

# Technical Efficiency and Its Determinants on Irish Potato Farming among Small Holder Farmers in Trans-Nzoia County-Kenya

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**Abstract:** - Increased pressure on land brought about by increased population in the highlands of Western Kenya such as Trans Nzoia County has led to increased land fragmentation and forced farmers to diversify their crops to alternative value chains that are more profitable and take less time to mature. An example of an innovation being promoted is the adoption of Irish potato as an alternative to maize farming. However, in determining farm productivity, only few studies have looked at the efficiency of the Irish potato production. This has prompted this study to determine the technical efficiencies of smallholder farmers' Irish potato production in the study area by providing empirical evidence on smallholder resource use efficiency. The objective of the study was to determine the technical efficiency and factors affecting it among smallholder Irish potato farmers in Trans Nzoia County. Exactly, 384 farmers were selected through a multi stage random sampling in Trans Nzoia County. The respondents were interviewed with the help of open and closed ended questionnaires. Data was analyzed using stochastic frontier models. The mean technical efficiency index was estimated at 0.65 indicating an opportunity of 35% for farmers to attain full efficiency. Technical efficiency was positively influenced by age of farmers (0.01); Education years (0.06); Years of farming experience (0.05); Frequency of extension services (0.05); Land Size (0.02) and negatively influenced by Household size. To achieve full efficiency of production, this study recommended the policy makers to factor in the socio economic characteristics of farmers while promoting alternative crop value chains and strengthen the extension services to potato growers.

**Keywords:** Crop diversity, innovation, resource use efficiency, stochastic frontier models, value chains.

## I. INTRODUCTION

In recent years, Western Kenya has experienced an increase in population leading to land fragmentation of the former large scale farms (Jayne, Chamberlin, & Headey, 2014) and the evolution of smallholder farmers. Trans-Nzoia County of Western Kenya, which has been known to be the Kenya's food basket, has also been affected by this phenomenon (Otieno, Jayne, & Muyanga, 2015). Repeated use of traditional agronomic practices has rendered most of the lands infertile (Vanlauwe, Descheemaeker, Giller, Huisin, Merckx, Nziguheba & Zingore, 2015) with no responses in the adoption of intensive land-augmenting technologies as a

result of institutional failures, market constraints and limited transfer and adoption of improved technologies by smallholders farmers hence stalling agricultural productivity and growth (Kassie, Teklewold, Jaleta, Marenny, 2015). This low productivity has resulted in stagnated rural incomes, fuelling a vicious cycle of poverty and food insecurity among the local communities (Valbuena, Groot, Mukalama, Gérard, B., & Tittone, 2015). Thus, farmers need to diversify and seek for alternative crops that require less time to mature in order to achieve the expected high yields.

It is widely known that crop diversification is essential for improved agricultural productivity. Muzari et al (2012) asserts that diversification of food and non-food crops, rural financial markets, dissemination of assets and information, development of agricultural research and extension facilities targeting smallholder farmer may all work together in prevent long-term famine through increased agricultural productivity. Recently, there has been a shift from maize to Irish potato farming among small scale farmers in Trans Nzoia due to its ability to grow in high altitude areas where maize does not do well and its high nutritive value (Gildemacher et al., 2006; MoA, 2004). In addition, it is an important food crop for many Kenyan smallholder farmers where it plays a major role in national food security and its demand has continued to increase over the years especially by urban consumers (MoA, 2007).

Improving productivity of smallholder farmers is important for economic development because small holder farmers provide a source of employment and a more equitable distribution of income. Technically efficient farmers are highly productive because they are able to use minimum level of inputs to produce a given level of output or produce maximum output from a given level of inputs. Many researchers and policymakers have focused their attention on the impact that adoption of new technologies can have on increasing farm productivity and income (Simtowe, 2006). However few studies have looked at the efficiency of agricultural production which is the main economic activity for many developing countries especially in Africa (Chirwa, 2007; Kibaara, 2005). Most agricultural efficiency studies have

focused on maize as it is the major staple food in the country. Kimhi (2003) looked at the relationship between plot size and maize productivity. Other studies have looked at the role of an efficient maize market policy in improving productivity (Zulu B., T.S. Jayne and M. Beaver, 2007). Even though the subject of technical efficiency is important, very few studies have focused on Irish potato which can be an alternative source of economic livelihood. Therefore, in order to improve Irish potato production and productivity it becomes vital to undertake technical efficiency analysis at farm level under the existing technology to enhance the contribution of the sector to national economy. The study therefore sought to investigate the technical efficiency of smallholder farmers' Irish potato production in Trans Nzoia County and the factors affecting it.

## II. MATERIALS AND METHODS

The study adopted a cross sectional survey due to the wide area of coverage in Trans-Nzoia County of Western Kenya. The target population of the study were Irish potato farmers in Trans Nzoia County of Western Kenya. Multi-stage sampling procedure was used in the selection of representative sample. The first step involved purposive selection of Cherang'anySub County of Trans Nzoia County due to the high shift to Irish potato farming the area. Secondly, groups of respondents were randomly selected using simple random sampling from a list gotten from the Ministry of Agriculture offices. The instrument for data collection was structured questionnaires. A total sample of 384 respondents was selected. The sample size was computed according to the formula developed by Kothari (2004)

$$n = \frac{z^2 \cdot p \cdot q \cdot N}{e^2(N - 1) + z^2 p \cdot q}$$

Where n is the sample size, z is the confidence interval (Z-value), p is the expected proportion and e is the acceptable margin of error. In this study, a 95% confidence interval was assumed and an expected proportion of 0.5; therefore, the sample size calculated as:

$$n = \frac{(1.96)^2 \cdot (0.5)(0.5)94870}{0.05^2(94870 - 1) + 1.96^2 \cdot 0.5 \cdot 0.5}$$

Giving a minimum sample size of 384 households.

The data was then edited, coded, and cleaned to ensure consistency, uniformity, and accuracy. Processing and analysis of data was done using STATA. Econometric analysis was used for analyzing the collected data. A

stochastic frontier approach was used to estimate the level of Irish production efficiencies (Coelli, 2005) and a multiple linear was used to identify factors that affect the technical efficiency level of the farmers.

*Econometric specification:*

To estimate the technical efficiency of Irish potato farms, a Cobb-Douglas Stochastic Frontier Model for the Irish potato farms was explicitly specified as follows;

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 X_{3i} + v_i - u_i$$

Where subscripts i refer to the *i*th farm being studied, Ln is natural logarithm,  $v_i$  is random errors while  $u_i$  is the shortfall in  $Y_i$ .

$Y$  = Total output of Irish potato in kilograms;

$X_1$  = Land is total area under Irish potato production measured in hectares;

$X_2$  = Total labour used in Irish potato crop (man-hours/ ha)

$X_3$  = Quantity of Irish potato seed cultivated in kilograms.

$X_4$  = Quantity of fertilizer used in Irish potato crop (kg/ha)

$X_5$  = Amount of pesticides (litres)

To identify the determinants of technical efficiency among Irish potato farms, Technical efficiency indices were regressed on farm and farmer characteristics using a multiple regression model. The model is specified as follows:

$$Y^* = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + e$$

Where;

$Y^*$  = Technical efficiency ratio

$Z_1$  = age of farmers;

$Z_2$  = education in years;

$Z_3$  = household size;

$Z_4$  = years of farming experience (Irish potato only);

$Z_5$  = Frequency of extension services

$Z_6$  = Land Size

## III. RESULTS AND DISCUSSION

Stochastic production frontier estimated using maximum likelihood method to test for existence of technical inefficiency in Irish potato production

Table 1: Maximum Likelihood Estimates for Technical efficiency

Stoc. Frontier normal/half-normal model		Number of obs = 384	
Log likelihood = -494.99014		Wald chi2(6) = 950.57	
		Prob > chi2 = 0.0000	
Lnharvests	Coefficient.	Std. Error	z-value
Lnland size	-.03	.05	-0.58
Lnseed	.37***	.04	8.59
Lnfertilizer	.28***	.05	5.32
Lnagrochemical	.06	.04	1.30
Lnlabour	.30***	.041	6.61
Lnpostharvest labour	.16***	.04	3.94
_cons	-1.09**	.36	-3.04
/Lnsig2v	-1.21***	.16	-7.53
/Lnsig2u	-.98***	.35	-2.76
sigma_v	.5458402	.0439121	
sigma_u	.6136011	.1085497	
sigma2	.6744478	.0972378	
Lambda	1.124141	.1470198	
Mean Technical efficiency	.65		
Likelihood-ratio test of sigma_u=0: chibar2(01)		= 3.79 Prob>=chibar2 = 0.026	

The maximum likelihood estimates of the stochastic frontier production function are presented in Table 1. The results indicate that the sigma square value is significantly different from zero, showing a good fit and correctness of the specified distributional assumption. The mean technical efficiency level was a 65 ranging from 22% to 88%. This meant that the smallholder farmers have a 35% opportunity to increase the potato production by using current technology.

#### Factors affecting Technical efficiency of Irish Potato farming

Technical efficiency was positively influenced by age of farmers (0.01), Education years (0.06), Years of farming

experience (0.05), Frequency of extension services (0.05) and Land Size (0.02). These results concur with Chepkwony, (2014) who found out that level of education and access to extension to be having a significant effect in technical efficiency of Irish potato production in Eldoret East Sub County of Kenya. While examining the Technical Efficiency of Smallholder Irish Potato Production in Nyabihu District of Rwanda, Muzungu Paul, (2011) also concluded that farming experience, house hold size, gender, marital status, farm Size and extension services were socio-economic factors influencing the farmers' technical efficiency.

Table 2: Factors affecting Technical efficiency of Irish Potato Production

Stoc. Frontier normal/half-normal model		Number of obs = 384	
Log likelihood = -494.99014		F(7, 487) = 2018.70	
		Prob > F = 0.0000	
		R-squared = 0.9667	
		Adj R-squared = 0.9662	
TE	Coefficient.	Std. Error	z-value
Age of farmer	.01***	.0015	3.87
Education in years;	.06***	.0014	43.43
Gender of the farmer	.15	.1970	0.76
Household size;	-.01***	.0014	-7.31
Years of farming experience	.05***	.0017	28.69
Access to subsidized fertilizer	.13	.2674	0.49
Access to certified seeds	.12	.2420	0.91
Frequency of extension services	.05***	.0015	33.17
Land Size	.02***	.0013	17.13
_cons	.168***	.0014	118.63

\_cons - constant, obs - observation

However, the coefficient of Household size (-0.01) had negative sign and inconsonance with a priori expectation. This can be attributed to the huge financial obligations and burden that are associated with having a large household. Table 2 presents the coefficients of efficiency function which explain levels of technical inefficiency among the respondents.

Some of the factors that did not influence technical efficiency included gender of the farmers, access to subsidized fertilizer and access to certified seeds.

#### IV. CONCLUSION

The study adopted a stochastic frontier approach to examine technical efficiency and its determinants on Irish potato smallholder farmers in the Trans Nzoia County of Western Kenya. Empirical results show that Irish potato smallholder farmers in Trans Nzoia produce averagely on the production frontier and are therefore averagely technically efficient. There is therefore the need for Irish potato smallholder farmers to increase their yield by 35% using the same level of inputs and existing technology. Farmer specific characteristics such as age of farmers, education in years; household size; years of farming experience and frequency of extension services were the important determinants of technical efficiencies in production. Based on the findings, it is recommended that stakeholders involved in agricultural development should take into consideration the farmer specific characteristics in designing programmes meant to improve technical efficiency in Irish potato production. Organized educational programmes for farmers need to be customized depending on farmers' characteristics in order to have an impact on their production efficiency.

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