information services. The results shows that farmers with access to soil-related agricultural information services were more technically efficient (average technical efficiency of 90%) in maize production compared to those without access to information (technical efficiency at 70%). Given the significant role that access to soil-related agricultural information services play on technical efficiency in maize production in the study area, the paper recommends improvements in farmers access to this important resources through: (i) the strengthening of the formal and informal agricultural extension services, (ii) a stronger linkage among agricultural research, agricultural extension, and farm level activities; and (iii) policy support for increased distribution of soil management inputs.

Key words: Maize; Soil information; Technical efficiency; Tobit analysis; DEA.

Introduction

Many researchers and policymakers have focused on the impact of adoption of new technologies in increasing farm productivity and income (Hayami and Ruttan, 1985). However, during the last two decades, major technological gains stemming from the green revolution seem to have been largely exhausted across the developing world. This suggests that attention to productivity gains arising from a more efficient use of existing technology is justified (Bravo-Ureta and Pinheiro, 1997). Inefficiency in production means that output can be increased without additional conventional inputs and new technology. Therefore, empirical measures are necessary to determine the gains that could be obtained by improving efficiency in agricultural production with a given technology. An important policy implication stemming from significant levels of inefficiency is that it might be cost effective to achieve short-run increases in farm output, and thus income, by concentrating on improving efficiency rather than on the introduction of new technologies (Shapiro and Müller, 1977).

Increasing per capita food production, productivity and raising rural incomes are key challenges facing small-scale farmers in *Kakamega* district, western Kenya. Here, over fifty percent of the population lives below the poverty line[2] and are food insecure (CBS, 2001, World Bank, 2000). Recent studies show that soil nutrient mining is widespread in western Kenya, resulting into land degradation and low crop productivity. For example, Smaling *et al*. (1993) reported average annual net soil nutrient mining of 42 kg N ha^{-1} $year^{-1}$, 3 kg P ha^{-1} $year^{-1}$, and 29 kg K ha^{-1} $year^{-1}$ from the soils in *Kakamega* district. In fact, soil fertility depletion has been identified as a major cause of the chronic food insecurity among the households in Kakamega district (Ojiem, 2006).

[2] According to the World Bank, (2000), definition spending less than one USA dollar per person per day is considered to be below poverty line.

This situation undermines the ability of many agrarian households to produce enough food for household subsistence (FAO, 2004, Smaling et al., 1993, Tittonell et al., 2005).One way of solving the problem of food shortage among farmers is to increase their agricultural productivity and efficiency of their agricultural production systems, especially given their limited access to arable lands. To attain this objective, provision of soil-related information services to the farmers such as application of inorganic fertilizers, organic manure, soil and water management and the use of improved commercial seeds, with the overall aim of addressing the rampant problems of soil and land degradation is imperative.

This study examines the effect of access to soil-related agricultural information services on maize productivity and the technical efficiency of the farming systems of Kakamega district. Soil-related agricultural information services in Kenya is done by agricultural extension service agents. This relationship links the soil-related information services to the agriculture extension services, making it necessary to describe the evolution of extension services in Kenya. The following section describes evolution of extension services in Kenya.

Evolution of extension services in Kenya

In Kenya, agricultural extension has evolved in tandem with the changing theories of development. Early extension models followed a 'cookbook' approach to new technology through state–provided extension services (McMillan et al., 2001). Until 1965, technologies were developed and run through extension pipeline to farmers, with agricultural development being the desired product. This was a top-down approach, where information originated from the Ministry of Agriculture and filtered down to farmers through extension agents. The system was not accountable to farmers. Hence, farmers were not involved in development of the disseminated technologies. Research and extension systems were focused mainly on large-scale farms or smallholders in high and medium potential areas. Trials and demonstrations were mostly undertaken on research stations (Davis and Place, 2003).

In order to reinforce technology transfer, the government had to put in place new models, focusing on the needs of small-scale and resource-poor farmers. This led to the introduction of the farming systems approach. The Farming Systems Research and Extension (FSR/E) model was operational between 1965 and 1980, as a response to the concern for small-scale farmers, including those in marginal areas. This approach was characterized by participation at farm level through farmer input in on-farm trials, and by interdisciplinary linkages and a systems approach to agricultural extension services delivery (Collinson, 2000). The distinctive feature of the FSR/E model was its three-way linkage between farmers, researchers, and extension service providers.

The most notable success of the above-mentioned two pioneer agricultural extension models was in the dissemination of hybrid maize technology in the late 1960s and the early 1970s. However, these extension models had some deficiencies. They comprised of a mix of *ad hoc* project components and lacked a consistent national strategy. Overall, these arrangements were expensive and ineffective (Gautam, 1999). Additionally, despite a well-established line of command down to the frontline extension worker and staff numbers presumed to be adequate at the time, the agricultural extension services were judged to be performing below its potential (Gautam, 1999). In addition, although women made up almost one-third of the farmers, and most farmers (81 %) were smallholders, extension efforts largely focused on men and large farm-owners.

In response to the above mentioned deficiencies, the World Bank (WB) and the Government of Kenya (GoK) initiated the Training and Visit (T&V) agricultural extension system in 1982. This system had been used successfully in Turkey and India. Kenya was the first African country in which this model was applied (Farrington, 1998). T&V was funded by the WB in two phases, under the National Extension Program (NEP) I and NEP II.

The objective of NEP I and II was to develop institutional arrangements that would facilitate delivery of agricultural extension services to smallholder farmers efficiently and effectively; through development of a cadre of well-informed, village-level extension workers who would visit farmers frequently and regularly. The role of the workers was to provide relevant technical messages, and bring farmers' problems to the attention of researchers. The extension staff was in-turn to receive regular training, with much improved research extension linkages. The T&V model expanded to cover about 90 % of the arable land in Kenya and used contact farmers to multiply their effects. The T&V model suffered because of poor project implementation arrangements, weak management and inadequate budgetary allocation, leading to persistence of problems experienced with earlier extension models. These inherent weaknesses of NEP I & II led to formulation of National Agriculture and Livestock Extension Program (NALEP) by the Ministry of Agriculture, Livestock Development and Marketing (MoALD&M) and Swedish international Development Cooperation Agency (SIDA). The positive aspects of NALEP were their wide coverage, strong staff training giving a strong frontline extension worker force, coupled with professionalism developed at the district-office level.

NALEP as a policy framework was designed to assist the implementation of the National Agricultural Extension Policy (NAEP). NAEP was prepared to bring on board both public and private service providers, as a way of finding means of addressing the complex, systematic issues that faces rural communities. This shift had been agitated by the recognition of the socio-economic and agroecological conditions of resource poor farmers as being complex, diverse and risk prone (Farrington, 1998). This strategy based on the Agriculture Sector Investment Programme (ASIP) concept, has been aimed at generating sustainable development in the agricultural sector through a more integrated and holistic approach (Kenya, 2001b). The NALEP is built on a partnership concept that entails deliberate investments and participation of various stakeholders in the agricultural sector. For example, beneficiary communities develop Community Action Plans (CAP), Farm Specific Action Plans (FSAP), and also participate in extension improvement through Participatory Rural Appraisals (PRA) and Participatory Monitoring and Evaluation (PME). It also endeavors to make extension demand driven, increase efficiency in extension service provision, putting in place alternative funding apart from the exchequer, promoting gender issues and curbing environmental degradation.

To be able to achieve this, NALEP has been organised around three core functions, i.e., (i) research; (ii) extension; and (iii) advocacy. Advocacy was to add value to the two other core functions by way of creating demand on the part of farmers for specific kinds of support, rather than technical and extension support for its own sake. The re-organization of agricultural extension services in Kenya provides an example of decentralization in a difficult context, partly due to lack of a comprehensive institutional framework to guide the process as well as the content. The extension system which encompasses soil-related information services has evolved to include four broad forms of delivery systems, based on modes of delivery and funding (Anderson and Van Crowder, 2000):

(i) **Public delivery and public finance**: Comprises the traditional government agricultural extension services consisting of the research station-extension agents-farmer linkages. This channel is constrained by lack of funds and the growing inability of the state extension services to effectively provide services to farmers.

(ii) **Public delivery and private finance**: This is a form where government staff can be contracted by private agencies.

(iii) **Private delivery and private finance**: This is a private extension with little or no government participation, such as commodity out-grower schemes, or delivery through producer associations. It's predominantly linked to commercialized firms and hence does not serve the low-income producers, though it may benefit the poor as consumers and labourers. Other examples of this delivery system include the Agrovet shops.

(iv) **Private delivery and public finance**: This approach is an essential element of reforming the extension services. It entails outsourcing the responsibility for extension delivery to private sector providers, e.g., Non Governmental Organizations (NGOs) and Community Based Organizations (CBOs). This channel has emerged as an important pathway, with several comparative advantages over the other channels, including grassroots contacts and use of participatory methods. International donors did not initially recognize and fund NGOs nor include them in development and research processes (Hangrave, 1999). However, following the structural adjustment programs of the 1980s and 1990s, donors became interested in NGOs since they were private entities. This shift in development thinking strengthened the move towards decentralization and privatization, resulting in more attention being given to NGOs, who now play a major role in delivery of extension services in Kenya.

All the four forms of extension delivery channels exist today in Kenya, sometimes all in a single geographic area, and interact in a variety of ways with other economic and institutional factors to influence households' decisions, output and welfare. Since soil-related information service is passed on through the above mentioned extension delivery services, it was necessary for this study to undertake an overview of the same delivery systems. This study examines the effect of access to soil-related agricultural information services on crop (maize) productivity and the technical efficiency of the farming systems of Kakamega district.

Methodology

Study area

Kakamega district is located in western Kenya. The area is classified as moist mid-altitude zone (MM) (Lynam and Hassan, 1998). The MM zone forms a belt around Lake Victoria, from its shores at an altitude of 1110 meters, up to an altitude of about 1500 meters above sea level. The district is largely comprised of the Lower Highland (LH), Upper Highland (UH), Lower Midland (LM) and Upper Midland (UM) agro-ecological zones (AEZ). The tea-growing areas are in the Southern part of the district classified as Lower Highland (LH) and the sugarcane growing areas in the North of the district mainly belong to the Lower Midlands (LM) (Jaetzold and Schimdt, 1982). However, maize is grown in the whole district. The soils are mainly ferralo-orthic Acrisols in the northern of the district and ferralo-chromic/orthic Acrisols in the southern part of the district. Other minor soil types in the area are Nitisols, Cambosols, and Planosols. Crop production in Kakamega district is constrained by soil N, P and K deficiencies (Lijzenga, 1998).

The annual average rainfall in Kakamega ranges between 700mm and 1800 mm, and is received in a bimodal pattern. While the first rainy season starts in February/March each year, the second rainy season commences in August/September. At lower elevation, rainfall is lower and the second rainy season is less reliable for crop production than the first longer rainfall season. Most farmers have two maize crops per year, stipulated by the bimodal rainfall.

Data sampling and collection

Farmers were selected through cluster sampling. The Kenya Central Bureau of Statistics (CBS) provided the Kenya's fourth National Sample Survey and Evaluation Programme (NASSEP IV) document; that was used as a master sampling frame designed to guide household surveys in Kenya (including *Kakamega* district). The sampling frame was developed from the most recent national population and housing census in 1999. The frame is usually updated after every ten years. In the districts, the population is stratified into subunits referred to as divisions, locations, sub-locations, clusters and household units. In Kakamega District, NASSEP IV covers 26 clusters of a size between 48 and 168 households containing a total of 2,687 households. With very few (urban) exceptions, the clusters are found in different rural sub-locations. The clusters are chosen to represent the typical livelihood zones of the district.

This study used a two-stage sampling design which is also employed by CBS for the national household survey. The number of sampled households from each stratum was proportional to the population share of that stratum (based on census information). Hence, sampling was proportional to size, leading to a self-weighting study sample. A total of 154 farm households were interviewed using a structured questionnaire, designed to collect information on quantities and costs of inputs (e.g., seed, labour), quantities and prices of outputs (e.g., maize), and other variables postulated to affect efficiency (e.g., gender, household size, main occupation of household head, agricultural training, farming experience, educational level of household head, etc.). The variables used in the first stage of the analysis to determine technical efficiency were: maize produced (as output variable) and land acreage, labour (family and hired) in man-days, fertilizer applied, and seeds (as input variables). Table 1 illustrates the output and input quantities per acre from the surveyed households. Data on farm-specific variables that were postulated to affect efficiency were also collected e.g; gender, household size, main occupation of the household head, agricultural training, farming experience, and education of the household head.

[Table 1]

The theoretical and empirical framework

According to the traditional theory of production economics, productive efficiency derives from technical as well as allocative efficiency. Whereas technical efficiency reflects the ability of the production unit to maximize its output for a given set of inputs (output-orientation) (Atkinson and Cornwell, 1994)

the level of technical inefficiency of a particular farmer is measured by the deviation of the observed farmer's output from the value of some potential or frontier production representing the maximum possible output that the farmer can achieve using the same level of inputs and production technology (Battese, 1992, Green, 1997). Battese (1992) further defines technical inefficiency of a firm as the factor by which the level of production is less than its frontier output and gives. Allocative efficiency reflects the ability of a firm or farm to utilize the available inputs in optimal proportions given their relative prices as well as the underlying production technology. Economic (or cost) efficiency is reached as the production unit is both allocatively as well as technically efficient and, is located at the tangency of the isoquant(s) and the isocost line(s) (Chambers, 1993).

Different approaches to measure efficiency have been proposed and applied (Charnes et al., 1994). Broadly, three quantitative approaches were developed to measure production efficiency: The parametric (deterministic and stochastic), the non-parametric [based on Data Envelopment Analysis (DEA)], and the productivity indices approach (based on growth accounting and index theory principles) (Coelli et al., 1998). Stochastic Frontier Analysis (SFA) and DEA are commonly used (Banker et al., 1984). Both methods estimate the efficient frontier and the firm's technical efficiency.

DEA uses linear programming methods to construct a non-parametric piece-wise frontier over the data (see Figure. 1). Individual efficiency measures are calculated relative to this frontier.

[Figure1]

The efficient frontier shows the best performance observed among the firms. An advantage of the DEA method is that multiple inputs and outputs can be considered simultaneously, and inputs and outputs can be quantified using different units of measurement. Charnes et al. (1978) proposed a model with an input orientation by assuming constant returns to scale (CRS) while Banker et al. (1984) considered a variable returns-to-scale (VRS) model.

Whereas farmer C in Figure 1 is technically and scale efficient, farmer G is technically and scale inefficient. At point G'', the farmer would be on the CRS frontier but inefficient with respect to the scale of operations. At point G', the farmer would be on the VRS-frontier as well as scale efficient. The general linear optimization problem which has to be solved (here as the envelopment form) can be derived by using duality in linear programming:

$$Min_{\theta,\lambda}\theta$$

$$\text{Subject to} \quad \begin{aligned} & -y_i + Y\lambda \geq 0, \\ & \theta x_i - X\lambda \geq 0, \\ & N1'\lambda = 1 \\ & \lambda \geq 0 \end{aligned} \qquad (1)$$

where y_i and x_i denote output and input of the $_i$th production unit and Y as well as X are the corresponding vectors. θ is a scalar and λ is a $Nx1$ vector of constants. The value of θ

obtained will be the efficiency score for the i^{th} firm and will satisfy $\theta \leq 1$ with a value of 1 indicating a point on the frontier, hence, a technically efficient firm.

The linear programming problem in (1) must be solved N times, once for each firm in the sample and a value of θ is finally obtained for each firm. $N1'\lambda = 1$ is the constraint assuring the formation of a concave hull of intersecting planes enveloping the data points more tightly than the CRS conical hull.

This paper focuses on the technical efficiency among maize producing farmers. The variables used in the first stage of the analysis to determine technical efficiency were: maize produced (as output variable) and land acreage, labour (family and hired) in man-days, fertilizer applied, and seeds (as input variables).

Tobit model

The use of a second stage regression model of determining the farm specific attributes in explaining inefficiency was suggested in a number of studies (Sharma et al., 1999, Dunghana et al., 2004). An alternative approach is to incorporate farm specific attributes directly into the stochastic frontier efficiency model (Battese et al., 2004). The strengths and weaknesses of both approaches were provided (Dunghana et al., 2004). This study used the second stage regression analysis to model farm specific attributes in explaining inefficiency in maize production.

The factors influencing technical efficiency of maize production were determined using standard Tobit[3] model among the households that received soil-related agricultural information services and those without the services. Tobit is a censored normal regression model that maximizes a two-part log-likelihood function (Tobin, 1958, Greene, 1997).

3 A full mathematical treatment of the Tobit model is not included as its usage is common in applied economics research. Thorough treatments of the model may be found in Greene (1997, pp 896 - 951)

Assume the theoretical Tobit model:

$$y_i = \begin{cases} y_i^* = \beta x_i + \varepsilon_i & if \quad y_i^* > 0 \\ 0 & if \quad y_i^* \leq 0 \end{cases} \tag{2}$$

The y^* is observed if $y_i^* > 0$ and is not observed if $y_i^* \leq 0$. The observed y_i^* is the latent dependent variable for the technical efficiency of the ith farm. x_i are the vector of independent variables which have been postulated to affect efficiency and include: demographic, socio-economic characteristics and farming systems of the household. The β consists of $\beta_{0,}\beta_{1,}\beta_2,.........\beta_n$; are the unknown parameter vectors associated with the independent variables for the ith farm. ε_i is the error term assumed to be normally distributed with zero mean and constant variance δ^2.

The factors affecting the technical efficiency of maize production can be presented thus:

$$y_i = \beta_0 + \beta_1 x + \beta_2 x + \beta_3 x + \beta_4 x + \beta_5 x + \beta_6 x + \beta_7 x + \beta_8 x + \varepsilon_i \tag{3}$$

β_0 is a general constant intercept. The three groups of variables (β's) are generally investigated in studies concerning the determinants of technical efficiency at the farm level. These are characteristics of the farm and the technology employed, location and environmental variables characterizing the conditions for farming, and human capital variables. Farm characteristics include farm size (β_1) although there is little agreement on how to measure the economic farm size (Lund and Price, 1998). Various measures (output, sales, inputs and incomes) have been used in various contexts. Standard man-days and standard gross margin (or income above variable costs) have also been applied. Much emphasis has been placed on the characteristics of on-farm human capital (years of education in this study) (β_2) of the household head. Munroe

(2001) also included education and the share of women in the household. The effect of the principal farmer's age (β_3) on efficiency has been extensively studied, but the conclusions are not consistent. In some studies age was considered as a proxy for farming experience and was found to have a positive relation with technical efficiency in samples of Hungarian and Polish crop farms, but a negative effect in Bulgarian crop farms and Hungarian dairy farms (Munroe, 2001).

The household size (β_4) and gender of household head (β_5) were specific household characteristics variables considered. Occupation of the household head was also considered. Studies showed that full-time farmers in Slovenia were more technically efficient than part-time farmers (Brümmer, 2001).

Variables, like gender, age of the household head and size of household cannot be considered for policy changes, since they are either fixed or take long periods of time to change. But, their inclusion is important because it shows their relationship with efficiency measures. The location and environmental variables were not considered in this particular study since it took place in one district only.

Respondents who had received soil related agricultural information services were presented with four choices of extension and information delivery systems that covered all possible sources to rank them on the basis of quality (using the likelihood of receiving advice from trained personnel as a proxy) and affordability. The four choices were: (i) **Public service**, which included services provided by government extension agents or research institutions; (ii) **Private service providers**, made up of agrovets and privately employed animal health assistants (AHAs); (iii) **Community-Based Organizations (CBOs)**, Non Governmental Organizations (NGOs) and other nonprofit agencies; and (iv) **Media**, which comprised any information source from newspapers, pamphlets, radio, or television.

Result and discussion

Almost 80% of the household visited did not access soil related agricultural information in the previous two years. The fact that only 20% of the respondents received soil-related agricultural information indicates that access to the information is skewed. The limited number of farmers accessing the services shows that the current soil-related information services and extension services in general has a limited scope of coverage. The households that accessed soil related agricultural information mainly got it from the government agricultural extension agents.

Delivery channels

Public delivery channels were the most affordable since they are provided at no cost to the client and also ranked first for quality (Table 2). This suggests that government extension agents are highly regarded by farmers and are more likely to be sought out for advice; and that such advice, once given, is relatively more likely to be adopted. Delivery of extension by CBOs and other similar organizations was surprisingly perceived to be of the lowest quality among the four channels. Given that such organizations also offer fairly affordable services, and that they are at the forefront of efforts to emphasize demand-driven extension services, expression of limited confidence is puzzling and raises interesting questions for further investigation.

[Table 2]

Technical efficiency (based on Non parametric efficiency scores)

The input oriented technical efficiency in the sample ranges from 1% to 100% (Constant Returns to Scale (CRS)) and from 29% to 100% (Variable Returns to Scale (VRS)). Households that had access to soil related agricultural information were more technically efficient in maize production with average of 90% (for the VRS model) and 41% CRS model. Hence they needed to reduce their physical input usage by only 10%. The analysis shows an average technical efficiency of about 35% (CRS model) and 70% (VRS model) for households without access to soil-related agricultural information services. Such households could decrease their physical input usage by 30% (and still obtain the same output level) (Table 3).

The ANOVA test was used to show any significant statistical differences in the technical efficiency estimates for the farm household groups that had access to and no access to soil-related agricultural information services. Based on these tests, the null hypothesis that the efficiency scores between the groups are not significantly different at the 1% probability level was rejected. The results show significant ($p=<0.01$) difference in technical efficiency between the groups with access to and without access to soil-related agricultural information services. Though the two groups are operating using the same technology; access to soil-related agricultural information services greatly affects their technical efficiencies and hence productivity.

[Table 3]

Factors affecting technical efficiency

Factors affecting the technical efficiency are summarized in Table 4. Age of the household head significantly ($P<0.1$) and negatively affected the technical efficiency in maize production among the group that had access to soil-related agricultural information services. Women with access to soil-related agricultural information services were more efficient as compared to the men in the same group. However, the gender factor was not significant among the households who did not access information. Household size was significant ($p=<0.01$) and negatively correlated with technical efficiency among those without access to soil-related information services. Larger households had the potential of providing cheaper farm labour. However, income that would have been used to purchase other farming inputs like seed and mineral fertilizer was allocated to other activities such as consumption; hence the negative effect on technical efficiency. In addition more man-days were provided per unit hence leading to technical inefficiency.

[Table 4]

Access to credit though significant among the group that accessed soil-related agricultural services; it had a negative effect on maize production technical efficiency in the whole sample. This can be explained by the fact that credit was accessed from either tea or sugarcane industries. Both crops competed for land with maize and the credit was only used for either the particular cash crop or diverted to cater for other household needs and consumption.

Conclusion and recommendations

Maize production was more technically efficient among farmers with access to soil-related agricultural information services than the group without access to the same information. Soil related information has been identified as a factor that has a positive impact on the technical efficiency among maize farmers. This is, therefore, a challenge to the extension agents to organize farmer training sessions and field schools to inform farmers about modern farming methods with an emphasis on soil management information.

The study results show that government agents are the preferred provider of agricultural information. They were considered as the most affordable and accurate source of information. Nonetheless, with the limited government funding, only 20% of the surveyed households had received any soil related agricultural information. Therefore, other modes of extension delivery are necessary to complement government efforts and fill the vacuum in accessing the extension services.

The findings show the importance of creating a well coordinated mechanism and delivery systems that allows key stakeholders in agriculture information extension to maximize their efforts by collaboration. These efforts will improve the technical efficiency of the farmers thus ensuring food security and surplus for the market. Given the significant role that access to soil-related agricultural information services can play on small-scale farmers' technical efficiency in maize production in the study area and similar environments, the paper recommends improvements in farmers access to this important resources through: (i) the strengthening of the formal and informal agricultural extension services, including those provided by NGOs and CBOs; (ii) a stronger linkage among agricultural research, agricultural extension, and farm level activities; and (iii) policy support for increased distribution of soil management practices, among others.

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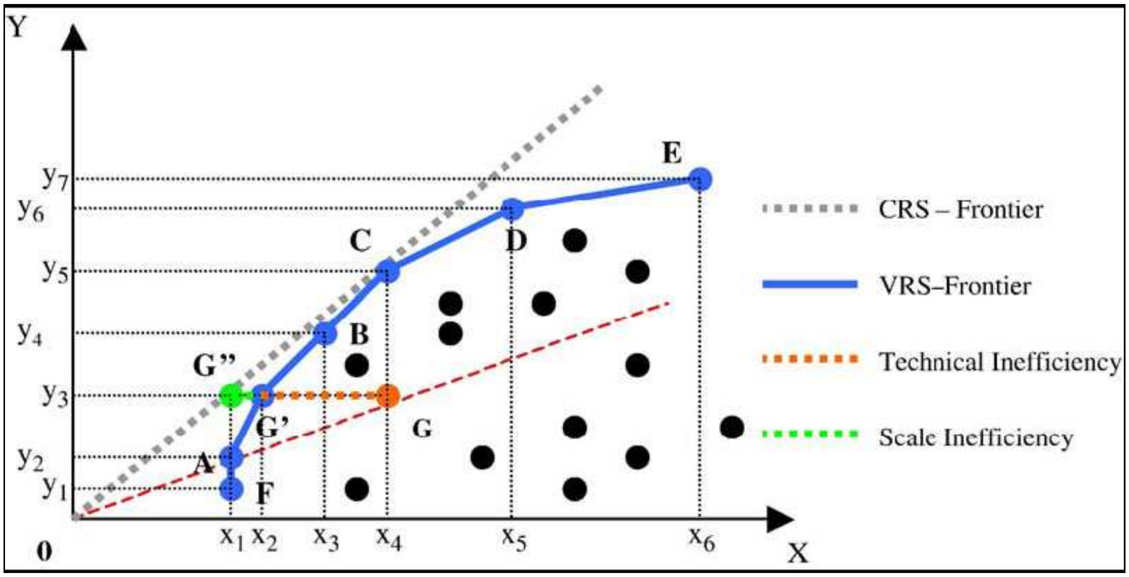

Figure 1: DEA VRS-production frontier: adopted from Sauer and Abdallah (2005)

Table 1: Maize output and input quantities per acre in Kakamega district, 2007 (n = 154)

	Min.	Max.	Mean	Std. Deviation
Maize output per acres kg/acre	30.00	4000.00	731.22	666.78
Seed value per acre in KES	16.67	4800.00	832.14	694.84
Total labor per acre (man days)	0.40	200.00	8.09	18.69
Area of maize (acres)	0.01	6.00	.84	0.98

Source: Authors compilation from survey, 2007

Table 2: Ranking of agricultural information delivery channels in Kakamega, 2007

Soil-related service delivery channel	Ranking by respondents	
	Quality	Affordability
Public service	1 (66)	1 (64)
Private service providers	2 (17)	3 (11)
Community based organization	4 (2)	2 (18)
Media	3 (15)	4 (7)

(Figures in parenthesis is % of respondents who ranked the delivery system in the position)

Source: Authors compilation

Table 3: Summary of Technical Efficiency (TE) scores for the two farmers categories

Farmer category	Measure	Technical efficiency VRS	CRS
Kakamega (n = 122) Without access to extension services	Min.	0.298	0.012
	Max.	1.000	1.000
	Mean	0.704	0.353
	Std Dev.	0.221	0.281
Kakamega (n = 31) With access to extension services	Min.	0.486	0.100
	Max.	1.000	1.000
	Mean	0.901	0.416
	Std Dev.	0.148	0.296

Source: Authors compilation

Table 4: Coefficients and t-ratios of factors influencing technical efficiency for the two farmer categories in Kakamega District, 2007

Variable	Technical efficiency –VRS			
	Farmers with access to extension (n = 31)		*Farmers without access to extension (n =122)*	
	Coefficient	t-ratio	Coefficient	t-ratio
Constant	1.565 (0.3081)	5.07***	0.883 (0.1968)	4.49***
Age of household head in years	-0.0036 (0.0024)	-1.70*	-.0007 (0.0013)	-0.51
Gender of household head	-0.1584 (0.0871)	-1.82*	0.0176 (.0498)	0.35
Education of household head (number of years in school)	0.0026 (0.1843)	0.14	-0.0041 (.0138)	-0.30
Household size	-0.00323 (.0036)	-0.90	-0.0216(0.0082)	-2.61***
Distance to market (km)	0.0115 (0.0198)	0.58	-0.0051 (0.0061)	-0.85
Main occupation of head	-0.0327 (0.0368)	-0.89	-0.0050 (0.0262)	-0.19
Total land size (ha)	0.0078 (.0066)	1.19	0.0073 (0.0122)	0.60
Use of manure (yes/no)	-0.089 (0.0644)	-1.39	0.0556 (0.0421)	1.4
Use of mineral fertilizer (yes/no)	0.1706 (0.0776)	2.20**	0.0379 (.0461)	0.82
Access to credit (Amount in KES)	-0.1461 (.0789)	-1.85*	-0.0818 (.0657)	-1.25

***Significant at 1% , **5% and *10%

Source: Authors own compilation