

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

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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 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, using the farm survey data collected from 160 maize farming communities in October- December 2009 for the cropping year 2009-10. The result of analysis of resource use efficiency of hybrid and open-pollinated maize shows that all resources were inefficiently utilized because the ratios were not equal to one. The ratio indicated 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 suggests 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.

Key words: Resource % Efficiency % Hybrid % Open pollinated

INTRODUCTION

More than a quarter of a billion Africans depend on maize as their staple food, often eating a quarter kilo or more of maize and maize products every day. Any interference to make maize available, either at the farm level or to the markets, has negative cost for the most vulnerable farmers [1]. Irregular rainfall, persistent drought and loss of soil fertility have all made the maize harvests in Africa vague. At the moment, several farm families cannot grow sufficient food to last the year and do not have income to buy food. Accepting donated food aid is often the only way to survive. This robs families of their dignity and restraints development [2].

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 [3-5]. In Nigeria, many researchers have found improved production technology to be a major factor in effort to become self-sufficient in maize production [6].

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 [7]. These breed are known to be early flowery, drought resistant, more vigorous and uniform, traits not found in the existing open-pollinated breed [8].

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 [5]. 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 [5].

However, paying for these seeds yearly can only be profitable, according to [8] 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. Who 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, concluded by adding that, as a rule of thumb, the first time application of hybrid maize grains, must enable the farmer receive an additional income, equal to at least three times, the added cost of procurement, of the hybrid maize grains.

Rusell, [9] 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 [8]. As sighted in Crow J.F. [10].

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.

MATERIALS AND METHODS

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

- C Demographic information such as age, educational level, farm size, farming experience, number of extension contact.
- C 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;
- C Finally marketing information like prices of inputs and output, quantity sold and mode of sales.
- C Data were also, obtained from Journals, Monogram, Published Books, which are significant to the scope of this study.

Overview of the Study Area: This study was conducted in Giwa Local Government Area of Kaduna State is located between Latitude 11° and 12°N and Longitude 7° and 8°E of the Prime Meridian [4]. Kaduna state is located in the Savannah ecological region of Nigeria, with a cultivatable area of about 34,000 km², the actual area cultivated is about 32,230 km² from an estimated land area of about 43,000 km² [11].

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 practise by farmers in Giwa LGA which is, for the most part cereals (like millet, rice, maize and sorghum); legumes (including cowpea; groundnut and soybean).

There are 23 Local Government Area (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 [4]. The nomadic Fulanis predominantly do the grazing and livestock rearing.

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.

Production Function Analysis: Different functional forms such as square root, quadratic, the linear, the semi-log and the Cobb-Douglas 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:

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

Specification of the Models

Cobb-douglas Production Function

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 (ha)

X_2 = seeds (kg)

X_3 = fertilizer (Kg)

X_4 = Insecticides (litre)

X_5 = Herbicide (litre)

X_6 = Labourn (man – day)

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:

$$r = \frac{M \text{ arginal} - \text{value} - \text{product}}{M \text{ arginal} - \text{factor} - \text{cost}} = \frac{MVP}{MFC}$$

Where

r = Is the efficiency ratio

MFC = Cost of one unit of a particular resource

The MVP Was Estimated as Follows:

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

$$MPP_{xi} = \frac{d_y}{d_{xi}} = b \frac{\bar{Y}}{\bar{X}_i}$$

Where Cobb-Douglas or double log form is the lead equation.

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

In the case of a Cobb-Douglas log form, the values of Log Y and the Log X

Where They Assume Their Arithmetic Means.

Where:

b_1 = 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

RESULTS AND DISCUSSION

Socio-Economic Profile of Respondents: 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 are in active production. Most of hybrid and open-pollinated maize farmers about 54% and 50%, respectively had a family size of 6-15 people. The average family size of 9 persons were obtained for both hybrid and open-pollinated maize farmers. The educational levels of both open-pollinated and hybrid maize farmers 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 4.1.1: Socio-economic characteristics of Hybrid and open-pollinated maize farmers

Age (Years)	Hybrid		Open-pollinated	
	Frequency	Percentage	Frequency	Percentage
# 29	14	18	8	10
30-39	15	19	8	10
40-49	23	29	15	19
50-59	19	19	18	23
60-69	9	11	15	19
\$ 70	4	5	16	20
Family Size				
01-05	14	18	15	19
06-10	24	30	23	29
11-15	19	24	17	21
16-20	19	24	19	24
21-25	3	4	3	4
26-30	1	1	3	4
Educational Qualification				
No formal education	4	5	1	1
Quaranic education	7	9	27	34
Primary education	9	11	16	20
Secondary education	17	21	12	15
Adult education	18	23	15	19
Tertiary education	25	31	9	11
Number of Extension Visits				
Once/month	7	8	5	6
Twice/month	23	29	20	25
Once/2months	31	39	28	35
Not at all	19	24	27	34
Total	80	100	80	100

Source: Field survey data, 2009

Output- Input Relationship in Hybrid and Open-Pollinated Maize Production: The semi-log function was chosen because it gave the most excellent fit to the data, based on its coefficient of multiple determinations, signs of the estimated coefficients and last but not the least the number of significant variables. An adjusted R² value of 0.82, for hybrid maize production and 0.59, for open-pollinated maize production, was reported, 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.

Output-input Relationship in Hybrid and Open-pollinated Maize Production Using Cob-douglas Production Function

Variable	Hybrid			Open-pollinated		
	Co-efficient	Std-Error	T-value	Co-efficient	Std-Error	T-value
Constant	6.55	0.45	14.55**	6.60	0.33	20.07**
Farm area	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-squared	85%			66%		
Adjusted R^2	0.82			0.59		
F-value	22.72**			0.001		
N	80					

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

Marginal Physical Productivity (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. 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, use resources (inputs) more efficiently than open-pollinated maize seed to obtain higher yield.

Marginal physical products of inputs in hybrid ad 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	372.70	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 (man-day)	2240.6	65.12	0.04	1.38	1261.04	55.90	0.37	8.35
Fertilizer (kg)	2240.6	6.04	1.61	597.51	1261.04	2.23	0.36	203.56
Insecticide (Litre)	2240.6	1.07	0.08	67.50	1261.04	0.79	0.16	255.40
Herbicide (Litre)	2240.6	1.41	-0.0	-143.00	1261.04	1.36	-0.11	-102.00

Source: Field survey, 2010 APP = Mean yield/Mean input, MPP = APP*Input elasticity, MPP - Marginal Physical Product

Resource Use Efficiency: The resources used in the production of hybrid and open-pollinated maize were not efficiently utilized. For hybrid maize production, fertilizer and insecticides were underutilized because the ratios were greater than one (6.75 and 2.23), respectively. While the open-pollinated maize counterpart had a fertilizer and insecticides efficiency ratios 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 (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 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 $(\frac{MVP}{MFC})$.

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.

Efficiency of resource use 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 (man-day)	1.38	75.70	400	0.19	8.35	45.91	400	0.11
Insecticide (litre)	167.52	9213.60	950	14.70	255.40	14047.03	950	14.70
Herbicide (litre)	-143.02	-7865.93	1100	-7.10	-102.00	-5009.86	1100	-4.50

Source: Field survey, 2010

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 compared with open pollinated maize, shows that all the resources used in the production of hybrid and open-pollinated maize were not efficiently utilized.

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