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# Economic Evaluation of Irrigated Maize Farms Towards Boosting Maize Productivity: A Case Study of Epe Lga, Lagos State

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**Abstract:** Policy thrusts geared towards radical economic development in Nigeria, over time, has always embraced among other measures, discouragement of imports over exports. Recent moves in agricultural economy of the country had been to discourage rice importation by either direct ban or through other means, seeing that rice is the second largest consumed food commodity in Nigeria. Quite a welcome development this is. Thus, the objective of the study is to investigate the third largest consumed commodity in the world (after wheat and rice). Two key variables focused on in the world over for increased maize production had been improved maize variety and fertilizer. However, this paper attempts to argue for a third variable which could reasonably boost Nigeria's maize production, in this case, irrigation. The study was conducted among small-holder maize farmers in Epe LGA, Lagos State to assess the resource productivity and returns in irrigated maize production. Eighty maize farmers were sampled (40 practising rainfed maize production and 40 depending on irrigation systems) through the use of structured questionnaire. The study revealed that irrigated maize farmers had higher relative productivities, gross revenue, gross margin and net farm income than non-irrigated maize farms.

**Key words:** Maize productivity · Epe Lga · Lagos State

## INTRODUCTION

The Nigerian government in trying to achieve a favourable balance of trade has over the years adopted various measures, prominent among which is ban on importation of certain commodities. A case in hand is the rice situation. Since 2002, the Nigerian government had been making moves to assure sustainable local rice production and by 2006 this is hoped to come to fruition. Efforts such as these are aimed at giving the nation's ailing economy, a new lease of life. A rather pro-active approach towards giving the nation's economy a new lease of life would however not just be to ban importation of certain commodities, but also to encourage enormously the exportation of certain critical commodities. By critical commodities, we mean those commodities for which Nigeria has economics comparative advantage in terms of economic productive resources and which commodities are at the same time of high market demand both locally and internationally.

Food-wise, the most important energy-food source for three-fourth of the world population is grains, chief of which we have wheat, rice, maize, barley, oats and a host of others [1]. According to Pardee [1], corn or maize ranks with wheat and rice as the world's chief grain crops and it is the largest crop of the United States. Given that the focus of the Nigerian government is presently on local rice production while discouraging importation, it seems wise to also adopt local maize production as a twin approach. The relevance of the above assertion is further betrayed in fiscal burden of maize importation on the budget of the Nigerian nation for a long time now, as indicated in Table 1.

The table indicates successive increase in the expenditures of the nation on the importation of maize until the period of the Structural Adjustment Programme (SAP) where stringent economic measures such as ban on importation, were available. Probably, the expenditure on maize importation is still on the increase.

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Table 1: Import of maize on five-year cumulative basis (₦ million)

| Year | Import expenditure | Change (%) |
|---|---|---|
| 1961-1965 | 0.054 | |
| 1966-1970 | 0.958 | 1674.07 |
| 1971-1975 | 2.178 | 127.35 |
| 1976-1980 | 219.863 | 1303.94 |
| 1981-1985 | 129.818 | 32.54 |
| 1986-1990 | 15.080 | -88.38 |
| 1991-1995 | 35.710 | 136.80 |

Source: Nigeria trade summaries, 2000

Maize or corn as it is commonly known is an important staple and animal feed. The world output of corn according to Moseman [2] in the early 1990's stood at more than 469 million metric tons annually. The United States of America is noted as the leading corn-growing country with more than 40% of the world's production. The success of America can be traced to the so-called Green Revolution. According to Moseman [2], in the 1960s, improved grain crop varieties with higher yields, stronger pest resistance and greater response to fertilizers improved productivity throughout much of the world. Pardee [1] suggested that observations in the 1980s indicated that intensive cultivation with heavy use of fertilizer and herbicides resulted in a net gain of about 11% in total corn or maize production. Today, Nigeria is still predominantly at this stage of production experience. Given the fact that corn originated in sub-tropical areas, a country like Nigeria, though tropical in climate, stands a better comparative advantage production wise.

Learning from the American experience, one would see that not just improved grain crop varieties with higher yield or strong pest resistance is all it took to be the world's leading maize producer. Moseman [2] explained that the rapid expansion of irrigation systems made it possible for the extension of corn acreage into drier areas in the Central and Western United States. Herein lies the key.

Some 2.4 billion people depend on irrigated agriculture for food and livelihood. Irrigation provides about 30% of the world's food from only 16% of the globally cropped area [3]. Irrigation is the artificial watering of land to sustain plant growth and is practiced in all parts of the world where rainfall does not provide enough ground moisture. Irrigation dates as far back as 5000 BC. In 1800, about 8.1 million hectares of land were under irrigation; this rose to 41 million hectares in 1900; to 105 million hectares in 1950 and to more than 222 million hectares today [4]. For maize, the average rain-fed yield is 3.4 tons per hectare in developed countries and for developing countries 1.8 tons per hectare. Irrigated yield for the same is 4.2 tons per hectare in developed countries and 2.9 tons per hectare in developing countries [5]. So, herein lies the evidence. Leading Asian food-grain producers rank high in the lists of countries with land area given to irrigation as is indicated in Table 2.

Table 2: Five leading countries with land hectarage under irrigation

| Country | Hectarage of land (million) |
|---|---|
| China | 77.0 |
| India | 39.0 |
| USA | 21.4 |
| Pakistan | 12.4 |
| Russia | 11.5 |

Source: Microsoft encyclopedia, 2004

In light of these above stated facts, irrigation could be considered as an essential factor towards furthering the betterment of maize production and productivity in Nigeria.

**Review of literature:** The literature work used as the basis of this work is that by Akintola [6]. His work underlined the importance of the water-element in maize production among other variables. Akintola [6] in forecasting food crop yields for maize and other crops based the work on certain meteorological variables. Secondary data were collected for the study over a 25 year period. Four related methods were adopted for analysis, among which were simple and multiple regression, Parvins method of decomposing yield variations and Minzer-Zarnowitz method of forecast evaluation. With respect to maize, the regression results showed that meteorological variables had a positive and enduring effect and was found to be relevant for forecasting crop yields. Total rainfall, the number of rainy day, soil temperature and time trend were among such meteorological variables. The result from the Parvins method indicated that if ideal weather condition had occurred every year, there would have been considerable increases in yields. For maize, this analytical method indicated 43.35% of total output. This last statement shows what is foregone, i.e. the opportunity cost of not adopting irrigation in maize production.

Rosegrant *et al*. [5] in their work beyond the shores of Nigeria and in the international scenarios investigated the impacts of irrigation water (referred to as IMPACT-WATER projections) on the world food prices in dollars per metric ton. Four different conditions were studied with respect to their impact on world food prices: they are the condition of Business-as-Usual (BAU), condition of low investment in irrigation development and water supply but high increases in rain-fed area and yield (LINV-HRF); and condition of low investment in irrigation development and water supply but high increase of effective rainfall use scenario. World maize prices per metric tons was highest under condition of no improvement in effective rainfall use scenario (at $106/mt), followed by condition of low investment in irrigation development and water supply but high increase of effective rainfall use (at $108/mt), followed by conditions of business-as-usual (at $106/mt); the lowest world prices for maize was obtained under condition of low investment in irrigation development and water supply but high increases in rain-fed area and yield. This shows that irrigation has a way of reducing world price of maize, ensuring benefit to both the producers and consumer no matter how little the investment.

On these bases, the general objective of this work is to investigate the economic attractiveness or otherwise of irrigated maize farms over rain-fed maize farms.

**Objective of the Study:**

- To compare the relative productivities of rain-fed maize farms with irrigated maize farms.
- To compare the gross margin from rain-fed maize farms with irrigated maize farms.
- To compare the net farm income from rain-fed maize farms with irrigated maize farms.
- To proffer recommendations based on findings.

## MATERIALS AND METHODS

**Area of study:** The area covered during the course of execution of this study was Epe Local Government Area of Lagos State, Nigeria. Ogun-Oshun River Basin Development Authority had a station operating in this area located in Itoikin. Other villages covered included Ajebo, Agbowa, Araga, Orugbo, Imota, Ketu, Molajoye, Igbonla and Mutakun.

**Methods of data collection:** Primary data was collected through personal interview and by the use of well structured questionnaire. 80 respondents were selected by simple random sampling, 40 of which were practicing irrigation farming and the other 40 practicing mainly rain-fed farming; meanwhile, all the 80 respondents practiced mixed cropping which included maize.

The empirical result presentation

NB: a 5%
b 10%
* Lead equation

The three functional forms used in estimating the production models were linear, semi-logarithm and double logarithmic (Cobb-Douglas) functions. The results are presented in Table 3-5 for the 80 sampled farmers, 40 sampled irrigated farms and 40 sampled non-irrigated farms respectively. The Cobb-Douglas equation was

Table 3: Regression result of the 80 farmers

| Functional forms | $B_0$ | $b_1$ | $b_2$ | $b_3$ | $b_4$ | $b_5$ | $b_6$ | F | $R^2$ | Adj $R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Linear | -568.47[a] | 573.10[a] | 63.72[a] | -1.34 | 855.74[a] | 0.009[b] | 0.05[a] | 208.41 | 0.9456 | 0.9410 |
| Standard error | 202.33 | 182.91 | 33.13 | 2.12 | 68.13 | 0.005 | 0.02 | | | |
| T value | -2.81 | 31.33 | 1.923 | 0.633 | 12.561 | 1.673 | 2.192 | | | |
| *Double log | 6.08[a] | 0.49[a] | 0.09[a] | 0.019 | 0.93[a] | 0.013 | 0.039[b] | 121.11 | 0.9098 | 0.9023 |
| Standard error | 0.19 | 0.098 | 0.017 | 0.047 | 0.056 | 0.01 | 0.008 | | | |
| T value | 32.77 | 4.997 | 5.227 | 0.404 | 16.552 | 1.278 | 5.135 | | | |
| Semi-log | -1543.64[b] | 1077.9[a] | -86.05 | 368.55[b] | 1902.1[a] | 45.22 | 43.39 | 20.14 | 0.7152 | 0.6915 |
| Standard error | 813.91 | 428.19 | 73.25 | 203.91 | 245.42 | 33.47 | 33.47 | | | |
| T value | -1.897 | 2.517 | -1.175 | 1.807 | 7.75 | 1.296 | 1.296 | | | |

Table 4: Regression result of 40 irrigation farmers

| Functional forms | $B_0$ | $b_1$ | $b_2$ | $b_3$ | $b_4$ | $b_5$ | $b_6$ | F | $R^2$ | Adj $R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Linear | 972.61[b] | 549.38 | 15.99 | -18.38 | 1131.9[a] | -0.002 | 0.0612 | 117.52 | 0.9553 | 0.9472 |
| Standard error | 504.72 | 363.87 | 53.67 | 13.74 | 192.86 | 0.015 | 0.0605 | | | |
| T value | 1.927 | 1.51 | 0.298 | -1.338 | 5.869 | -0.125 | 1.012 | | | |
| *Double log | 2.12[a] | 0.40[a] | 0.02 | -0.20[a] | 0.55[a] | 0.51[a] | 0.003 | 124.57 | 0.9577 | 0.9500 |
| Standard error | 0.57 | 0.13 | 0.097 | 0.08 | 0.12 | 0.07 | 0.0075 | | | |
| T value | 3.698 | 3.218 | 0.184 | -2.630 | 4.499 | 7.721 | 0.433 | | | |
| Semi-log | -1360.72 | 1135.81 | 230.61 | -16.13 | 3086.5[a] | 5.42 | -1.17 | 18.59 | 0.7717 | 0.7302 |
| Standard error | 3359.61 | 735.37 | 567.39 | 451.20 | 718.29 | 389.57 | 43.94 | | | |
| T value | -0.405 | 1.545 | 0.406 | -0.036 | 4.297 | 0.014 | -0.027 | | | |

Table 5: Regression result of 40 non-irrigation farmers

| Functional forms | $B_0$ | $b_1$ | $b_2$ | $b_3$ | $b_4$ | F | $R^2$ | Adj $R^2$ |
|---|---|---|---|---|---|---|---|---|
| Linear | -492.40[a] | 618.02[a] | 804.93[a] | 1.78 | 0.011[b] | 147.42 | 0.9455 | 0.9491 |
| Standard error | 229.11 | 237.04 | 73.82 | 2.24 | 0.005 | | | |
| T value | -2.149 | 2.60 | 10.904 | 0.794 | 1.886 | | | |
| * Double log | 6.42[a] | 0.49[a] | 0.89[a] | 0.013 | 0.004 | 142.44 | 0.9437 | 0.9371 |
| Standard error | 0.20 | 0.099 | 0.05 | 0.047 | 0.009 | | | |
| T value | 32.095 | 4.911 | 17.74 | 0.274 | 0.432 | | | |
| Semi-log | -776.20 | 1171.3[b] | 1686.1[a] | 281.69 | 22.22 | 20.70 | 0.7089 | 0.6746 |
| Standard error | 1098.29 | 544.25 | 275.08 | 259.23 | 47.75 | | | |
| T value | -0.707 | 2.152 | 6.129 | 1.087 | 0.465 | | | |

chosen as the lead equation, among others, based on relative agreement with the a priori expectation of the parameters and the statistical and econometric criteria.

The equations are as follows:

$$Y = 6.08 + 0.49\,X_1 + 0.09\,X_2 + 0.019\,X_3 + 0.93\,X_4 + 0.013\,X_5 + 0.039\,X_6 \quad R^2 = 0.9098$$
(0.19) (0.098) (0.017) (0.047) (0.056) (0.01) (0.008) F = 121.11 (1)

$$Y = 2.12 + 0.40\,X_1 + 0.02\,X_2 - 0.20\,X_3 + 0.55\,X_4 + 0.51\,X_5 + 0.003\,X_6 \quad R^2 = 0.9577$$
(0.57) (0.13) (0.097) (0.08) (0.12) (0.07) (0.0075) F = 124.57 (2)

Where, Y = output of maize (kilogram)
$X_1$ = seed variety (dummy: local = 0; improved = 1)
$X_2$ = irrigation experience (years)
$X_3$ = labour input (man-days)
$X_4$ = land size (hectares)
$X_5$ = costs of other inputs (N)
$X_6$ = costs of irrigation infrastructures (N)

$$Y = 6.42 + 0.42\,X_1 + 0.89\,X_2 + 0.013\,X_3 + 0.004\,X_4 \quad R^2 = 0.9437$$
(0.20) (0.099) (0.05) (0.047) (0.009)
F = 142.44 (3)

Where, Y = output of maize (kilogram)
$X_1$ = seed variety (dummy: 0 = local; 1 = improved)
$X_2$ = land size (hectare)
$X_3$ = labour input (man-days)
$X_4$ = cost of other inputs (N)

Equations 1, 2 and 3 represent the models for the 80 sampled farms, 40 sampled irrigated farms and 40 sampled non-irrigated farms respectively. The $b_i$'s represent the marginal productivities of the variable inputs, while the $b_0$ is the intercept. The figures in parentheses are the standard errors. In equation 1, the essential variable inputs for all the sampled farms were $X_1$, $X_2$, $X_4$ and $X_6$, which were significant at 5 and 10%. It could be noticed that irrigation experience and costs of irrigation infrastructures, both were highly significant with 5 and 10% levels of significance respectively.

In equation 2, $X_2$ and $X_6$ were not significant at 10% among the sampled irrigated farms; this was because only irrigated farms were solely considered in the equation. $X_3$ in equation 2 had a negative marginal productivity. This implies an over-utilization of labour input among the sampled irrigated farms. It might be advisable that the irrigation farmers should reduce the amount of labour input in order to achieve the goal of profit maximization.

In equation 3, $X_1$,$X_2$ and $X_4$ are significant at 5% and 10%. Seed varieties and land size were the most significant variable inputs. The improved seed varieties seemed to be more productive than the local varieties. This is because they are bred for high yield and resistance against pests, diseases and drought. Land size was discovered to be directly proportional to output.

Maize monocropping was an uncommon practice in the study area; hence it was advisable to consider other crops when computing the gross margin analysis. These other crops included leafy vegetables, tomato, pepper, okra, cassava and yam, among other crops. From Table 6 and 7, it could be deduced that irrigation systems had higher investment costs than rain-fed systems. However, it had more than twice the gross revenue from maize, the gross margin and the net farm income, compared to the non-irrigated systems. This would suitably draw a conclusive assertion that irrigated systems are more productive than rain-fed systems.

Table 6: Gross margin per hectare of irrigated and non-irrigated maize-based farms

| Items | Rain-fed farms | Irrigated farms |
|---|---|---|
| Gross revenue from maize | 9136.14 | 19242.48 |
| Gross revenue from other crops | 10987.16 | 14704.92 |
| Total variable cost | 12654.46 | 16124.39 |
| Gross margin per hectare | 7468.84 | 17823.01 |

Source: Field survey, 2000

Table 7: Net farm income per hectare of irrigated and non-irrigated maize-based farms

| Items | Non-irrigated farms | Irrigated farms | Irrigated/non-irrigated ratio |
|---|---|---|---|
| Gross revenue (Maize) | 9136.14 | 19242.48 | 2.11 |
| Gross revenue (other crops) | 10987.16 | 14704.92 | 1.34 |
| Total variable Cost | 12654.46 | 16124.39 | 1.27 |
| Gross margin | 7468.84 | 17823.01 | 2.39 |
| Total fixed cost | 643.15 | 2910.62 | 4.53 |
| Net farm income | 6825.69 | 14912.39 | 2.19 |

Source: Field survey, 2000

**Findings and recommendation:** The sources of irrigation water among the sampled farmers were the river basin of Ogun-Oshun River Basin Development Authority, springs and underground aquifers, with over 70% dependent on the river basin. It was discovered that farmers that were dependent on the irrigation system of Ogun-Oshun River Basin Development Authority had the most productive performance with average output per hectare being 1.023 tons per hectare. Those deriving their irrigation water from springs had average output per hectare as 0.8 tons per hectare and the performance of farms with irrigation water from underground aquifer was 0.44 tons per hectare. Average output of irrigated systems was discovered to be 0.96 tons per hectare, as against 0.91 tons per hectare for rain-fed systems. All these figures are relatively low when compared to expectation. This might be due to poor management of resources and seasonality of water volumes (in cases of springs and underground aquifers). However, the high productivity of the RBDA's farmers might not be unconnected with the improved technology inputs involved, which might be inadequately available in other sources of irrigation water. These included improved seed varieties, tractor facilities, herbicides, pesticides and fertilizers. The RBDA ensured the availability of these inputs for successful irrigation programme.

Therefore, farmers should be encouraged to avail themselves of the opportunities of the irrigation programmes organized by the River Basin Development Authorities within their localities. This could be enhanced by forming farmers' co-operatives to obtain water resources and other essential inputs, necessary for improved production and productivity of maize. In addition, farmers should usually obtain improved seed varieties from reliable sources. Moreover, farmers practicing irrigated farming in the study area should reduce the level of labour input which was being over-utilized. This is in order to achieve profit maximization goal.

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