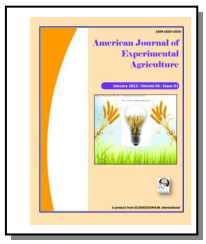

American Journal of Experimental Agriculture
1(3): 86-95, 2011

SCIENCEDOMAIN *international*
www.sciencedomain.org

Efficiency of Resource Use in Hybrid and Open-Pollinated Maize Production in Giwa LGA of Kaduna State, Nigeria

Taiwo Bintu Ayinde[1], R. A. Omolehin[1] and U. Ibrahim[2]*

[1]Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria, Kaduna State, Nigeria.
[2]Crop Production Programme, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

Research Article

Received 31st January 2011
Accepted 22nd February 2011
Online Ready 16th March 2011

ABSTRACT

Maize (*Zea mays* L.) is one of the most important cereal crop in Nigerian agriculture. The crop occupies a crucial place than other cereal crops since it is used as food, feed, fodder and other industrial raw material. The aim of this study was to conduct a comparative study on the productivity of hybrid and open-pollinated maize, with the participation of farmers in Giwa Local Government Area of Kaduna state. Precisely, it evaluated the current hybrid and open-pollinated maize production technologies by describing their major socioeconomic factors, and most importantly identifying the economic difference between hybrid and open-pollinated maize, using the farm survey data collected from 160 maize farming communities in October- December for the cropping year 2009-'10. The result of analysis of resource use efficiency of hybrid and open-pollinated maize showed that all resources were inefficiently utilized because the ratios were not equal to one. The resource use efficiency of hybrid and open pollinated maize production in the study area was computed from Efficiency ratio r i.e., the ratio of MVP (Marginal Value Product) and MFC (Marginal Factor Cost). The ratio indicates that sampled farmers underutilized fertilizer and insecticides. The efficiency ratio for seeds, labour and herbicides were less than one showing that the sampled farmers over-utilized seeds, labour and herbicides on the farms. This study suggested the need to bring more area under hybrid maize cultivation. Furthermore, there is need for special training, seminars, field demonstrations and technical support for the maize farmers. As most of the communities had no formal education, the extension program should be intended to the less educated farmers. In addition, the credit facility particularly the procedure for loan should be made simple to improve hybrid and open-pollinated maize production in the study area.

**Corresponding author: Email: ibrusman2007@yahoo.com*

Keywords: Hybrid maize, Open pollinated maize, Resource use efficiency, Marginal Physical Productivity, Efficiency ratio;

1. INTRODUCTION

The traditional area of maize cultivation in Nigeria has been the south of latitude 8°N where it can be grown twice a year. However, it is recognized that the higher solar radiation received in the northern part of the country where it has not been traditionally grown as a popular crop has led to the increasingly importance and expansion of maize production in this zone (Alamu, 2001; Ologunde, 1987; Kogbe and Adediran, 2003). In Nigeria, many researchers have found improved production technology to be a major factor in effort to become self-sufficient in maize production (Iken and Amusa, 2004).

Production of hybrid maize simply put, are the result of crossing two different breeding lines. They represent the first generation originating from the cross (F1). They differ from pure line varieties and open-pollinated varieties in that the seed they produce will not be saved and replanted but the parental lines have to be crossed each time to produce new seed (Shull and East, 1910). These breed are known to be early flowery, drought resistant, more vigorous and uniform, traits not found in the existing open-pollinated breed (Duvick, 1999).

Recently, hybrid maize production has been given extensive promotion among farmers in Nigeria. Conversely, hybrid maize is famous for its high requirement for plant nutrients and other production inputs (Kogbe and Adediran 2003). Although, it is widely grown in many countries of the world; generally farmers have been trained with the principle that every clause vital for utmost performance of hybrid maize have to be satisfied to maximum capacity prior to attainment of optimal income. Consequently, additional production cost discourages, most farmers engaging in hybrid maize production (Kogbe and Adediran 2003).

However, paying for these seeds yearly can only be profitable, only if the important qualities needed by the farmers are found in the hybrid maize seed, since just being hybrids or illustrating heterosis (hybrid vigour) is not enough (Duvick, 1999). Duvick (1999) further illustrated, that the price of the hybrid maize seed, ought to be low enough to assist, the farmer to make considerable profits from annual repeated investments in costly hybrid maize seed, when compared to the open-pollinated maize that can be recycled, i.e., farmers will risk venturing into improved hybrid maize production technology only when they have some guarantee of a reasonable price, as well as a reliable market for their crop. Duvick (1999) concluded by adding that, as a rule of thumb, the first time application of hybrid maize seed must enable the farmer to receive an additional income, equal to at least three times the added cost of procurement of the hybrid maize seed.

Rusell (1974) made severe effort to separate the effect of proper management of farm operations from the use of better genetic strains (i.e., the use of hybrid maize). With hybrid seed conserved from 1930 to 1970 and growing the hybrid and open-pollinated maize under the similar environment, he found a homogeneous boost in yield from the newer strains (hybrid maize) as against the heterogeneous nature of open-pollinated maize variety. He concluded that 60% or more of the improved performance was genetic. Similar result was also reported by Duvick (1977) and Crow (1998).

The importance of maize as both food and cash crop has necessitated the need for this study, which is to conduct a comparative study, on the productivity of hybrid and open-pollinated maize, of farmers in Giwa Local Government Area of Kaduna state. Precisely, it will evaluate current hybrid and open-pollinated maize production technologies by describing their major socio-

economic factors and most importantly identifying the economic difference between hybrid and open-pollinated maize.

2 MATERIALS AND METHODS

Primary and Secondary data were used for this study. The primary data were collected based on 2009 cropping season using detailed structured questionnaires with the aid of an enumerator. The interview method of data collection was used. The data collected includes:

1. demographic information such as age, educational level, farm size, farming experience, number of extension contact.
2. production information on hybrid and open-pollinated maize, this includes inputs used, like fertilizer and other agro-chemicals, land, seed planted, quantity of input, labour and output/yield which will be measured in kg/ha;
3. finally marketing information like prices of inputs and output, quantity sold, and mode of sales.
4. Data were also, obtained from Journals, Monogram, published books, which are significant to the scope of this study.

2.1 OVERVIEW OF THE STUDY AREA

This study was conducted in Giwa Local Government Area of Kaduna State is located between Latitude 11^0 and 12^0 N and Longitude 7^0 and 8^0 E of the Prime Meridian (Oguntolu, 2005). Kaduna state is located in the Savannah ecological region of Nigeria, with a cultivatable area of about 34,000 sqkm, the actual area cultivated is about 32,230 sqkm from an estimated land area of about 43,000 sqkm (Anonymous, 2009).

The typical weather is mostly categorized by constant dry and wet seasons. The rains begin in April/May and stops in October, while the dry season sets in, in late October and ends in March of the subsequent year. Relative humidity varies between 20% and 40% in January, and 60% and 80% in July. The mean annual high temperature also varies between 34° and 28°C. Crop cultivation is practiced in the upland and lowland (Fadama areas) of Kaduna state which is essentially rain fed in upland system while in low land areas, both wet and dry season farming occurs. Upland farming is being practiced by farmers in Giwa LGA, most part of which is for the cereals (like millet, rice, maize and sorghum) and legumes (including cowpea; groundnut and soybean).

There are 23 Local Government Areas (LGAs) in Kaduna State, from which Giwa LGA was purposively selected because of proximity of some institutions and organizations concerned with the cultivation of hybrid and open-pollinated maize, the intense activities of seed companies in the area and farmer's participation in on farm trials. Small-scale farmers carry out agricultural production predominantly. The cropping systems in the area are also dominated by mixed cropping, although sole cropping is practiced. In addition, significant parts of the populations are involved in livestock keeping which depends on grazing (Oguntolu, 2005). The nomadic Fulanis predominantly does the grazing and livestock rearing.

2.2 SAMPLING PROCEDURE

The study adopted a cross-sectional sample survey design. The population of farmers involve in the study are hybrid and open-pollinated maize farmers in Giwa LGA of Kaduna State. Based on the list of maize farmers obtained from the Agricultural Development Programme, a multi-stage sampling procedure was applied to select 160 farmers involved in maize production. In the first

stage, eight wards were purposively selected based on the intensity of maize production in the study area. The surveyed ward were *shika, Giwa, Likoro, Galadima, Yakawada, hayin madara, Kidandan, Makarfi*. Secondly, a community was also randomly selected from each of the wards. Finally, 20 maize farmers were randomly selected and interviewed from each community to make up a sample size of 160.

2.2.1 PRODUCTION FUNCTION ANALYSIS

Different functional forms such as square root, quadratic, the linear, the semi-log and the Cobb-Douglass production functions were used to analyse the data. The lead equation was the semi-log model. It was chosen for further analysis, to determine the production function for hybrid and open-pollinated maize production, which was used to achieve objectives two.

The criteria that guided the choice of the lead equation were:

i) The value of coefficient of multiple determination (R^2);
ii) The correctness of the signs of the regression coefficients and
iii) The significant t-values

2.4 SPECIFICATION OF THE MODELS

Cobb-Douglass in its general form is given as:

Y = a + $X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e$ in the linear form it is expressed as

Log Y = a+ $b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6$ + e

Where
Y = *crop output from hybrid and open pollinated maize (Kg)*.

$X_1 = farmsize(\text{ha})$

$X_2 = seeds(kg)$

$X_3 = fertilizer(Kg)$

$X_5 = Insecticides(litre)$

$X_5 = Herbicides(litre)$

$X_6 = Labour(man-day)$

$Y_1 X_1 to X_6$ are already defined in the implicit form.

b_1 to b_6 are the regression coefficients

a = constant term; e = error term

Estimation of Resource Use Efficiency:

This is computed as follows:

$$r = \frac{M\,\text{arg}inal - value - product}{M\,\text{arg}inal - factor - \text{cos}t} = \frac{MVP}{MFC}$$

Where

r = the efficiency ratio

Marginal Factor Cost (MFC) = cost of one unit of a particular resource

The Marginal Value Product (MVP) was estimated as follows:

$$MVP_{xi} = MPP_{xi} * P_y$$

$$MPP_{xi} = d_y / d_{xi} = \beta \bar{Y} / \bar{X}_i$$

Where Cobb-Douglas form is the lead equation.

Note: $\bar{Y}$ and $\bar{X}$ are the arithmetic mean values of output and input being considered respectively.

Where: β = is the estimated regression coefficient of input X_1

P_y = is the unit price of output.

X_i = is the various input i.e., 1 to n.

If r = 1, implies that resources are efficiently utilized i.e. MVP = MFC=1

r > 1, it implies that resources are underutilized i.e. MVP >MFC
r < 1, it implies that resources are over utilized i.e. MVP < MFC

3. RESULTS AND DISCUSSION

3.1 SOCIO-ECONOMIC PROFILE OF RESPONDENTS

The socio-economic characteristics of Hybrid and open-pollinated maize farmers have been shown in Table 1 (Tables 1a to 1d). The age distribution of the hybrid and open pollinated maize farmers in the study area indicates 65% and about 39% of hybrid and open-pollinated maize farmers respectively were between the ages of 29 and 49 years and they are in active production. Most of hybrid and open-pollinated maize farmers of about 54% and 50%, respectively had a family size of 6-15 people. The average family size of 9 persons was obtained for both hybrid and open-pollinated maize farmers.

The educational level of both farmers' groups in the study area shows that about 44% and 33% of hybrid and open-pollinated maize farmers have secondary and adult education, respectively. More than 31% and over 11% of hybrid and open pollinated maize farmers have tertiary education, respectively. 24% and 34% of the hybrid and open pollinated maize farmers respectively were not visited by extension agents during the production season.

The implication of this finding is that the extension programme in the study area are either understaffed or underequipped as indicated by a large percentage of the respondents that were unreached by the extension services in the study area.

Table 1. Socioeconomic characteristics of Hybrid and open-pollinated maize farmers

Table 1a. Distribution of Hybrid and Open-pollinated maize farmers by age

Family size	Hybrid		Open pollinated	
	Frequency	Percentage	Frequency	Percentage
≤ 29	14	17.5	8	10
30-39	15	18.75	8	10
40-49	23	28.75	15	18.75
50-59	15	18.75	18	22.5
60-69	9	11.25	15	18.75
≥ 70	4	5	16	20
Total	**80**	**100**	**80**	**100**

Source: Field survey data, 2009.

Table 1b. Distribution of Hybrid and Open-pollinated maize farmers by family size

Family size	Hybrid		Open pollinated	
	Frequency	Percentage	Frequency	Percentage
01-05	14	17.5	15	18.75
06-10	24	30.0	23	28.75
11-15	19	23.75	17	21.25
16-20	19	23.75	19	23.75
21-25	3	3.75	3	3.75
26-30	1	1.25	3	3.75
TOTAL	**80**	**100**	**80**	**100**

Source: Field survey data, 2009.

Table 1c. Educational qualification of hybrid and open-pollinated maize farmers

Educational qualification	Hybrid		Open pollinated	
	Frequency	Percentage	Frequency	Percentage
No formal education	4	5	1	1.25
Quranic education	7	8.75	27	33.75
Primary school education	9	11.25	16	20
Secondary school education	17	21.25	12	15
Adult education	18	22.5	15	18.75
Tertiary education	25	31.25	9	11.25
Total	**80**	**100**	**80**	**100**

Source: Field survey data, 2009.

Table 1d. Distribution of respondents according to extension visit

No. of Extension Visit	Hybrid		Open pollinated	
	Frequency	Percentage	Frequency	Percentage
Once per month	7	8.75	5	6.25
Twice per month	23	28.75	20	25
Once per two months	31	38.75	28	35
Not at all	19	23.75	27	33.75
Total	**80**	**100**	**80**	**100**

Source: Field survey data, 2009.

3.2 OUTPUT- INPUT RELATIONSHIP IN HYBRID AND OPEN-POLLINATED MAIZE PRODUCTION

The cob-douglass function was chosen as it gave the most excellent fit to the data. The criteria for choosing the cob-douglass production were based on its coefficient of multiple determinations, signs of the estimated coefficients and the number of significant variables. An adjusted R^2 value of 0.82, for hybrid maize production and 0.59, for open-pollinated maize production, was reported (Table 2), implying that the inputs used in maize production explained 85% of the variation in the output of hybrid maize production and 66% for open-pollinated maize production in the study area. The numbers of significant variables were four for hybrid maize production namely farm-size (land); seeds; labour being significant at 1% levels of probability and fertilizer at 5% levels of probability. Open-pollinated maize production on the other hand, also has four significance variables namely farm size (land); labour, are significant at 1% level of probability while seeds and insecticides are significant at 5% levels of probability.

Table 2. Output-Input relationship in hybrid and open-pollinated maize production using Cob-Douglas production function

Variable	Hybrid			Open-pollinated		
	Co-efficient	Standard Error	T-value	Co-efficient	Standard Error	t-value
Constant	6.55	0.45	14.55**	6.60	0.33	20.07**
Farm size	0.72	0.09	7.82**	0.50	0.10	4.91**
Seeds	0.03	0.01	3.06**	0.05	0.03	1.98***
Labour	3.77	0.90	4.18**	0.37	0.08	4.62**
Fertilizer	1.61	0.10	16.1***	0.36	0.12	3.01
Insecticides	0.08	0.08	1.01	0.16	0.08	1.95
Herbicides	-0.09	0.09	-1.01	-0.11	0.08	-1.38
R^2	85%			66%		
Adjusted $\bar{R}^2$	0.82			0.59		
F-value	22.72**			0.001		
N	80					

*** - Significant at 1% probability level*** - Significant at 5% probability level*

3.3 MARGINAL PHYSICAL PRODUCT (MPP) OF INPUTS IN HYBRID AND OPEN POLLINATED MAIZE PRODUCTION

The highest MPP (597.5) was observed for fertilizer and lowest for labour (1.38) which was closely followed by land, insecticides, and seeds having MPPs of 372.7, 167.5 and 3.45, respectively (Table 3).

Table 3. Marginal physical products of inputs in hybrid and open-pollinated maize production

Input	Hybrid				Open-pollinated			
	$\bar{Y}$	APP	Input elasticity	MPP	$\bar{Y}$	APP	Input elasticity	MPP
Land (ha)	2240.6	8.00	0.72	372.7	1261.04	9.95	0.50	63.37
Seed (kg)	2240.6	36.12	0.03	3.45	1261.04	68.31	0.05	205.21
Labour (manday)	2240.6	65.12	0.04	597.51	1261.04	55.9	0.37	8.35
Fertilizer (kg)	2240.6	6.04	1.61	1.38	1261.04	2.23	0.36	203.56
Insecticide (L)	2240.6	1.07	0.08	67.5	1261.04	0.79	0.16	255.40
Herbicide (L)	2240.6	1.41	-0.0	-143.0	1261.04	1.36	-0.11	-102.0

*Source: Field survey, (2010); APP = Mean yield/Mean input, MPP = APP*Input elasticity, MPP – Marginal Physical Product*

However the use of herbicides has a negative impact on its output i.e., for each additional increase in the unit of herbicides (-143.0) there is a decrease in the output of hybrid maize production. The MPPs values of open-pollinated maize peaked with insecticides (255.40), and were closely followed by seeds (205.21) then fertilizer (203.56). Land and labour have MPPs of 63.37 and 8.35, respectively. Herbicides (-102.0) also has a negative impact on output of open-pollinated maize. Since MPP is the addition to total product (yield) resulting from a unit increase in the use of a variable input, we can conclude that the use of hybrid maize seed gave a higher output than the open-pollinated maize seed counterpart as the additional inputs used resulted in a greater output. This confirms the test of hypothesis that says hybrid maize seed, uses resources (inputs) more efficiently than open-pollinated maize seed to obtain higher yield.

3.4 RESOURCE USE EFFICIENCY

The resources used in the production of hybrid and open-pollinated maize were not efficiently utilized (Table 4). For hybrid maize production, fertilizer and insecticides were underutilized because the ratios of MVP and MFC were greater than one (6.57 and 2.23) respectively, while the open-pollinated maize counterpart had a fertilizer and insecticides efficiency ratio of 9.70 and 14.7, respectively. This implies that an increase in their usage may have increased the yield per hectare of maize. The reasons for underutilization could be due to the high price and scarcity of fertilizer and inadequate extension staff. The efficiency ratio of hybrid maize production, for seeds; labour and herbicides were less than one i.e., 0.51, 0.19 and -7.1, respectively. On the other hand, open-pollinated maize production has efficiency ratios of 0.92, 0.11, and -4.5, showing that the sampled farmers over-utilized seeds, labour and herbicides, respectively on the farms. This could be inferred to be as a result of low wage rate for labour and predominant use of family labour which was abundant and usually not valued. The resource use efficiency in hybrid and open pollinated maize production in the study area was computed using equation ($\frac{MVP}{MFC}$).

Table 4. Resource use efficiency in hybrid and open-pollinated maize production

Resources	Hybrid				Open-pollinated			
	MPP	MVP	MFC	r = $\frac{MVP}{MFC}$	MPP	MVP	MFC	r = $\frac{MVP}{MFC}$
Seed (kg)	1.86	102.75	200	0.51	205.21	50.77	55	0.92
Fertilizer (kg)	597.25	32848.53	5000	6.57	203.56	11196.67	5000	2.23
Labour	1.38	75.70	400	0.19	8.35	45.91	400	0.11
(man-day)	167.52	9213.6	950	14.7	255.4	14047.03	950	14.7
Insecticide	-	-7865.93	1100	-7.1	-102	-5009.86	1100	-4.5
(litre)	143.02							
Herbicide (litre)								

*Source: Field survey, (2010); MPP (Marginal Physical Product) = APP*Input elasticity, APP = Mean yield/Mean input; MVP = Marginal Value Product; MFC = Marginal Factor Cost.*

The result of hypothesis test of resource use efficiency of hybrid compared with open pollinated maize, shows that all the resources used in the production of hybrid and open-pollinated maize were not efficiently utilized. Hence we reject the null hypothesis and conclude that there was in proper utilization of resources in the production of hybrid and open-pollinated maize.

4 CONCLUSION

This study has shown that hybrid and open-pollinated maize production is a reasonably profitable venture. However the use of hybrid maize was found to be more profitable than the open-pollinated maize by farmers in the study area, although its productivity is still small. Possible reason for this near to the ground profit were due to the unpredictable pattern of rainfall, lack of funds and also lack of access to credit, lack of proper education and even when visited by extension agents to be enlightened on least cost combination for optimum productivity, the farmers do not have the aptitude to comprehend the package. Low yield of maize was also attributed to under and over utilization of some of the production inputs. However, higher outputs can be realized by increasing the level of resources dedicated to hybrid maize production principally by improving the farmer's contact to credits to purchase inputs like fertilizer and helpful services.

The result of hypothesis test of resource use efficiency of hybrid and open pollinated maize, shows that all the resources used in the production of hybrid and open-pollinated maize were not efficiently utilized.

REFERENCES

Alamu, J.F. (2001). Economic Analysis of Maize Production Using Two Technologies in Kaduna State. J. Arid Agric., 11, 125-129.

Anonymous. (2009). Hybrid vigor. Definition from Answers.com http://www.answers.com/topic/heterosis-1.

Anonymous. (2009). International Institute of Tropical Agriculture (2009); Importance of maize Utilization and processing. http:www.iita.org/cms/details/trn-mat/irg351.html.

CIMMYT, (2007). International Maize and Wheat Improvement Center. Enhanced, Drought-tolerant Maize to Give Farmers Options, Even with Global Warming.

Crow. F.J. (1998). 90 Years Ago: The Beginning of Hybrid Maize. Genetics Soc. Am., 148, 923-928.

Duvick N.D. (1999) Commercial Strategies for Exploitation of Heterosis, For presentation to 'The Genetics and Exploitation of Heterosis in crops, An international Symposium' 17-22 August 1997, Mexico City, Mexico, CIMMYT.

Iken, J.E., Amusa, N.A. (2004). Maize Research and Production in Nigeria. Afr. J. Biotechnol., 3(6), 302-307.

Kogbe, J.O.S., Adediran, J.A. (2003). Influence of nitrogen, phosphorus and potassium application on the yield of maize in the savanna zone of Nigeria. Afr. J. Biotechnol., 2(10), 345-349.

Oguntolu, O.W. (2005). Factors Affecting Participation of Out growers In Certified Hybrid Maize Seed Production In Giwa Local Government Area. Unpublished PGDFM Thesis; Ahmadu Bello University, Zaria.

Russell, W.A. (1974). Comparative performance for maize hybrids representing different eras of maize breeding. Proc. 29th Ann. Corn Sorghum Res. Conf., pp. 81-101.

Shull, G.H., East, E.M. (1910) Hybridization method in corn breeding. Am. Breeder's Magazine 1, 98-107.