Impact of small scale irrigation technologies on crop production by fadama users in Kogi State, Nigeria

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ABSTRACT

The study examined the impact of small scale irrigation technology in crop production under Fadama areas of Kogi State. To achieve the objective of the study, data were collected from 96 farmers engaged in various crop enterprises under the Fadama. The farmers were randomly selected. Descriptive Statistics, Farm Budgeting Model. Farm production Model and Linear Programming Model were used to analy the data. The results showed that fadama users are small-scale farmers cultivating small hectare of land and using simple farm tools, but practice pump irrigation or calabash system. Furthermore, they produce more than one crop enterprises. The farm Budgeting Analysis shows that Fadama cultivation is profitable. Farm production function revealed that land, labour and purchased inputs had a positive relationship with the output of the enterprises. The linear programming analysis revealed that opportunities exist for increasing profit through resources re-organisation. It was suggested that extension workers and private organizations assist the fadama users in reducing post-harvest losses via provision of processing and storage facilities. Furthermore, continuous monitoring of soil and water quality as well as ground water table was advocated, in order to ensure sustainability of fadama irrigation in the area.

Keywords: Impact, Fadama users, crop production and small scale irrigation technologies.

INTRODUCTION

Nigeria is predominantly an Agricultural country blessed with an estimated 98.3million hectares of productive land resources of which about 75 per cent is arable, and an estimated human population of over 110million (World Bank, 1996), which is predominantly agrarian. This not withstanding, Nigeria lags behind in its ability to grow enough food to feed its ever-increasing population.

Despite its importance, Nigeria Agriculture has to a large extend not diverted itself from most of the characteristics of the peasant economy that were prominent in the pre-independence period (Adewumi and (Omotesho, 2002). Food and Fibre shortages resulting in under-nourishment of people and under-capacity utilization of industries have become the rule rather than exception. This couple with increasing populating pressure has resulted in food insecurity (Ndanitsa, 2005).

(Okuneye 1986) revealed that one of the possible causes of the decline in food production is inefficient allocation of resources in agricultural production potentials of the economy. Land, Labour, capital and water resources are inefficiently allocated thereby leading to decrease in their productivity.

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 irrigation development policies. One of the most recent irrigation policy thrust of the government is small-scale fadama (in-land valley lands which are low-lying, seasonally flooded, characteristic moisture retention capacity development). Fadama help in stabilizing

production in Nigerian parts of the country with marginal rainfall (Ismail, 2004). Niger State is one of the core states implementing the project through the Niger State Agricultural Development Project and the Niger State Fadama Development Office (NSFDO)

Problem Statement
A critical assessment of the performance of fadama farming in Niger State however, reveals that the sub-sector is bedeviled by a number of technical, financial, institutional and human resources problems which submerges farmers persistently in the vicious cycles of poverty, due to low income from low productivity and investment. The study will assist the fadama users to increase resource utilization. But the question is, it what extent have the farmers thrive in fadama cultivation using small-scale irrigation technology? It is important to investigate this question in order to evaluate the impact of the small-scale irrigation technologies by fadama users. In pursuing the answer to this broad question, several specific research questions need to be answered. Those addressed by this study include:
i. How has the small-scale irrigation technologies affected resource-use by farmers?
ii. How has it affect farmers' choice of enterprise?
iii. Are farmers maximizing profit or obtaining the highest possible income from the technologies.
iv. How has the technologies affected fadama farm plan using Niger State as a case study? This study aims at providing answer to these and several other related questions.

The broad objectives of the study is to assess the impact of small scale irrigation technologies on crop production by fadama users in Niger State of Nigeria.

The specific objective are to:
i. Highlight the socio-economic characteristics of the fadama users,
ii. determine the levels of resources use by the fadama user engaged in small-scale irrigation technology:
iii. Determine the type(s) of crop enterprises engaged by the fadama users.
iv. Determine the Net Farm Income (NFI) of the fadama users engaged in each of the enterprise.

Development an optimum farm plan for fadama users that will be profitable and sustained for a very long period of time in specific situations.

Theoretical Framework
Fadama farming using small-scale irrigation has been identified as a key source of Agricultural growth and development as opposed to previous irrigation development policies (such as those of the River Basins Development drive), whereby irrigation schemes were designed and managed by government agencies for farmers. Fadama irrigation has a long history 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 in diverse cropping systems. Several hundreds of fruit tress like citrus, mango and cashew, etc are planted within and around fadama lands, this provides cash income as well as food crops to the farmers. This identifies fadama as a critical resources within the semi-arid Northern Nigeria.

(Ogunfowora 1970) studies the potential role of arming in the food production sector of Nigerian Agricultural Industry. Two model were designed and tested. The first model was designed to characterize the peasant farming farm operating entirely on a semi-subsistence basis, while the second model characterized a family farm with commercial orientation in the sense of incorporating labour hiring and capital borrowing. The solution of the Linear Programming (LP) problems posed in these two model revealed that there is a wide range of income opportunities in peasant farming through efficient combination of enterprises, increase in resources base and improvement in managerial ability that is required for the operation of larger farm units. The results also show that an efficient combination of enterprises will provide an inbuilt stability against income variation arising from yield and price changes.

(Tsoho 2005) used LP approach to examine the possibilities of comparing Tomato/Onion/Peper and Tomato/Onion to determine which yield optimum returns. His findings was that Tomato/Onion/Peper and Tomato/Onion be carried out on 0.39 and 0.62 hectares of land respectively, and that this will yield an optimum returns to labour and management of = N= 31.806.15.

MATERIALS AND METHODS

The study Area:
The study was conducted in Kogi State, in fadama lands lying the river bank of River Niger (i.e flood plains of Koto Karfe Fadama). The Fadama is cultivated by small-scale farmers who are migrants mostly from neighbouring states of Zamfara, Kebbi, Sokoto, Kaduna and Kwara. The climate is characterized by a distinct dry and wet season with annual rainfall varying from 1,200mm in the North to 1,600mm in the South (KG Diary, 2007). To avoid idleness of their resources during the dry season, farmers undertake dry season irrigated farming especially in the fadama lands which are found in the flood plains of River Niger and their tributaries. Crops grown in the fadama include Rice, Tomato, Pepper, Sweet Potato, Cassava and Green Vegetables. They irrigate their farm lands using pump and calabash or Bucket. Shadouf is however, uncommon in the area.

Sampling procedure and data collection:
The sampling size of the study was 96 fadama users. The choice of this number was on the basis of the preliminary survey of the study area. Random sampling was however used to draw the sampling size. The choice of random sampling technique was to give equal opportunity or chances to each farm family of being selected.

Data for the study were collected from the selected farmers for the 2006/2007 irrigation season by the researcher and assisted by trained extensions works using Interview guide with aid of a well structured questionnaires. Data were collected between December, 2006 and January, 2007. The data collected include input-output, demographic and price data.

Measurement of variables:
The resource constraints in the study area include Land, Labour Capital and irrigation water. The various levels of constraints were determined by what the "representative" farmer 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 (Okeneye,1985) 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.

The Land Constraints:- Land used represents the arithmetic mean of land cultivated by the farmers in the study area, and was measured in hectares (ha).

Labour Constraint:- Aggregated family, communal and hired labour measured in mandays was obtained and the total labour used per hectare muse be less than or equal to this value. A man-day referred to an average man working for eight (8) hours.

Capital Constraint:- The maximum own capital available was obtained by determining the arithmetic mean of farmers expenses (costing capital items) on purchased inputs like fertilizers, seeds/seedlings, agro-chemicals, fuel, etc. The mean capital devoted to each crop or crop mixture determined and summed up to obtain the total capital used in the study area.

Water Input Constraint: Small-scale irrigation technologies such as pump and calabash system were carried out by respondents in the area. The average water input expressed in ha-cm was similarly obtained.

Furthermore, the basic activities in the study area refers to the crops grown. The enterprises include Sole rice (X1), Sole sugar care (X2), cassava/sweet Potato (X3), vegetable Tomato/Pepper (X4). These activities are defined in units of one hectare (1ha), for each of the enterprises.

Data Analysis:
The first and third objectives of the study were achieved through Descriptive Statistics such as tabulations, frequency distributions, mean (averages). The second objective was achieved by Farm production Model, the fourth objective was achieved by Farm Budgeting Model while the fifth objective was achieved was achieved through Linear programming.

The Farm Budgeting Model:
The Farm Budgeting Model used is of the form:

NFI   =   **GI TVC TFC**

Where:
NFI = Net Farm Income
GI   = Gross Income (Total Revenue)
TVC = Total variable Cost
TFC = Total Fixed Cost

The Farm production Model
The model comprised the regression analysis. The production function model used is expressed as:

$Q = f(X1, X2, X3, U)$

Where:

Q	=	Energy content of output in kilocalories (kcal.)
X1	=	Farm size in hectares (ha)
X2	=	Labour input in Mandays
X3	=	Value of purchased inputs in Naira (=N=)
U	=	Error term

The linear programming model
Linear programme is obten helpful in decisions   requiring a choice among a large number of alternatives. It has been employment in several studies for determining the optimal organization of peasant farming system in Nigeria (Ogunfowora,1980).

The Linear programme model employment the study area was estimated as:

Max.Z	=	$\sum (Pjqj – cj$
	=	$\sum a?jxij ? B?$
	=	$Xj ? O (j = I - m$

Where;
Z = Return of owners labour and management (=N=/ha).
Pj = price of jth crop per unit in Naira (=N=)
Qj = Quanitty of jth crop in calorie/kilogram
Cj = Total variable cost of labour and purchased inputs.
Aij= Per unit requirement of jth activity carried out
m = The number of activities and it ranges from 1- 4
jth = Resource, ranges from 1-4
bi = The level of jth resources
b1 = Average farm size (ha)
b2 = average labour available per farmer in man-day/ha
b3 = Average capital employed per farmer in =M=/ha
b4 = average water input in cm-ha.

RESULTS AND DISCUSSION

Socio – economic characteristics
Table 1 shows that over 95 percent of the respondents were males with females accounting for only 4.17 percent. This confirms the popular belief in the area that farming is an occupation for the male folks while the female folks are only to prepare food for the males while working on their farms. It also confirms the religions belief that women in Purdue 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 consider 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 (75%) were within the age groups of 21 – 50 years. Because of the tedious nature of manual farming which characterized the farming system in the area, only adults of working age could take into fadama farming using pump and calabash irrigation technologies. The age group also represents the most economically active age group.

Similarly, the reason for this low percentage of young farmers (7.29) could be due to rural- urban migration and the quest for modern education in urban centres.

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Table 1: Socio-economic characteristics of the respondents

Characteristic	Frequency	Percentage
Gender Distribution of Respondents		
Male	92	95.83
Female	4	4.17
Total	96	100.00
Age Distribution of Respondents		
Characteristic	Frequency	Percentage
Age Group		
10-20 years	7	7.29
31-40 years	20	20.83
41-50 years	37	38.54
51-60 years	15	15.63
61-70 years	2	2.08
Total	**96**	**100.00**

Medle age group = 41 -50 years
Mean age group = 40 years

Educational Status of Respondents

Highest Educational Level obtained

Characteristic	Frequency	Percentage
Qur'anic education	44	45.83
Adult education	21	21.88
Primary education	19	19.79
Secondary education	8	8.33
Tertiary	4	4.17
Total	**96**	**100.00**

Marital Status of Respondents

Characteristic	Frequency	Percentage
Marital Status		
Single	21	21.88
Marriage	67	69.80
Divorced	4	4.16
Widower	4	4.16
Total	**96**	**100.00**

Family size of Respondents

Characteristic	Frequency	Percentage
Family size		
1-5	30	31.25
6-10	43	44.70
11-15	17	17.71
16-20	4	4.17
21-25	3	2.08
Total	**96**	**100.00**

Average family size = 8
Standard deviation = 4.6
Sources: Field Survey Data, 2007.

Education, is a very important factor in the development of any country's economy.

Determines the quality of skills of the farmers, his a locative abilities and show well informed the is, of the innovations and technology around him. Roger and Shoemaker (1971) informed and (Obibuaku 1983) stated that education is not only an important determinant of adoption of innovation but also a tool for successful implementation of innovation. Table 1 reveal the educational status of respondents. The table reveals that half of the respondents in the study area had no formal education. This corroborates with the findings of (Tsoho 2005).

Marital status of respondents may become an important factor in agricultural production especially when farm labour is in short supply. Married couple with large family size may have large supply of labour to work on the

farm and this may increase the size of farm land cultivated.   Table 1 also reveals that about 70 percent of respondents (69.80%) in the study are were married couples having average family size of eight (8) (also in table).

This is an indication of their chances of getting family labour for use on their farms.

Crop Enterprises:

Table 2: Crop Enterprises

Crops grown/Cropping	Farm plot	Frequency	Percentage
	Pattern	size (ha)	
Sole paddy rice	44.76	61	63.54
Sole sugar cane	11.71	15	15.63
Tomato/pepper mixture	7.18	12	12.50
Cassava/sweet Potato mixture	6.44	8	8.33
Total	**70.09**	**96**	**100.00**

Sources: Field Survey Data, 2007

Table 2 shows that farmers in the study area cultivated a total of six (6) crops grown in four (4) cropping pattern. Further analysis show that fadama users in the area practiced both mixed and sole cropping – sole paddy rice, sole sugar cane, Tomato/pepper mixture and cassava/potato mixture. Sole paddy rice, (grown by 63.54% of all the respondents), was the most popular followed by sole sugar cane (15.63%), tomato/pepper mixture (12.50%) and cassava/sweet potato mixture (8.33%) in 44.76ha, 11.71ha and 6.44ha respectively. Farmers practicing mixed cropping believed that they did so in order to guard against risk of failure of one crop and it diversify their
sources of income.

Table 3 shows the costs and returns analysis of all the crop enterprises in the study area.

Further analysis shows that fadama cultivation using small-scale irrigation technology has a Higher Net Farm Income (NFI) for all enterprises in the area =N=29,583.16/ha for sole paddy   rice N=6,944.30/ha for sole sugar cane, =N=6,012.58/ha for Tomato/Pepper mixture, and cassava/potato mixture; and this is not only because of effective exibitation of available human and material resources but also because of better marketing prospects (especially for the paddy rice growers) with the Federal Government ban on importation of food items. This findings corroborated with those of Erhabor, 1982; Ofojekwu, Erhabor and Kalu, 1990; Mayaki eta, 1990' Palmer and Philip, 1990; Baba, 1993; and Tsoho, 2005. All the authors in Their separate study recorded a high positive financial returns to fadama farming using farm budgeting approach.

Levels of resource-use/Impact of Input or Output
Factors that influenced output (Q) of all the 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 (U). The regression analysis results for each of the four functional forms examined in the production function were Linear, Semi-log, Exponential and Double log equations.

From the regression estimate in table 4, the lead equation selected was Double-logarithm (Cobb-Douglas). This was based on it fitness criteria, for example, apart from the fact that it
has a relatively higher R^2 value, it also has two significant expected signs of regression coefficients coefficients both in terms of economic and agricultural logic, and is considered as the appropriate form to The estimated (lead) equation is presented thus.

$$Q = -0.396 + 3.583 x_1 + 0.462 x_2 + 0.216 x_3$$
$$= -(0.762)\ (0.168)\ (0.143)$$
$$= (-0.396)\ (12.716)\ (2.750)^*\ (1.078)$$
$$R^2 = 0.79$$
$$F = 84.322^*$$

From the lead equation, land and labour were significant $(P < 0.05)$. Furthermore, land, labour and purchased inputs has a positive relationship with output. Therefore, more land labour and purchased inputs should be allocated to fadama farming under small scale irrigation in order to effect the much needed increase in output, ensure food security and self- reliance in the study area

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Table 4. Summary of regression analysis results

Functional Forms Constant		Regression	Coefficient	Parameters	R2	F-value
		X1	X2	X3		
Linear	-2259.724	928.843	1.514	-0.01844	0.68	47.372
S.E.	(309.578)	(119.268)	(0.404)	(0.033)		
t-value	(-7.299)	(7.788)	(3.747)	(0.556)		
Exponential	-6682.940	4357.708	151.711			
S.E	(1504.952)	(777.391)	(1027.622)	(553.381)	0.57	29.722
t-value	(-4.441)	(5.606)	(2.619)	(0.274)		
Semi-log	0.771	0.691	0.0002658	0.0000257		
S.E.	(0.126)	(0.48)	(0.000)	(0.000)	0.80	91.011
t-value	(6.130)	(14.254) (1.618)		0.932		
Double – log	-0.216	3.583	0.462	0.216		
S.E	-	(0.762)	(0.168)	(0.143)	0.79	84.322
t-value	-0.396	(12.716)	(2.750)	(1.078)		

Sources: Field Survey Data, 2007

Table 5. Optimum Farm Plan (Enterprise Combination)

No variable Coeff.		Solution	Opportunity Cost	Objective Coefficient	Min. Obj. Coefficient	Max. Obj.
1.	X1	+0.65762812	0	+66517.03	+4127.023	+Infinity
2.	X2	0	+34297.457	+9714.5996	-Infinity	+4401
3.	X3	0	+35306.422	+15455.750	-Infinity	+5076
4.	X4	0	+20638.039	+33601.602	-Infinity	+5423

Max. Objective =   =N=43,743.47
Source: Field Survey Data, 2007

Table 6: Resources Constraints for Fadama crop Farmers

No.	Constraints	Status	RHS	Shadow Price	Stack or Surplus	Min. RHS	Max.RHS
1.	Land	Loose	?+0.7300	0	+0.072	+0.072	+0.658
2.	Labour	Loose	?+154.12	0	+60.51	+60.51	+93.607
3.	Capital	Tight	?+123634.97	+3.4623	0	0	+1402
4.	Irrigation Water Loose		?108.71	0	+97.74	+97.74	+Infinity

Max. objective =   =N= 43,743.47
Source: Field Survey Data, 2007

Table 5 shows the summary of the optimum far flan, obtained through Linear Programming, for fadama farmers engaged in small scale irrigation technologies. It can be seen that out of the various crops/crop combinations earlier listed, only sole paddy rice entered the optimum. Plan this should be carried out on a 0.66ha of fadama land, as this is capable of yielding an optimal optimal income of =N=433,743.47. Similarly, the result further show that capital was exhausted in the plan as it is the most limiting resource. (Table 7) it has a shadow price of =N=3.46. Other resources are in surplus. The Linear Programme Model Estimated is:

$$Max. Z = 66517.02 X_1 + 9714.60 X_2 + 15455.75 X_3 + 33601.60 X_4$$
$$Land = 1 X_1 + 1 X_2 + 1 X_3 + 1 X_4 < 0.73 ha$$
$$Labour = 142.34 X_1 + 96.15 X_2 + 108.55 X_3 + 98.04 X_4$$
$$\leq 154.12 \, madays.$$
$$Capital = 19212.94 X_1 + 12712.55 X_2 + 14662 X_3 + 15666.71 X_4 \leq =N= 12634.97$$
$$Irrigation \, water: 148.62 X_1 + 151.15 X_2 + 123.45 X_3 + 169.03 X_4 \leq 109.71 ha\text{-}cm$$

Where Z=Return to Labour and other management.

CONCLUSION

The study examined the impact of Small-scale Irrigation Technologies on Fadama Crop Production types and level of resources used and their impact on output, enterprises choices, income and organization of fadama farms. The optimum farm plan computed showed that reorganization of fadama farms would yield more income to paddy rice

growers. There is the need for extension workers, collaboration with researchers, other agencies like the National Fadama Development Project (NFDP), TO ASSIST Farmers in allocating farm resources optimally, Profits in the area could also be increased through elimination or reduction of post-harvest losses, which are currently high, Most Fadama crops are highly perishable and when there is glut in the market, which is frequent in the area, farmers lose substantial parts of their harvests. This could be checked if relevant agencies like the state ADP, National Fadama Development Project, in partnership with the private sector, establishes processing and storage firms in the area.

Finally, there is the need for the relevant authorities to monitor soil and water quality, as well as the ground water table at various fadama irrigation sites in the state. This will ensure early detection of such problems as soil salinity and declining water table, which could endanger sustainability of fadama irrigation.

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