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EFFECT OF IRRIGATION, ENERGY AND ENVIRONMENTAL FACTORS ON AGRICULTURAL PRODUCTIVITY IN NIGERIA

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ABSTRACT

The success of agricultural production is measured by the amount of solar energy, water consumption that is captured and converted into food per unit land area as a result of manipulating plant, land, water and other resources. Irrigation schemes in developing countries especially in Sub-Sahara Africa (SSA) including Nigeria suffer from very low water use efficiency, resulting in water logging and salinity problems. Therefore, this study investigated the problem of how urban and irrigation interests can work together and to work on how to meet future water needs of Nigeria. The objectives are to develop and use available renewable energy technology such as biomass, hydropower, photovoltaic's, wind power and other technologies to make intensive agricultural production more sustainable. Both primary and secondary data were used for the study. Well structured questionnaire and interview schedule were used as approach to collect data from 80 respondents and six-stage modeling approach was used for assessing regional or landscape scale environmental impacts was adopted to analyze the impact of water irrigation, energy and environmental factors on agricultural productivity. The results showed that irrigation users are small-scale farmers, cultivating small hectare of land using simple farm tools, practices pump irrigation or calabash system. Regression analysis revealed that land, labour purchase inputs had a positive relationship with the output of the enterprises, while the linear programming analysis revealed that opportunities exist for increasing profit through resources re-organization, budgetary analysis was used to show that irrigation is profitable.

KEYWORDS: Effect, Water, Irrigation, Energy, Environment, Agriculture, Productivity, Photovoltaic's, Hydropower, Biomass

INTRODUCTION

Irrigation agriculture is crucial to the economy, it is too important to be marginalized as it vital for world food security. However, irrigated agriculture often radically changes land use and is a major consumer of freshwater. Recognizing that the full potentials of Nigeria agriculture could not be realized without the development of her water resources for irrigation, governments in Nigeria have adopted various development policies to implement irrigation (Palmer and Philip [1]).

Agriculture has an important impact on the environment. Pollutant sources from land use and poorly managed agriculture is causing widespread deterioration of ground water and surface water, while over irrigation results in water logging and the consequent accumulation of salts will lead to salinization of top soils and groundwater if not provided with proper drainage. Intensification of agriculture may lead to an increase in degradation of water quality and irrigated land because of an increasing intensity of inputs in agriculture (Aremun and Ogunwale [2]).

The study revealed that water is scarce in the northern part of Nigeria; there will be an increase in use of brackish water and sewage effluents for irrigation. Recycling of water although may improve efficiency of use of water, it could also reduce both surface and groundwater quality. However, increased water withdrawals will lead to salt intrusion in estuaries and over-draught coastal aquifers. Maximum management of water quality is required to prevent these conditions and there is the need for proper monitoring of inflows and effluent water, in the same manner, recycling and reuse systems should take into account its cumulative effect overtime and its impact on the soil and water environment (Edwards [3]).

The protection of water is not based on the prevention of pollution alone, but also to the recovery, conversation and the development of their self-purifying power. At this level, the restoration of rivers and lakes is an important task to be accomplished.

Problem Statement

A critical investigation of the performance of irrigation farming in Nigeria reveals that sub-sector are deficient in technical, financial, institution and human resources which subject farmers to persistent in the vicious cycles poverty, due to low income from low productivity and investment. This study examined the constraints encountered by the irrigation users and provided solution to increase resource utilization. Therefore, these questions are fundamental to this study:

- What extents have the farmers thrive in irrigation farming using small-scale irrigation technologies?
- How can urban and irrigation interest work together on how to meet future water needs of Nigeria/
- How can renewable energy technology such as biomass, hydropower, photovoltaics, wind power and other technologies be made available for the benefits of farmers use?
- The main objective of this study therefore is to analyze the economic impact of water, irrigation, energy and environmental factors on agricultural productivity in Nigeria. Specifically, the study:
- Highlight the socio-economic characteristics of irrigation users,
- Identify the type(s) of crop enterprises engaged by the irrigation farmers in the study area,
- Determine how urban and irrigation interest can work together on how to meet future water needs for Nigeria
- Determine how renewable energy, technologies such as biomass, hydropower, photovoltaic's, wind power and other technologies can be made available for the benefits of farmers use.

Justification of the Study

The benefits of irrigation have resulted in lower food prices, provision of employment, more rapid agricultural and economic development. The spread of irrigation has been a key factor behind the near tripling of global grain production; therefore, there is need for a critical assessment of the performance of irrigation farming in the study area in order to achieve more of benefits of irrigation.

THEORETICAL FRAMEWORK

Farmers using irrigation have been identified as a key source of agricultural growth and development as opposed to previous irrigation development policies according to River Basin Development, where irrigation schemes were

designed and managed by government agencies for farmers. Irrigation has been long practiced in northern Nigeria where farmers have traditionally undertaken irrigation through the use of such technologies and methods as shadouf, buckets and calabash to produce high value agronomic and horticultural crops which are widely grown such as rice, sugar cane, cocoyam, leafy vegetables among others diverse cropping system. Fruits trees like citrus, mango and cashew, etc are planted on agricultural lands, this provides cash income as well as food crops to the farmers (Ohikere [4]).

(Worlf [5]). Observed that irrigation has made higher and more reliable yield possible as crops can be planted more than once in a year within the topics, apart from bigger and reliable yield as against yearly cultivation, which is often at the mercy of seasonal rainfall.

MATERIALS AND METHODS

The study was conducted in Patigi local government area of Kwara state, the population at 2006 census was 45, 494 (22, 712 males and 22, 782 females. The major inhabitants are Nupe people while some are Yoruba and Hausa. They engage in planting of crops such as rice, sugar cane, groundnut, millet, melon etc. The climate is characterized by a distinct dry and wet season with annual rainfall varying from 1, 200mm to 1, 600mm. It is located approximately on the intersection of latitude $8^{o}44^{I}$ North and longitude $5^{O}44^{I}$

Sampling Procedure and Data Collection

A multi-stage random technique was used to select the respondent. Firstly, the study area was stratified into 8 cells. The second stage involved random selection of four cells out of the eight cells. The third stage involved random selection of two villages from each cell making a total of 8 villages. The last stage involved random selection of 10 respondents from each village making a total of 80 respondents. The sample size of the study was eighty irrigation users. The choice of this number was on the basis of the preliminary survey of the study area. The choice of random sampling techniques in the last stage was to give equal opportunity or chances to each farm family of being selected. Data for this study were collected from the selected farmers for the 2012/2013 irrigation season by the researcher and assisted by extension agents using well structured questionnaire and interview schedules. Data were collected between December, 2012 and January, 2013.

Measurement of Variables

There are two major variables in this study: they are the dependent variable and independent variable. The dependent variable is the total farm output, while independent variable includes land, labour, capital, irrigation water and socio-economic characteristics such as age, sex, marital status, educational level, households size etc. the resource constraints and irrigation water. The various levels of constraints were determined by what the “representative” farmers in the study area had. The representative farmer in the study area was taken to be the farmer who used the arithmetic mean of each of the resources. This view was supported by (Tsoho, [6]) who reported that “A representative farm can be used to depict a typical the farm in the sample” he further noted that although representative farms are often synthesis in the sense that none of them depict an actual farm, their component can be found on the majority of the farms they represent.

Data Analysis

Descriptive statistics such as tabulations, frequency distributions, mean (averages) were used to capture the first and second objectives. The third and fourth objectives were achieved by the use of multiple regression, logit model

analysis and linear programming techniques of data analysis.

The Multiple Regression Model

The coefficient of multiple determinations (R^2) was obtained as a measure of goodness of fit. It is the percentage of total variation of the dependent variable (Y) explained by the variation in the independent variable (X_1-X_n). The equation with the higher R^2 value explain the variation better and was regarded a better fit. The regression coefficients for the various inputs used was tested using chi-square test to determine the inputs to which output is highly responsive, only those variables whose variable whose computed t-values are significant at 1%, 5% and 10% was taken to have significant influence variation in output.

The Multiple Regression Equation and Explanation of Variables

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... + \beta_n X_n + \varepsilon$$

Where Y = (total farm output) dependent variable.

- X_1= Age of Respondents
- X_2= Sex (Male of Female)
- X_3 = Marital Status
- X_4 = Educational Level
- X_5 = Household Size
- X_6 = Land (Resource constraints in the study area)
- X_7 = Labour (Resource constraints in the study area)
- X_8 = Capital (the monetary value of machinery and tractors)
- X_9 = Irrigation (method of supply water into dry land)
- X_{10} = Water (water within wetlands, rivers, groundwater and ditches)
- ε = error term

Farmers Age

This is the age of the ith farmer measured in years. Evidence from previous studies shows that the age of an individual affects his mental attitude to new ideas and this may influence adoption in one of several ways. Younger farmers have been found to be more knowledgeable about irrigation practices and may be more willing to bear risk and adopt a technology because of their longer planning horizons. The older the farmer, the less likely he adopts new ideas of irrigation practices as he gains more confidence in his old ways and methods. On the other hand, older farmers may have more experience, resources or authority that may give them more possibilities for trying a new method of irrigation practices. Generally, there is no agreement on the sign of this variable in the adoption literature as the direction of the effect is location or technology specific.

Gender of Farmer

Women farmers are generally perceived to face more constraints on their farms and this will negatively affect their adoption of new irrigation ideas. This variable is expected to have a negative sign on the dependent variable. Male farmers are scored 1, while female farmers score zero.

Level of Literacy

Education is a measure of the ability to assess new technology, posited that education and experience are two common measures of human capital (the ability to acquire and process information about a new technology) which may be used as proxies for risk. It is therefore expected to have a positive impact on the decision to adopt irrigation practices. Uncertainty and risk aversion have been shown to decrease the propensity for individual to adopt technologies. However, while measuring an individual's risk perceptions and risk aversion is difficult, economic theory posits that their perceptions are influenced by information and human capital. Thus, following earlier empirical findings, the maintained hypothesis is that level of literacy is positively related to adoption behavior. It measured as number of years spent in school.

RESOURCE/TECHNOLOGY CHARACTERISTICS

Household Size

This comprises all the people living under the same roof and who eat from the same pot with the ith farmer. Some previous studies show this variable to be positively related to adoption behavior as it provides a larger supply of family labour while other studies view that this variable has a negative relationship with adoption since increased household size increases consumption pressure.

The Linear Programming Model

Linear programming is often helpful in decisions requiring a choice among a large number of alternatives. It has been employed in several studies to determine the optimal organization of peasant farming system in Nigeria (Ogunfowora [7]).

The linear programming model employed for the study area was estimated as.

$$MaxZ = \sum (p_j q_i - c_i)$$

$$= \sum A_i X_{ji} - b$$

$$= X_i (j = 1 - M)$$

Where;

Z = Return of owners labour and management (N/ha)

p_j = price of j^{th} crop per unit in naira (N)

q_j = quantity of j^{th} crop in kilogram

c_j = Total variable cost of labour and purchased inputs

A_j = per unit requirement of j^{th} activity carried out

M = the number of activities and it ranges from 1-4

i^{th} = Resource, ranges from 1-4h

b_i = the level of j^{th} resources

b_1 = average farm size (ha)

b_2 = Average labour available per farm in man-day/ha

b_3 = average capital employed per farmer in man-day/ha

b_4 = average water input in cm/ha

RESULTS AND DISCUSSIONS

Socio - Economic Characteristics

Table 1 show that over 81 percent of the respondents were males with females accounting for only 17.3 percent. This confirms the popular belief in the area that farming is a primary occupation for the male folks while the female folks are only to prepare food and maintain home for the males while working on their farms. It also confirms the religions belief that women in pedal are not to leave their homes for any outside activities.

Table 1 also shows the age distribution of respondents. Age is the length of past life or existence of a person. It is an important factor to be considered in determining the quality of labour employed and the labour force prevalent in any given enterprise. Age is particularly important considering the tedious nature of manual farming. In the study area, more than half of the respondents (80%) were within the age groups of 25-60 years. Because of the tedious nature of manual farming which characterized the farming system in the area, only adults of working age (25-50years) could take into irrigation farming using pump, calabash and pipe watering irrigation methods. The age group also represents the most economically active age group. The reason for low percentage of youth/young farmers (8.4%) could be due to rural-urban migration and the quest for modern education urban centers. Capital stock is the monetary value of machinery and tractors, including pumping machines, soil preparation equipment/machines and crop harvesters used in agriculture. Irrigation: Irrigation is captured as irrigation intensity defined as irrigated land per total crop area.

Findings revealed that water resource use conservation measure within the study area on irrigated crop sector of agriculture accounts for 80-90 percent of the nation's water use (water lost to the environment by evaporation, crop transpiration, or incorporation into products). Population growth, environmental flows (i.e. water within wetlands, rivers, and groundwater systems that is needed to maintain natural ecosystems), and energy-sector growth expand the demand for water resources. The independent variables considered were standardized as following; farm output in kilogramme, water in litres, and age in years e.t.c.

Table 1: Socio-Economic Characteristics of the Respondents

Characteristics		
Gender Distribution of Respondents	**Frequency**	**Percentage**
Male	66	81.5
Female	14	17.3
Total	80	100.00
Age Distribution of Respondents		
Characteristics	**Frequency**	**Percentage**
Age(group)		
25-40 years	11	8.4
41-50 years	32	39.3
51-60 years	33	40.8
60 Above	4	4.8
Total	**80**	**100.0**

Source: Field survey, 2013

Middle age group= 40-50 years

Mean age group=40 years

Table 2: Educational Status of Respondents

Characteristics	Frequency	Percentage
Level of Education		
Primary	25	31.2
Secondary	22	26.7
Tertiary	11	13.4
No formal education	22	28.7
Total	**80**	**100.00**

Source: Field survey, 2013

Table 3: Marital Status of Respondents

Characteristics	Frequency	Percentage
Marital status		
Married	61	75.3
Divorced	8	9.9
Widowed	6	7.3
Single	2	2.5
Total	**80**	**100.00**

Source: Field survey, 2013

Table 4: Family Size of Respondents

Characteristics	Frequency	Percentage
House size		
1-5	28	34.7
6-10	40	49.1
11-15	8	10.1
>16	5	6.1
Total	**80**	**100.00**

Source: Field: Survey, 2013

Average Family size=8

Standard deviation= 4.8

Education; is a very important factor in development of any country`s economy.

The quality of skills of the farmers determines their level of locative abilities and show well informed of innovations and technology around him. Roger and Shoemaker [8]) reported that education is not only an important determinant of adoption of innovations but also tools for successful implementation of innovation. Table1 Shows the educational status of the respondents in the study area, it shows that (28.7%) of the respondents had no formal education. This is in accordance with the reports of (Tsoho, [6]). Agricultural production required marital status and it become an important factor especially when farm labour is in short supply. It is possible for married couple with large family size to have large supply of labour to work on the farm and this may increase the size of farm land cultivated. Table1 also shows that (75.3) percentage or respondents (60.7%) in the study area were married having average family size of 8 persons and hence some satisfied family labour for use on their farms.

Levels of Resource Use/Impact of Input or Output

Factors that influenced output (Q) of the entire crop enterprises were regressed against the explanatory variables farm size in ha (X_1), labour input in mandays (x_2), value of purchased inputs in Naira(X_1) and the random error term (μ).

The regression analysis result for each of the four functional forms examined in the production unction was linear, semi-log, exponential and double log of equations.

From the regression estimate, the lead equation selected was Double- Logarithm (Cob-Douglas). This was based on fitness criteria, for example, apart from the fact that it has a relatively higher R^2 value, it's also has two significant expected signs of regression coefficients both in terms of economic and agricultural logic, and is considered as the appropriate form to the estimated (lead) equation is presented as follows:

$Q = -0.485+4.682\times_1+0.572\times_2+0.317\times_3$

$= -0.485+ (4.682) + (1.144) + (0.951)$

$= (-0.485)(13.815)(3.851)(2.089)$

$R^2=0.85$

$F=94.433$

From the equation, land and labour were significant ($P<0.05$). Also, land, labour and inputs have a positive relationship with output. Henceforth, more land, labour and inputs should be allocated to irrigation users in order to affect the much needed increase in output, ensure food security in the study area.

From the table it can be seen that there is significant between the independent variables, this suggest that there is no problem of multicollinearity in the data use, hence the data use are judge free of problem of multicollinearity.

Table 5: Crop Cultivated by the Respondents

Crop Cultivated	Frequency	Percentage
Maize	61	75.3
Sorghum	29	35.3
Rice	10	12.3
Cassava	75	93.8
Yam	59	72.8

Table 6: Contd.,

Vegetable	23	28.4
Others	36	44.4
Total	**80**	**100.0**

Table 6: Impact of Irrigation

Crop Cultivated	Frequency	Percentage
Decline the crop yield	8	9.9
Increase the crop yield	79	97.5
Stunted crop growth	2	2.5
Food shortage	7	8.6
Food secure	77	95.1
Food price increase	4	4.9
Food price decrease	40	49.4
Others	21	25.9
Total	**80**	**100.0**

Table 7: Impact of Drought

Crop Cultivated	Frequency	Percentage
Food shortage	40	49.4
Decline in crop yield	61	75.3
Stunted crop growth	76	93.8
Decrease in land area cultivated	15	18.5
Poor quality of crops	34	42.0
Others	24	42.0
Total	**80**	**100.0**

Table 8: Irrigation Method

Crop Cultivated	Frequency	Percentage
Ditch irrigation	37	49.7
Terraced irrigation	10	12.3
Drip irrigation	16	20
Sprinkler irrigation	3	3.7
Rotary irrigation	5	6.2
Center irrigation	9	11.25
Total	**80**	**100.0**

Table 9: Problem Encountered

Crop Cultivated	Frequency	Percentage
Maintenance problem	77	95.1
Water availability	40	49.1
Insufficient irrigation materials	21	25.1
Others	30	37.0
Total	**80**	**100.0**

Table 10

Result of Logit Regression Analysis	Co-Efficient	Standard Error	T-Ratio
Age	37.86	9.647	3.925***
Sex	-39.65	24.41	-1.626*
Marital status	-1.166	24.41	-1.338
Household size	189.5	82.36	2.302**

Table 10: Contd.,

Primary occupation (farming)	76.23	126.2	0.604
Total	**14.4**	**65.42**	**2.22****

Source: field survey Data, 2013.

Log-likelihood = -65.08

Dependent variable = Irrigation user (Rep. by 1), while non irrigation user (Rep. by 0)

***significant at 1%

**significant at 5%

*significant at 10%

Table 5 shows the optimum results obtained through multiple regression, linear programme and logit regression model analysis for irrigation users (farmers) in the study area. It can be seen that out of the various crops combinations listed on the table above, cassava and maize entered the optimum. The table shows that 97.5% of the respondents indicate that irrigation increase their crop yield, while 95.1% claimed to have maximum food security as a result of irrigation methods practice in the study area. The difference in the variation of these impacts could be attributed to level of farm soil fertility. It was revealed from the table that 49.5% of the respondents indicated that drought increase the stunted growth of their crop, this impact may be attributed to individual farmer level of understanding. It was revealed that 49.7% of the respondents practiced ditch irrigation, 12.3% used terraced irrigation, and 20% used drip irrigation while 37%, 6.2 and 11.25% used sprinkle irrigation, rotary and center irrigation. The variation in the method used by the individual farmer depends on the cost and level of understanding of the irrigation users (farmer) in the study area as indicated by the farmers are maintenance problem 95.1%, water availability 49.1%, insufficient irrigation materials 25.1% as it was revealed on the table with their percentages.

It was tested to confirm that irrigation and drought have both positive and negative significant effects on agricultural productivity. Also it was revealed on table 5 that age is statistically significant at 1% with a coefficient value of 37.86% with a positive sign, sex is significant at 10% with a negative sign.

It further shows that household size is statistically significant at 5% with a value of a 189.5 with a positive sign, while total land area are also significant at 5% with a value of 14.4%. Household size has the highest coefficient value which implies that it existed as the most important factor that greatly determined the output of the farmers in the study area.

CONCLUSIONS

The study examined the effect of water irrigation, energy and environment factor on agricultural productivity. The optimum irrigation farming computed showed that re organization, well planned and proper irrigation application would yield more income to farmers

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REFERENCES

1. Palmer, J. L and Philip, D. O. The economics of fertilizing wheat in two major Nigerian irrigation schemes in Maurya. Proceeding of the National Workshop held at IAR. Samam, Zaria. Pp 189-198. (1990).
2. Aremu J. A, Ogunwale, S. a (1994). Comparative Analysis of Small and large scale irrigation schemes in Northern Nigeria. Fact finders Int. pp165-185. (1994).
3. Edwards, G. A/ grove, T. C, Harwood, R. R, Pierce colfer, O. J. The role of Agro- Ecology and Integrated Farming System in Agriculture sustainability, Agric. Ecosyst. environ. 46 (4):99-121. (1993).
4. Ohikere, J. Z and Ajogwu, Felix Ejeh,. Impact of small scale irrigation technologies on rop production by Fadama users in Kogi State, Nigeria. Applied science Research 3 (2) 854-86. (2012).
5. Worlf, P. The problem of sustainability of irrigation system. Applied Geogr. 45(46) 55-62. (1995).
6. Tsoho, B. A. "Economics of Tomato-based cropping systems under small-scale irrigation in Sokoto State, Nigeria" Unpublished Msc. Thesis submitted to the Department of Agricultural Economics and Farm Management, University of Ilorin, Ilorin, Nigeria. Pp 87-95. (2005).
7. Ogunfowora, O. Capital and credit market in Nigerian Agricultural Development paper No 8. Department of Agricultural Economics and Extension, University of Ibadan. 5: 15-18. (1980).
8. Rogers, E. M. and shoemaker, P. C. Diffusion of innovation. The free press of Glencoe, N.Y. Pp 367. (1971).