

# Technical Efficiency of Sole Maize and Maize/Melon Intercrop in Osun State, Nigeria



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## Abstract

Intercropping has been found out to have enormous economic advantages for the farmer, although with some possible adjoining disadvantages attributable to competition and lack of adequate management. This study therefore analyzed and compared the technical efficiencies of sole maize and maize/melon intercrop farmers in Osun State with a view of determining the factors that influences it. Purposive sampling was used to select 47 respondents each for sole maize and maize/melon intercrop system. Stochastic frontier production function was used to estimate the technical efficiencies. The study revealed that the mean technical efficiency of maize/melon intercrop farmers was higher than that of the sole maize farmers. Costs of land, labor and implement were the factors affecting the sole maize farmers' efficiency, while the maize/melon intercrop farmers' efficiency was significantly determined by costs of land, labor and capital. No significant factor determines inefficiency for sole maize farmers. However, land security and extension visit were the major significant inefficiency factors found out to reduce the inefficiencies of maize/melon intercrop farmers in the study area. It is recommended that farmers in the study area should venture into the intercropping of maize and melon more than sole maize cropping; government should strengthen land security and give adequate motivation to extension agents to visit farmers more in order to increase their technical efficiencies.

**Keywords:** Technical efficiency; Sole maize; Maize/melon intercrop; Stochastic frontier production

## Introduction

The growth of two or more crop species simultaneously in the same field during a growing season is known as intercropping [1]. Numerous literatures have often argued in favor of one cropping system over the other [2-5]. It was reported that farmers intercropped for varied reasons [6], including insurance against crop pests, yield increment, weed control and high monetary returns to the farmers. Intercropping is a common practice in tropical developing countries because of its several advantages [7,8] and maize and cassava intercrop has been described as the most prevalent and most productive enterprise with highest net margins in southern Guinea savanna ecology [9].

The cultivation of maize in combination with other crops is a common practice in the tropics [10]. About 73% of the maize in Nigeria is under intercropping [11,12]. Several studies have been carried out on monoculture maize and melon as influenced by intra-row spacing [13,14], The incorporation of 'egusi' melon into maize/cassava intercrop at the right time has been reported to be more profitable and more environmentally friendly [15]. However, it was also reported [16] that the intercropping increased competition between crops and weeds for nutrients and light. In some cases, the output of one crop may be increased through a decline in the production of the other, a situation referred to as 'dominant'

and 'dominated', respectively [17]. In some other cases an increase in output of one crop could help to bring about an increase in output of the other crop; this situation is referred to as 'mutual co-operation' [18]. Therefore, the need arises to determine the technical efficiency of sole maize and maize/melon intercrop farmers in Osun State in order to ascertain how efficient each cropping system is and compare to be able to determine which has technical advantage over the other in the study area.

The objectives of the study were to determine the technical efficiency of sole maize and maize/melon intercrop farmers and factors affecting technical efficiency of sole maize and maize/melon intercrop farmers.

## Materials and Methods

### Study area

The study was performed in Osun State, South-west, Nigeria. It is located between Longitude 7.0° N and 9.0° N, and latitude 2.8° E and 6.8° E with thirty Local Government Areas (LGAs). Osun State is an inland state with Osogbo as the capital.

A total of 94 farmers were purposively samples with the assistance of extension agents from Osun State Agricultural Development Program (OSSADEP) from the two LGAs namely: Atakunmo-

sa West and Iwo based on the predominance of maize and maize/melon intercrop in these LGAs relative to the rest. Forty-seven questionnaires were administered on each of Sole-maize farmers and Maize/Melon intercrop farmers.

**Data collection**

Primary data were collected from respondents with the aid of structured questionnaire. Information collected includes socio-economic characteristics of the respondents, farm characteristics; quantities and prices of inputs and output in the area during the farming season.

**Methods of data analysis**

The technical efficiency of both sole maize and maize/melon intercrop and the inefficiency factors were estimated with stochastic frontier production function. The model is specified as follows:

$$\ln(Y_i) = \beta_0 + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \beta_3 \ln(X_3) + \beta_4 \ln(X_4) + V_i - U_i \quad (1)$$

where:

$Y_i$  = Revenue (₦)

$x_1$  = Cost of land

$x_2$  = Cost of labor (₦)

$x_3$  = Capital sourced (₦)

$x_4$  = Implement cost (₦)

$V_i$  = random or stochastic disturbance term. This captures random variables which are assumed to be identically, independently and normally distributed with zero mean and a constant variance ( $\sigma^2$ ).

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \varepsilon_i \quad (2)$$

where:

$Z_1$  = Age of respondent

$Z_2$  = Gender of respondent (female = 1; otherwise = 0)

$Z_3$  = Family size of respondent

$Z_4$  = Years of education of respondent

$Z_5$  = Membership of cooperative society/association (Yes = 1; otherwise = 0)

$Z_6$  = Years of farming experience

$Z_7$  = Land security level (Very low = 1, Low = 2, High = 3, and Very high = 4)

$Z_8$  = Extension visit (Yes = 1; otherwise = 0)

$\delta_0, \delta_i$  = parameters that were estimated

$\varepsilon_i$  = random disturbance term

The technical efficiency of an individual farm is defined in terms of the observed output ( $Y_i$ ) to the corresponding frontier output ( $Y_i^*$ ) given available technology, that is:

$$TE_i = Y_i/Y_i^* = f(X_i; \beta_i) \exp(V_i - U_i) / f(X_i; \beta_i) \exp(V_i) \quad (3)$$

$$TE_i = \exp(-U_i) \quad (4)$$

So that,  $0 \leq TE \leq 1$ . If  $TE=1$ , the farm is said to be technically efficient and its output is on the frontier. Otherwise, that is, if  $TE < 1$ , the farm is technically inefficient because it could have produced more outputs with the given level of inputs irrespective of input prices.

The estimates for all the parameters of the stochastic frontier production function and the inefficiency model were simultaneously obtained using the computer program Frontier 4.1 [19].

**Results and Discussion**

**Estimates of the parameters in the stochastic production frontier function**

Table 1 presents the maximum likelihood estimates of the stochastic production frontier model for both sole maize and maize/melon intercrop farmers. The results revealed the presence of technical inefficiency among both group of farmers in the study area based on the significance of gamma and the Likelihood Ratio ( $\lambda$ ) test.

The estimated elasticities of the independent variables revealed that costs of land (-1.62), labor (-20.00) and implement (-3.16) were the significant factors affecting the level of production for sole maize farmers. Cost of land was significant at 10% and reduces technical return as its level increases for sole maize farmers. This is because the managerial ability of most of the farmers becomes inefficient with increasing farm size. The costs of labor and implement, both significant at 1%, also reduce the level of output with increasing use. This may not be unconnected with the fact that as more labor and implements becomes available, utilization becomes inefficient as a result of excess supply.

**Table 1:** Determinants of technical efficiency and inefficiency among sole maize and maize/melon intercrop farmers in the study area.

	Variable	Sole Maize			Maize/Melon Intercrop		
		Coefficient	SE	t-ratio	Coefficient	SE	t-ratio
b0	Constant	106.36	1	106.46***	-145.38	1	-145.91***
b1	Inland	-1.62	0.99	-1.65*	-3.33	1	-3.32***
b2	Inlabour	-20	0.97	-20.63***	21.7	0.87	24.93***
b3	Incapital	1.19	0.97	1.22	11.5	0.82	14.01***

b4	Inimplement	-3.16	0.98	-3.24***	-0.77	0.97	-0.79
Inefficiency Model							
d0	constant	0	1	0	2.15	0.58	3.73***
d1	Age	0.02	0.15	0.15	-0.01	0.02	-0.43
d2	Sex	0.02	0.99	0.02	-0.21	0.22	-0.97
d3	Family size	-0.11	0.89	-0.12	-0.03	0.06	-0.57
d4	Years of education	-0.04	0.19	-0.21	-0.03	0.03	-0.92
d5	Cooperative member	0.01	0.99	0.01	-0.12	0.29	-0.4
d6	Farming experience	-0.01	0.14	-0.05	0.02	0.02	1.14
d7	Land security	0.33	0.68	0.49	-0.21	0.1	-2.17**
d8	Extension visit	-0.04	0.99	-0.04	-0.2	0.06	-3.31***
sigma2		0.17	0.28	0.59	0.09	0.02	5.70***
gamma		1	0.21	4.85***	1	0	26039.36***
log likelihood function	3.41			15.21			
LR test of the one-sided error	18.41			35.14			

Source: Field survey, 2016.

(\*\*\*), (\*\*), and (\*) denote significance at 1, 5, and 10% respectively, ( $\Delta$ ) indicated dummy variables, SE is standard error.

For the maize/melon intercrop farmers, the technical efficiency was significantly influenced by cost of land (-3.32), labor (24.93) and capital (14.01). A unit increase in the cost of land, leads to 3.32 reductions in output. For labor and capital, a percent increase in their costs leads to an increase of 24.93 and 14.01 respectively in the level of outcome.

### Technical inefficiency analysis

Table 1 presents the factors that statistically influence the inefficiency of sole maize and maize/melon intercrop farmers in the study area. For the sole maize farmers, no significant variable which is not consistent with the findings of some studies [20,21], while only land security (-2.17) and extension visit (-3.31) were the major determinants of inefficiency for the maize/melon intercrop farmers in the study area significant at 5% and 1% level.

This implies that as land security increases, technical inefficiency decreases. Also, as extension visit increases, the technical inefficiency reduces thereby leading to increasing technical efficiency of the maize/melon intercrop farmers.

### Technical efficiency analysis

From Table 2, the mean predicted technical efficiency for the sole maize farmers was 69% lower than that of the maize/melon intercrop farmers (75%) and that on average, maize/melon intercrop farmers were more technically efficient than the sole maize farmers. This implies that sole maize farmers were 31% inefficient more than the inefficient maize/melon intercrop farmers (25%). This is in tandem with recent findings [4,15,22]. However, this finding negates another research [23] that in maize-melon mixtures, the sole crop components yielded higher than the corresponding crops in intercropping situation.

**Table 2:** Distribution of technical efficiency scores of both sole maize and maize/melon intercrop farms.

Technical Efficiency Range (%)	Sole Maize			Maize/Melon Intercrop		
	Frequency	Percentage	Cumulative Percentage	Frequency	Percentage	Cumulative Percentage
21-30	2	4.26	4.26	2	4.26	4.26
31-40	1	2.13	6.39	2	4.26	8.52
41-50	5	10.64	17.03	2	4.26	12.77
51-60	9	19.15	36.17	8	17.02	29.79
61-70	6	12.77	48.94	5	10.64	40.43
71-80	8	17.02	65.96	5	10.64	51.07
81-90	8	17.02	82.98	9	19.15	70.22
91-100	8	17.02	100	14	29.79	100

Total	47	100		47	100	
Mean	0.69			0.75		
Minimum	0.28			0.26		
Maximum	1			1		

For an average sole maize farmer that operating at the highest level of efficiency, such farmer is saving a cost of 31% (i.e.  $1 - (0.69/1) \times 100$ ). An efficient maize/melon farmer is saving 25% cost (i.e.  $1 - (0.75/1) \times 100$ ). However, majority of sole maize farmers (51.06%) had technical efficiencies between 71-100% while the percentage for the maize/melon intercrop farmers was 59.58%.

### Conclusion and Recommendations

The study brought to fore the differences in level technical efficiency of sole maize and maize/melon intercrop farmers in the study area, more importantly as a result of inefficiencies in the farming system employed. The study revealed that the mean technical efficiency for the maize/melon intercrop farmers was higher than that of the sole maize famers, meaning higher efficiency. Costs of land, labor and implement were the factors affecting the level of sole maize farmers' productivity, while the maize/melon intercrop farmers' productivity was significantly determined by costs of land, labor and capital. Also, land security and extension visit were the major significant inefficiency factors found out to reduce the inefficiencies of maize/melon intercrop farmers in the study area.

Based on the findings of this study, the following were recommended for the farmers in the study area.

1. It is advised that famers in the study area should venture into the intercropping of maize and melon more than sole maize cropping.
2. The rights to land should be strengthened to enable maize/melon intercrop farmers enjoy better technical returns from the land.
3. Also, extension agents should make more visits to the farmers, bringing more innovations and information, to ensure that farmers achieve a higher level of technical efficiency.

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