# RESOURCE USE EFFICIENCY IN MAIZE-RICE INTERCROPPING IN BOSSO LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA

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**ABSTRACT**
The study examined resource-use efficiency of maize-rice intercropping in Bosso Local Government Area of Niger State. Primary data were used for this study in which seventy respondents were randomly selected using structured questionnaires out of which sixty with vital and reliable information were retrieved. The data were analysed using descriptive statistic, gross margin, and production function. The result shows that 30% of the respondents fall below 45 years of age and 81.67% of them are married. Majority (41.66%) of the respondents had no formal education. About 67% of the respondents had farming as their primary occupation. The predominant system of land tenure in the area is through inheritance. The estimated gross income gives an average value of ₦ 192,116.04k per hectare/annum, while net farm income was estimated at ₦54,723.71k respectively. The production function shows that farm size($X_1$), capital input ($X_4$) and planting material ($X_5$) were significant factors influencing output of maize-rice at 1%, 10% and 5% level of probability respectively. The efficiency ratio indicates that farm size and planting materials were underutilized and capital input was over utilized. Elasticity of factor input and return to scale give an estimated value of 1.194 which implies an increasing return to scale. The major problems faced by the farmers are high cost of transportation, price fluctuation, poor storage facilities and high cost of farm input incentives. It is concluded that maize-rice intercropping are profitable in the study area. It is also recommended that good roads should be provided for the farmers for easy transportation of their farm produce and provision of improved varieties of seeds should be made available to the farmers at a timely manner and at affordable price.
**Keywords:** Efficiency, Gross Margin, Maize, Net, Income, Rice, Resource-use

## INTRODUCTION

Maize (*Zea mays*) is a mono plant which bears male organs, the stamens and the female organ (Okoruwa, *et al*., 2006). It is the most efficient plant for capturing the energy of the sun and converting it to food (Maigida *et al*., 2003). Maize therefore serve as core of the major source of calories in Nigeria as well as other part of the world (Okoruwa *et al.*, 2006). It is important in human nutrition as an excellent source of carbohydrate and good quality oil (Maigida *et al*., 2003). It is ecologically processed in to fraction of grains, hull and endosperm for production of a wide range of product for various uses (Maigida *et al*., 2003).

Rice (*Oryza sativa*) on the other hand, is a staple food of the most important cereals crops in Nigeria, Africa and the world at large. A sample of milled rice grain on average will contain about 80% starch, 7-10% protein, 0.5% ash and 12% water (Grist, 2008). It is important in starch making for clothes, food and cosmetics (Abo, *et al*., 2008). Rice is economically processed through soaking/steeping, steaming\per boiling and drying. This process changes both the physical and chemical qualities of milled rice (Chang, 2006).

In Nigeria the major factors responsible for the declining agricultural productivity is farmers' limited access to production inputs which are necessary for attaining a high level of production (Alabi, 2008). It is observed that crop farmers mostly carry out their production under conditions involving seed varieties. The farmers in Bosso Local Government Area do not grow on a large scale farm land due to inadequate funds, inadequate fertilizers; poor road network to transport farm produces to urban areas, lack of good storage fertilities, poor communication and so on. The problems lead to the low quality yields produce of farmer (Akobundu and Fagade, 2008).

The broad objective of the study is to determine resource - use efficiency of maize - rice intercropping in Bosso Local Government Area of Niger State while the specific objectives were to: describe the socio-economic characteristics of respondents, determine the factors affecting maize - rice intercropping, determine the various costs and returns involved in maize - rice intercropping, evaluate the economy of scale for maize - rice intercropping and to identify the constraints affecting maize - rice intercropping in the study area

The study of the resource-use efficiency of maize-rice intercropping in Bosso Local Government Area of Niger State will provide the needed information for proper understanding of these constraints and how to manage them by farmers in the study area. It would also serve as source of material to

students and researchers who want to conduct research on similar or related work.

## METHODOLOGY

### The Study Area

Bosso Local Government Area (LGA) is the study area and is one of the 25th LGA's of Niger State. However, it is characterized by two distinct seasons, the dry and wet seasons. Niger State is located within latitudes 8° 12°N 1 1°30N and Longitudes 3°30°E-7°20E.

A purposive sampling technique was used to select Bosso Local Government Area. This is because maize - rice intercropping is practiced more in those areas. A simple random sampling technique was used to select the respondents so as to give each respondent equal opportunity to be selected.

### Sampling Technique and Sample size

The Local Government Area is divided in to two districts and under these districts are villages and wards. The districts are:- Bosso and Maikunkele, from each districts five villages were randomly selected. The selected villages from Bosso district are: Gada, Shatta, Garratu, Sabondaga and pompo. While, those selected from Maikunkele were: Jimi, Kampala, Yamma, Popoi and Kudu. From each of the sampled villages, 10% of the maize-rice respondents were randomly selected, which bring the total sample size to 60 farmers.

### Data Collection

Primary data were used for the study which were obtained by the used of sixty (60) structured questionnaires. Information collected included: Socio - economic characteristics of the respondents such as: Age, Education level, Sex, Marital status, Household size and so on; production variables such as output of rice, output of maize, labour input, capital input and marketing variables like price of inputs and price of outputs.

### Data Analysis

Descriptive statistics such as mean, frequency distribution, percentages and coefficient of variation were used to analyzed the data collected. Also, inferential statistics such as multiple regression analysis, Gross margin analysis, Resource – use efficiency, Elasticity of production and Return to scale were used. The coefficient of variation and multiple regression analysis were used to determine the extent to which the input used explained the variability in the output. To estimate the production function, the linear, semi-log and cobb-dougglas regression functions were employed. The best regression fit was determined by a combination of $R^2$, the level of significant of the overall equation (f-statistics), the level of significant of each coefficient (t-statistics) and correct signs of the coefficient relative to apriority expectation (Olayemi and Olayide, 2001).

### Models specification

i. The coefficient of variation is stated as:

CV = SD/X .100

Where:

CV = Coefficient of Variation

SD = Standard -Deviation and

X = mean

ii. The regression model is written as:

$Y= f(X_1, X_2, X_3, X_4, X_5, X_o, \ldots e)$

Where:

Y = output of maize-rice (kg)

$X_1$ = farm size (Ha).

$X_2$'= fertilizer used (kg).

$X_3$ = labour inputs (man-days)

$X_4$= capital inputs

$X_5$ = planting materials (kg).

$X_6$ = Agrochemicals (litres).

E = error

Explicitly, these functions take the following forms:

Y = za+ b x1 +b2x2+b3x3+b4x4+b5x5+b6x6+e (linear)

Logy = a+ bi x1 +b2x2+b3x3+b4x4+b5x5+b6x6+e (semi-log)

Logy = a-f-b1 x1 +b2x2+b3x3+b4x4+bsxs+b6x6+e (double log)

The resource use efficiency was computed for each resource input used as follows:

$$r = \frac{MVP}{MFC}$$

Where:

r = efficiency ratio

MVP = marginal value product of a variable input.

MFC= marginal factor cost the mvp was estimated as follows

MVP = mpp.py

PY = price of output

If r = 1, resources were efficiently used, if r > 1, resources were underutilized, if r < 1 the resources were over utilized.

iii. Elasticity of production and return to scale was used and was computed for input used as follows:

$$Epi = RTs \quad (1 = i \text{ to } n)$$

Where;

$Ep_i$ = Elasticity of productions of input x:

$RT_S$ = Return to scale (sum of elasticity of production).

Gross margin (GM) is the difference between gross income (GI) and the total variab1e cost (TVC) and is expressed as follows:

GM = GI -TVC

Where:

GM = Gross margin

GI = Gross income

TVC = Total variable cost

## RESULTS AND DISCUSSION

### 1. Socio-Economic Characteristics of the Respondents

Table 1 shows that 70% of the respondents were male while 30% of were female. This shows that maize - rice inter-cropping is mostly done by men in Bosso LGA, Niger State. This could be because most women in this State are secluded in purdah and restricted to house activities than those of farming.

The table also shows that 81.67% of the respondents were married while 18.33% were single, indicating that most of them were responsible and more reason to engage in inter-cropping of maize and rice in the study area.

It can also be seen that 75% of respondents fall within the age bracket of 25 - 45 years old. Furthermore, 25% of the sampled farmers were 46 years and above old. Rahman *et al* (2002) believed that farmer's age may influence adoption in several ways. Older farmers may have more resource that makes it more likely for them to try new technologies. On the other hand, it may be that younger farmers are more likely to adopt than older farmers because of better education and more exposure to new ideas.

The table reveals that majority of the household size (83.33%) had between 1-20 persons in their household while 13.33% had 21-30 persons.

Table 1 also shows that majority (66.67%) of maize – rice farmer's respondents took farming as their only occupation while 13.33% of them were into farming and trading, 10% as farmers and civil servants and another 10% combined farming and studies.

It is noted from the table that 34.99% of the respondents had no formal education. In addition, 64.93% of sampled respondents had no formal education. Njoku (2006) observed that formal education has a positive influence on adoption of innovation.

The table reveals that majority (66.67%) the respondents had farming experience of more than 10 years while about 25% of them had 6-10 years of experience in maize - rice intercropping

Table 1 also shows that majority (43.33%) of the respondents grow maize - rice for consumption and selling purposes. Furthermore, 10% of sampled respondents grow maize-rice mixtures for consumption only, 20.00% grow maize-rice mixtures for selling only while 26.67% of the respondents grow maize - rice mixtures for educating their children.

It is also reveals that 70% of respondents acquired land used for maize - rice production through inheritance, while about 8.33% of sampled respondents borrowed the land used for maize - rice production. Alamu *et al* (2002) believed that respondents with more resources including land is more likely an advantage of new technology.

The table indicates that 83.33% of the respondents used hired labour, 13.33% used family labour while 3.33% combined family and hired labour.

Table 1 also reveals that 68.33% of used hand tools as mode of land cultivation, 25.00% sampled respondents used tractor as mode of land cultivation and 6.67% of them used animal traction as mode of land cultivation. Ogungbile *et al*. (2002) stated that respondents' ownership of equipment may influence their ability to adopt the improved technology, for example, a respondents who own work bulls and tractor or implement will be more amenable to adopting a planting date.

The table indicates that 68.33% of the respondents had less than five hectares of land while 31.67% of them had between 6-9 hectares of land.

The table shows that 58.33% of the sampled respondents store their grains in barn while. 41.67% of sampled respondents store their maize-rice in silo

Table 1 indicates that 66.67% of the respondents acquired their capital for maize - rice production through personal savings, 16.67% of the respondents acquired their capital through loans from family and friends, 16.67% of the respondents acquired capital from cooperatives. Rahman *et al*, (2002) indicated that access to capital; age and experience in farming may explain the tendency to adopt innovation and new technology

**Table 1: Socio-Economic Characteristics of the Respondents**

| Variables | Frequency | Percentage |
|---|---|---|
| **Sex** | **Frequency** | **Percentage** |
| Male | 42 | 70.00 |
| Female | 18 | 30.00 |
| **Total** | **60** | **100.00** |
| **Marital Status** | **Frequency** | **Percentage** |
| Married | 49 | 81.67 |
| Single | 11 | 18.33 |
| **Total** | **60** | **100.00** |
| **Age (years)** | **Frequency** | **Percentage** |
| 25 -35 | 15 | 25.00 |
| 36-45 | 30 | 50.00 |
| 46-55 | 10 | 16.67 |
| 56 and above | 5 | 8.33 |

| | | |
|---|---|---|
| **Total** | **60** | **100.00** |
| **Family** | **Frequency** | **Percentage** |
| 1-10 | 35 | 58.33 |
| 11-20 | 15 | 25.00 |
| 21-30 | 8 | 13.33 |
| 31 and above | 2 | 3.33 |
| **Total** | **60** | **100.00** |
| **Occuption** | **Frequency** | **Percentage** |
| Farming only | 40 | 66.67 |
| Farming/Trading | 8 | 13.33 |
| Farming/Civil servant | 6 | 10.00 |
| Farming/Students | 6 | 10.00 |
| **Total** | **60** | **100.00** |
| **Education level** | **Frequency** | **Percentage** |
| Primary education | 8 | 13.33 |
| Secondary education | 8 | 13.33 |
| Tertiary education | 5 | 8.33 |
| No formal education | 39 | 64.93 |
| **Total** | **60** | **100.00** |
| **Years of experience** | **Frequency** | **Percentage** |
| 1-5 | 5 | 8.33 |
| 6-10 | 15 | 25.00 |
| 10 and above | 40 | 66.67 |
| **Total** | **60** | **100.00** |
| **Cropping pattern** | **Frequency** | **Percentage** |
| Selling | 12 | 20.00 |
| Consumption | 6 | 10.00 |
| Consumption and Selling | 26 | 43.33 |
| Educating children | 16 | 26.67 |
| **Total** | **60** | **100.00** |
| **Mode of land acquisitions** | **Frequency** | **Percentage** |
| Inheritance | 42 | 70.00 |
| Lease | 10 | 16.67 |
| Purchase | 3 | 5.00 |
| Borrowing | 5 | 8.33 |
| **Total** | **60** | **100.00** |
| **Types of labour** | **Frequency** | **Percentage** |
| Family labour | 8 | 13.33 |
| Hired labour | 50 | 83.33 |
| Family and hired labour | 2 | 3.33 |
| **Total** | **60** | **100.00** |
| **Mode of land cultivation** | **Frequency** | **Percentage** |
| Hand tools | 41 | 68.33 |
| Tractor | 15 | 25.00 |
| Animal traction | 4 | 6.67 |
| **Total** | **60** | **100.00** |
| **Size of farmland** | **Frequency** | **Percentage** |
| 1 -5 | 41 | 68.33 |
| 6-9 | 19 | 31.67 |
| **Total** | **60** | **100.00** |
| **Mode of storage** | **Frequency** | **Percentage** |
| Barn | 35 | 58.33 |
| Silos | 25 | 41.67 |
| **Total** | **60** | **100.00** |
| **Source of capital** | **Frequency** | **Percentage** |
| Personal saving | 40 | 66.67 |
| Loans from family/friends | 10 | 16.67 |
| Loans from cooperatives | 10 | 16.67 |
| **Total** | **60** | **100.00** |

**Field Survey, 2023**

**2. Cost and returns analysis**

Table 2 indicates the costs and returns analysis of sampled respondents. The various cost incurred on different types of resources used and the revenue obtained from respondents there as at the period based on the prevailing market price as at the period of survey were shown on the table. Because the sampled farmers were small scale, their fixed costs was negligible, so only the variable cost were considered. The gross income estimated gives an average value of ₦192, 116.04 per annum and net farm income was estimated at ₦54, 723.71 per annum.

**Table 2: Distribution of respondents by Average Gross Margin**

| Variable cost | Average cost (₦) per year |
|---|---|
| Transportation | 41,620.00 |
| Cost of loading and offloading | 15,200.03 |
| Commission agent cost | 5,100.02 |
| Hired labour cost | 50,132.06 |
| Maize seed cost | 6,000.04 |
| Rice seed cost | 5,250.01 |
| Storage cost | 4,360.07 |
| Fertilizer cost | 5,780.00 |
| Agrochemical cost | 3,950.08 |
| Total variable cost | 137,392.33 |
| Gross/income | 192,116.04 |
| Net income | 54,723.71 |

**Source: Field Survey, 2023**

**3. Multiple Regression Analysis for Sampled Respondents**

Table 3 presents the multiple regression results. The linear equation was chosen as the lead equation. The $R^2$ value of 0.789 reveals that 78.9% of the variation in the dependent variable was explained by the independent variables ($X_1$- $X_6$) included in the model. The variable $X_1$ and F-value were significant ($P<0.01$) and the $X_5$ was significant ($P<0.05$). The $X_4$ was significant ($P<0.010$).

**Table 3: Multiple Regression Analysis and Descriptive Statistic of Sampled Respondents**

| Variables | Linear | | Semi log | | Double log | | Exponential | |
|---|---|---|---|---|---|---|---|---|
| | Coefficient | t-value | Coefficient | t-value | Coefficient | t-value | Coefficient | t-value |
| Constant | -1914445 (375774.017) | -0.051 | -427145 (293195.8) | -0.146 | (1.003) | 11.9***86 | 11.442 (0.419) | 77.033*** |
| Farm size $X_1$ | 92739.1201 (8929.197) | 0.389*** | 230941.0 (31076.297) | 7.431 | 0.920 (0.106) | 8.653*** | 0.333 (0.32) | 9.447*** |
| Fertilizer $X_2$ | 861.028 (888.685) | 0.970 | 36376.246 (43709.461) | 0.832 | 0.146 (0.150) | 0.974 | 0.004 (0.004) | 1.084 |
| Labour Input $X_3$ | 1.694 (1.711) | 6.990 | 15967.150 (20970.937) | 0.761 | 0.004 (0.027) | 0.057 | 4.68E-006 (0.000) | 0.692 |
| Capital Input $X_4$ | 0.619 (0.342) | 1.812* | 4874.842 (7963.826) | 0.612 | 0.010 (0,027) | 0.0363 | 2.05E-006 (0.000) | 1.519 |
| Planting Material $X_5$ | -1.509 (0.690) | -2.189** | 13809.7 (13098.508) | -1.054 | -0.055 (0.045) | -1.233 | -5.1E-006 (0.000) | -1.862* |
| Agrochemicals $X_6$ | -3.720 (10.376) | -0.359 | -7964.784 (25508.298) | -0.312 | -0.073 (0.087) | -0.834 | -3.6E-005 (0.000) | -0.874 |
| $R^2$ | 0.789 | | 0.700 | | 0.735 | | 0.751 | |
| F-Value | 33.084*** | | 20.186*** | | 24.068*** | | 26.707*** | |

**Source: Field survey, 2023**

***Significant at 1% Level of Probability
**Significant at 5% Level of Probability
*Significant at 10% Level of Probability

**4. Descriptive Statistics and other Parameters of Sampled Respondents**

Table 4 observes that $X_3$ had the highest variability with coefficient of variation of 137. 26%. Also, $X_6$ had the lowest variability with coefficient of variation of 38.23%.

**Table 4: Descriptive Statistics/Other Parameters of Sampled respondents**

| Variable | Y | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ |
|---|---|---|---|---|---|---|---|
| Mean | 295381.67 | 2.98 | 36.53 | 4167.50 | 54840.00 | 28033.33 | 2568.33 |
| Standard Deviation | 140971.536 | 1308 | 11.423 | 5730.346 | 28553.674 | 16305.314 | 981.954 |
| Coefficient of Variation C.V (%) | 47.73 | 43.89 | 31.67 | 137.26 | 52.06 | 58162568.33 | 38.23 |

**Source: Field Survey, 2023**

**5. Resource Use Efficiency of Sampled respondents**

Table 5 reveals that the estimated efficiency ratio (r) shows that two significant inputs ($X_1$ and $X_5$) in the model were underutilized, while $X_4$ was over utilized. This implies that the resources ($X_1$ and $X_5$) were not efficiently utilized.

**Table 5: Distribution of the Respondents by Estimated Efficiency ratio(r)**

| Variable | Mpp | Mvp | Mfc | r (efficiency ratio) |
|---|---|---|---|---|
| Land ($X_1$) | 92739.120 | 37,095,648 | 4,000 | 9,273,912 |
| Capital ($X_4$) | 0.6 19 | 123.8 | 2,289.89 | 0.054063 |
| Planting materials ($X_5$) | -1.509 | 30L8 | 20.00 | 15.09 |

**Source: Field Survey, 2023**

**6. Elasticity of Production and Return to Scale of Sampled respondents**

Table 6 indicates that, the elasticity of production was less than 1 for the farm size ($X_1$); fertilizer inputs ($X_2$); and labour inputs ($X_3$). The sum of elasticity of production otherwise called return to scale was estimated at 1.194 which implies increasing return to scale.

**Table 6: Distribution of Respondents by Estimated Elasticity of Production and Return to Scale**

| Variable | r (efficiency ratio) |
|---|---|
| Land($X_1$) | 0.936 |
| Capital ($X_4$) | 0.115 |
| Planting materials ($X_5$) | 0.143 |
| **Total** | **1.194 (Return to Scale)** |

**Source: Field Survey, 2023**

**7. Constraints Encountered by the Respondents**

**1. Marketing Problems faced by the respondents**

Table 7 reveals the marketing problems encountered by the respondents. These include: market price fluctuation (33.33%), high cost of transportation (41.67%), and dubious act of middlemen (25.00%) respectively.

**2. Production Problems faced by the respondents**

It can be seen from the table 7 that 46.67% of the respondents were faced by inadequate capital, 31.67% of respondents had pest and diseases infestation as their major constraint, while 21.67% of them complained of lack of rainfall at the right time.

**3. Storage Problems Encountered by Respondents**

Table 7 indicates that 66.67% of the respondents had problems of insect/pest infestation in storage, 25.00% of the respondents had problems of diseases attack on their produce, while 8.33% of them had problems of theft.

**Table 7: Constraints Encountered by the Respondents**

| Variables | Frequency | Percentage |
|---|---|---|
| **Marketing Problems** | **Frequency** | **Percentage** |
| Market price fluctuation | 20 | 33.33 |
| High cost of transportation | 25 | 41.67 |
| Dubious act of middlemen | 15 | 25.00 |
| **Total** | **60** | **100.00** |
| **Production Problems** | **Frequency** | **Percentage** |
| Inadequate capital input | 28 | 46.66 |
| Pest and diseases attack | 19 | 31.67 |
| Lack of rainfall at the right time | 13 | 21.67 |
| **Total** | **60** | **100.00** |
| **Storage Problems** | **Frequency** | **Percentage** |
| Insect/pest attack | 40 | 66.67 |
| Diseases | 15 | 25.00 |
| Theft | 5 | 8.33 |
| **Total** | **60** | **100.00** |

**Source: Field Survey, 2023**

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

It can be concluded that farm size ($X_1$), capital inputs ($X_4$) and planting materials ($X_5$) were significant factors influencing output level of maize - rice. The $X_1$ was significant at 1% level of probability. Also, $X_4$ was significant at 10% level of probability, while $X_5$ at 5% level of probability. The result further indicated that despite the various problems faced by the sampled farmers, maize-rice intercropping was profitable in the study area.

### Recommendations

Based on the findings of the result, it is hereby recommended that:

i. Government should provide fertilizer inputs and agrochemicals at subsidized rate and tractor hiring service to the farmers to increase their farm size and production.
ii. Good roads should be provided for the farmers for easy evacuation of farm produce.
iii. Government should provide credit facilities (loan) to the farmers to increase maize - rice production.

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