FUDMA Journal of Agriculture and Agricultural Technology
ISSN: 2504-9496
Vol. 4 No. 2, December 2018: Pp 43-52

EFFECT OF SMALL-SCALE IRRIGATION SCHEME ON FOOD SECURITY OF FARMING HOUSEHOLDS IN KWARA STATE, NIGERIA.

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ABSTRACT

In recent times, the global focus has been on eradicating food insecurity. Various international organizations and governments of developing nations through schemes that enhance food production have made their contributions. This study focused on the assessment of the effect of small scale irrigation scheme on food security of farming households in Kwara State, Nigeria. Primary data was used for the study. Using a two stage random sampling, three (3) Local Government Areas were randomly selected from the twelve (12) local governments that have irrigation project under the Lower Niger River Basin were randomly selected in the first stage. Thirty (30) irrigation and non irrigation farming households were each randomly selected in each Local Government Area for the study. A total of 180 households were used for the study. A structured questionnaire was used to collect useful information from the respondents. The data collected was analyzed using descriptive statistics, logistic regression, food security index and 4-pointLikert type scale. The results showed that adoption of irrigation Scheme is significantly affected by age, household size, years of schooling, farm size, farm income, farming experience, access to extension service and membership in farmers Association. The result also showed that about 78.5% and 53.8% of the irrigation and non irrigation farming households are food secure respectively. The effect of irrigation on the farming households that adopted the scheme revealed an average increase of 1157 kcal/AE/day calorie intake. The constraints faced in accessing the irrigation scheme were inadequate awareness of the scheme, cost of irrigation water, distance to irrigation site, unfairness of water distribution, inadequate government supports, and enforcement of cropping pattern.

Keywords: Irrigation, food security, small scale and households

INTRODUCTION

Agriculture plays an important role in the growth of many developing economies and has the potential to reduce poverty as it provides employment for the teeming populace, food for human consumption and raw materials for industrial use. In Nigeria, over 50% of the economically active people are engaged in agriculture with per capita farm size ranging from 0.5ha - 3ha. Despite this, food security is still an issue in the country. (Berdegue and Swinnen, 2009). This is because smallholder farmers have not been performing well in terms of their agricultural output because of erratic rainfall patterns in these areas. The majority of the farmers in these areas have failed to achieve food security because of unreliable rainfall and other factors contributing to agricultural production in these areas. Smallholder farmers suffer from low incomes and living standards, poor nutrition, poor housing and health (Mawunya and Adiku, 2013).

Access to irrigation water is the key to reduce the impacts of climate variability and change on food security and regional economies (International Food Policy Research Institute, IFPRI, 2001).Irrigation can be described as the application of water to the soil to make available essential moisture for plant growth. It also serves as insurance against drought and to provide a cooling effect on the soil environment for plant growth and development. So, irrigation is aimed at improving and raising the productivity of soil resources. The principle, according to Hudson (1975), is that the environment is characterized by fair to good soils but poor and unreliable low precipitation as it is the case in dry and semi-dry lands. Irrigation tries to meet additional water requirement of crops during the wet season and supplies water to the farm during the

dry season. This is because precipitation is irregularly distributed throughout the year in arid and semi-arid regions. In other words, the irrigation system is aimed at increasing and improving agricultural yield, particularly in moisture-deficient environments.

Irrigation contributes to livelihood improvement through its direct and indirect benefits. The direct benefits of irrigations are; high productivity, lower risk of crop failure, and higher and year-round farm and non-farm employment, increased income, food security, and poverty reduction. Irrigation enables smallholders to adopt more diversified cropping patterns, and diversify income base sources. Indirectly irrigation benefits as a potential to become 'nuclei of growth' which are attractive for inward investments in other infrastructure and services such as banking to facilitate this growth (Hussien and Hanjira, 2004).

In Nigeria, about three percent of the cultivated area (0.9 million hectares) use water management techniques, of which approximately 0.2 million hectares are irrigated with equipment such as pumps and tube wells. Of the cultivated area that benefits from water management, more than 95 percent uses small-scale irrigation schemes managed by the private sector and the farmers themselves (Takeshima *et al*., 2010).

In Kwara State, irrigation farming has been a long time practice of the people to boost their productivity. For example, most of the floodplain of rivers and streams that drain the state are cultivated, particularly during the dry season. Indeed, some settlements such as Lasoju along Ogbomoso-Ilorin road are known for dry season vegetables of various species. In these settlements, women and children are engaged in basin irrigation. Basin irrigation, according to Sangari (1991), involves the use of hand buckets, calabash and the construction of the simple basin and field channels for water control and management.

There are several irrigation schemes or projects in Kwara state and most of them are under the supervision of Lower Niger River Basin Development Authority (LNRBDA), examples are the Oke-Oyi Irrigation Scheme, Tada Shonga irrigation Project, Oyun irrigation Project, Rogun irrigation Project, Erin-Ile Water Supply and irrigation Project. Most of these projects had an improvement in the agricultural productivity in rice, vegetable and maize production but has not been sustained due to poor funding and government instability.

It is a known fact that if agricultural productivity of farmers is increased, it will enable farmers to produce more food, increase their income, reduce the problem of poverty and inturn lead to better diets. Hence the objectives of this study are to:

- describe the socio-economic characteristics of smallholder irrigation and non-irrigation farmers.
- examine factors affecting participation of farmers in irrigation scheme.
- estimate the food security status of the smallholder irrigation and non-irrigation farmers in the study area
- determine the effect of irrigation farming on households food security.
- identify the constraint to irrigation farming in the study area.

MATERIALS AND METHODS

Study Area

This study was conducted in Kwara state in the North-central zone of Nigeria. The area is under the moist savannah agro-ecological zone. The state lies between latitude 7˚15′ and 6˚18′ N of the equator. The state shares boundaries with Osun, Oyo, Ondo, Kogi, Niger and Ekiti states. It also shares an international boundary with the Republic of Benin. The state presently comprises of sixteen (16) Local Government Areas. It is characterized by two major climatic seasons namely: the wet and dry seasons. The wet season last between April and October during which there is rain and the dry season with no rain is between November and March. The rainfall ranges between 50.8mm during the driest months to 2413.3mm in the wettest months. The major crops cultivated in the state include maize, cassava, yam, rice groundnut, sorghum, melon, cowpea, okra, pepper and some leafy vegetables. The state is characterized by river Niger running through it and some other smaller rivers like Asa (Kwara State Agricultural Development Project, 2007).

Sampling Procedure and Data Collection

The respondents interviewed for the study were randomly selected from three (3) local governments that have irrigation schemes namely: Oke-Oyi (Oshin) irrigation project at Ilorin East Local Government,

Tadal-Shonga irrigation project at Edu Local Government Area and Moshi Gada irrigation scheme at Baruten Local Government Area among the twelve local government areas under the scheme. Sixty (60) respondents were randomly selected from each of the local government comprising of 30 irrigation farmers and 30 non irrigation farmers. A total of 180 farmers were used for the study.

Analytical Tool/Techniques

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, \ldots\ldots U)$

Y_i = Irrigation (dummy Variable; 1= adopters, 0=otherwise)

X_1 =Marital status (dummy variable; 0=Single, 1=Married, 2=Widow/Widower, 3=Divorced)

X_2 =Farming experience (years)

X_3 = Educational Status (0=Non formal, 1=primary, 2=secondary, 3=Tertiary)

X_4 = Gender (dummy Variable;1= Male, 0=otherwise)

X_5 = Household Size (Adult Equivalence)

X_6 = Total farm income (Naira)

X_7 = Membership in farmers Association (dummy variable; 1 =member,0=non-member)

X_8 = Extension agent contact (dummy variable; 1=extension visit, 0=otherwise)

$\in$= Error term

Food Security Index

The food security (Z) index as applied by Fakiyesi (2001) is given by the formula $\mathbf{Z}=\frac{Yn}{R}$: where Yn is the n^{th} household's daily per capita calorie intake and R is the recommended per capita daily calorie intake. Thus, Z_n=1 for Y_n>1 (i.e. food secure households) and Zn= 0 for Yn< 1(i.e. food insecure households).$\mathbf{H}=\frac{M}{N}$: where **H** is the headcount ratio, **M** is the number of insecure household and **N** is the total sample. The nutrients content of both produced and purchased food items were used to derive calorie availability. A daily recommended level of 2470kcal per capita and 65g protein per day defines the food security line, used in this study (Omotesho, Adewumi, and Fadimula, 2007).

Propensity Score Matching (PSM)

Propensity Score Matching (PSM) addresses the differences in groups prior to treatment by reducing the total collection of observed pre-treatment covariates into a single composite score that is then used to create a comparison group that is similar to the treated group with respect to observed covariates.

Logistic Regression

Logit regression was used to estimate the determinant of adoption of irrigation scheme. This defined adequate measurable indicator that will distinguish between irrigation and non irrigation farmers. A binary variable indicate whether or not the farmer will participate in the scheme.

The explanatory and dependent variables used in our econometric model are defined as follows

Propensity Score Matching was first established in the seminal paper by Rosenbaum and Rubin (1983).

The theoretical basis of the Propensity Score-Matching method lies in the results derived by Rosenbaum and Rubin (1983). The main idea can be summarized using the following theorems

Theorem 1*: the Propensity Score $p(X) = P(D=1|X)$ is a balancing score, $X \perp D \mid p(X)$*

Theorem 2*: if the Conditional Independence Assumption (CIA) holds, then the potential outcomes are independent of the treatment status, conditional on the propensity score $p(X)$*

$Y_1, Y_0(\,) \perp D \mid X \Rightarrow Y_1, Y_0(\,) \perp D \mid p(X)$

$ATT = E\,Y_1(|\,D=1) - E\,Y_0(\,|D=1) = E_p(x)\,|D=1\;E\,Y_1(|\,D=1, p(X)) - E\,Y_0[\,(|\,D=0, p(X))]$

Average Treatment Effect: The study used ATE to assess the impact of irrigation farming on food security of farming households. Where p = participation in irrigation farming (p = 1 for irrigation farmers using irrigation, and p = 0 for farmers not using irrigation farming); Y_1 = outcome (food security

of irrigation farming households using irrigation; Y_0 = outcome of the non irrigation farming households. The difference in outcomes between the two matched groups can be interpreted as the impact of irrigation farming on the farming households (Smith and Todd, 2001).

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Irrigation and Non-Irrigation Farming Household Heads

Table 1 revealed that 59.8% and 53.3% of the irrigation and non irrigation farming household heads respectively fall within the age bracket of 28-45 years, the mean age of beneficiaries and non-beneficiaries are 43.2 and 48.2 years respectively, which indicate that majority of the farmers, are still in their middle age and have required strength for farming activities in the study area. Typically, young people adopt innovations faster, as older farmers have a tendency to stick to their old production techniques and they are usually unwilling to accept change (Simtowe and Zeller, 2006).

It was also revealed that 91% and 94% of the beneficiaries and non- beneficiaries were males. This indicates that farming is dominated by male in the study area. This agrees with the findings of Ipaye (1995) that farming is still regarded as the male occupation. Olaleye (2000) also reported that commercial farming is mostly carried out by males while females involve in light farm operation.

The result also revealed that those who are married among the irrigation and non-irrigation farmers are about 91% and 98% respectively and the modal class for household size for both the irrigation and non irrigation farmers is 3-6. The distribution of farmers also showed that more than 50% of irrigation farmers had at least secondary education while less than 40% of non irrigation farmers had minimum of secondary education respectively. This shows that there are more educated farmers among the beneficiaries than the non-beneficiaries. This agrees with Kareem *et al*., (2008) and Bamiro (2007) that education has implication on agricultural productivity through the adoption of new technology.

The result presented in table 1 also show that the mean farm size of the beneficiaries and non-beneficiaries is 5.8 and 4.2 hectares respectively. This implies that the beneficiaries cultivated more farmland than the non-beneficiaries, which might be the reason why they practice irrigation farming due to their large farm size which necessitates the need for regular and consistent water supply for their farming activities. Most of the beneficiaries have access to extension service than the non-beneficiaries. This could have accounted for the reason why the beneficiaries got better information on new development and adopt innovation and techniques faster than the non-beneficiaries.

Table 1: Distribution of respondents according to their socio- economic characteristics

	Irrigation Farmers (N=90)		Non-Irrigation Farmers(N=90)		All Farmers (N=180)	
Characteristics	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Age						
≤30	2	2.2	0	0.0	2	1.1
31-45	52	57.8	48	53.3	100	55.6
46-60	36	40.0	42	46.7	78	43.3
Mean Age	42.5		48.2			
Gender						
Female	8	08.9	5	5.6	10	5.6
Male	82	91.1	85	94.4	170	94.4
Marital Status						
Single	8	8.9	2	2.2	10	5.6
Married	82	91.1	88	97.8	170	94.4
Educational Level						
No formal	18	20.0	34	37.8	52	28.9
Primary	24	26.7	22	24.4	46	25.6
Secondary	29	32.2	26	28.9	55	30.5
Tertiary	19	21.1	8	8.9	27	15.0
Household size						
<3	15	16.7	14	15.6	29	16.1
3-6	49	54.4	67	74.4	116	64.4
>6	26	28.9	9	9.0	35	19.5
Farming Experience						
≤10	9	10.0	18	20.0	27	150
11-20	48	53.3	39	43.3	87	48.3
21-30	15	16.7	26	28.9	41	22.8
>30	18	20.0	7	7.8	25	13.9
Mean	22.05		16.02			
Farm Size(hectares)						
>5	39	43.3	56	62.2	95	52.8
5-10	51	56.7	34	37.8	85	47.2
>10	0	0	0	0	0	0.0
Mean	5.8		4.2			
Farms Association						
Non-member	09	10.0	36	40.0	45	25.0
Member	81	90.0	54	60.0	135	75.0
Extension Contact						
Access	72	80.0	21	23.3	93	51.7
No Access	18	20	69	76.7	87	48.3
Total	90	100	90	100	180	100

Source: Field survey, 2017

Distribution of Irrigation and Non-Irrigation Farming Income Based on their Annual Farm Income

Table 2 presents the annual income of the farming households in the study area. The farming households on the irrigation scheme and the non irrigation farming households have a mean income of ₦922, 000 and ₦ 640, 780 respectively from their farming activities. This shows that participation in irrigation farming increases the annual income of farming households which eventually improves their livelihood.

Table 2: Distribution of Respondents according to their Annual Farm Income

Farm Income (₦)	Irrigation Farmer (N=90)		Non-irrigation (N=90)	
	Frequency	Percentage	Frequency	Percentage
< 500,000	14	15.6	26	28.9
500,0000 – 1,000,0000	68	75.6	64	71.1
> 1,000,000	8	8.8	0	0.0
Total	90	100.0	90	100.0
Mean	922,000		640,780	

Source: Field Survey, 2017; ₦ = Naira

The results in table 3 revealed that Adoption of irrigation Scheme is significantly affected by age, household size, years of schooling, farm size, farm income, farming experience, access to extension service and membership in farmers Association.

The coefficient of age was negative and significant at 5%, implying that younger farmers have more likelihood of adopting irrigation scheme. Household size was also positive and significant at 1%, it implies that the larger the household the likelihood of using irrigation farming. The coefficient of participation in farmers association was positive and significant at 1%, implying that the participation in farmers association increased the likelihood of adopting irrigation. The positive and significant coefficient for group membership points at the important role played by social networks in disseminating technology information. The importance of social networks such as interactions with neighbors and farmer groups in agricultural technology dissemination has been widely documented (Bandiera and Rasul, 2006; Duflo, Kremer, and Robinson, 2011; Gathiaka, 2012; Matuschke and Qaim, 2009; Wollni and Andersson, 2014)

The coefficient of years of schooling was positive and significant at 1% which implies that the more educated a person the more likelihood of adopting irrigation scheme. This is likely to be because such a farmer is exposed to better information and can easily adopt new methods. This is in collaboration with the result of Musigha *et al*. (2004) who found that education was positively related to adoption.

The coefficient of access to extension service and training was also positive and significant at 1%, implying that an increase in access to extension service increased the likelihood of adopting irrigation scheme. This is so because majority of the beneficiaries have access to extension agents that teach them on improved farming techniques of cultivation .Similarly, extension workers provide farmers with information on the availability of new and improved technology. Empirical results have revealed that extension contact has a significant influence on farmer adoption of new technology (Zegeye *et al*., 2001).

The coefficient of farm size was also found to be positive and significant at 1%. This shows that the larger the farm size of a farmer the more the likelihood to in irrigation farming.

Similarly, the coefficient of farmers income from farm was positive and significant at 5%, implying that farmers with higher income can afford to adopt irrigation scheme. Farming experience was also positive and significant 10%, it implies that more experienced farmers have the likelihood of practicing irrigation farming.

The coefficients of determination with value 0.6074 shows that the explanatory variables explain about 60.7% of the variations in the adoption of irrigation farming implying that more of the variations is explained by the model.

Factors Affecting Farmer's Participation in irrigation scheme

Table 3: Logit regression result of factors affecting participation

Variables	Odds Ratio	Coefficient	p>Z
Age	0.913407	-0.0905733**	0.010
Household Size	1.640808	0.4951891***	0.000
Gender	0.334360	-1.095537	0.210
Farmers Association	122.234582	4.805942***	0.000
Extension contact	8.713852	2.164914***	0.000
Farm Size	1.284866	0.2506541***	0.005
Years of Schooling	1.160628	0.1489614***	0.000
Marital Status	0.630092	-0.4618901	0.341
Farming Experience	1.043459	0.0425415*	0.083
Farm income	1.000004	0.000004**	0.015
Constant	0.110521	-2.202546	0.112

Source: Field survey, (2017).

* Significant at 1%, **significant at 5%, ***significant at 10%.Number of observation = 180. LR chi^2 (11) = 151.57. Prob> chi^2 = 0.0000. Log likelihood =-48.980872 Pseudo R^2 = 0.6074

Food Security Status of the Irrigation and Non-Irrigation Farmers

Table 4 presents the households food security status of irrigation and non irrigation farmer's households.

About 79% and 54% of the irrigation and non irrigation farmer's households were food secure respectively. The mean daily energy and protein available to the food-secure households for irrigation and non irrigation farmer's are (16048.62 Kcal and 386.46g)and (15045.26 Kcal and 349.61) respectively while the daily per capita energy for food secure households for irrigation and non irrigation farmer's households are 3550.50kcal and 2950.05kcal respectively.

Table 4: Food Security Status of Farming Households

	Irrigation Farmers		Non- Irrigation Farmers	
	Food Secure	Food Insecure	Food secure	Food Insecure
Household Percentage	78.5	21.5	53.8	46.2
Mean Adjusted Household Size	4.52	4.83	5.10	5.41
Household daily energy availability (Kcal)				
Household daily per capita energy(Kcal)	16048.62	10746.75	15045.26	11492.74
Household daily protein availability (g)	3550.50	2225.00	2950.05	2124.35
Household daily per capita protein availability(g)	386.46	234.26	349.61	244.75
	85.50	48.50	68.55	45.24
Head Count Ratio	0.785	0.215	0.538	0.462

Source: Field survey, 2017

Impact of Irrigation Farming on Food Security Status of Farming Households

Table 5 reveals that Average Treatment Effect on the Treated (ATT), which measures the impact of irrigation scheme on food security of households that adopts the scheme, showed that the calorie intake increased on the average by 1157 kcal/AE/day. The increment in the calorie intake of the adopters was significant at 1%.

Average Treatment Effect of the irrigation scheme on the Untreated (ATU) showed that if the non-adopters had adopted the scheme, the improvement in their calorie intake would have been increased by 1035kcal/AE/day while Average Treatment Effect (ATE) shows that if a respondent was to be picked randomly, the calorie intake would increase by 1042 kcal/AE/day, since ATT is greater than both ATU and ATE, it implies that irrigation scheme has impact on the food security of the farming households adopting the scheme.

Impact of Irrigation Scheme on Calorie Intake of Farming Households

Table 5: Treatment Table

Variable	Sample	Treated	Control	Difference	S.E.	T-Stat
Farm Income	Unmatched	1748.756	964.722	784.034	5375.8433	3.74***
	ATT	2192.691	1035.647	1157.044	8766.3476	3.75***
	ATU	1900.567	865.178	1035.389	-	-
	ATE			1042.4264	-	--

Source: Field Survey, 2017**;** *, **, *** indicate the coefficients are statistically significant at 10%, 5% and 1% level respectively. T-values are based on Bootstrapped standard error. ATT is Average Treatment Effects on the Treated,

ATU is Average Treatment Effect on the Untreated and

ATE is Average Treatment Effects.

Constraints to the Irrigation Scheme

Table 6 presents the distribution of beneficiaries according to the constraints faced in accessing the irrigation scheme. Inadequate awareness of the scheme was ranked 1st among the constraints which makes it the most severe constraint to the accessibility of the scheme, this might be due to the fact that farmers did not have adequate information on the importance of the scheme. Also, cost of irrigation water was ranked 2nd among the constraints faced in accessing the scheme, this implies that the irrigation water is more expensive for some of the farmers to afford which affect their use of the scheme. The distance of their farm to the irrigation site was ranked 3rd which shows that the site of the irrigation scheme is far to their farms, this affects their ability to access the scheme. The 4th challenge faced by farmers in assessing the scheme is the unfairness of water distribution, this shows that the irrigation water is not made available to all the farmers in equal proportion. Inadequate government supports was ranked 5th among the constraints. The least and the 6th of the challenges faced by farmers in assessing the scheme is the enforcement of cropping pattern, this shows that farmers were compelled to plant and use a particular cropping pattern.

Table 6: Constraints to the Irrigation Scheme

Constraints	Not severe	Mild	severe	Very severe	Mean	Rank
Cost of irrigation water	5	11	45	210	3.01	2nd
Inadequate awareness	5	22	51	226	3.38	1st
Distance to irrigation site	4	62	78	83	2.51	3rd
Inadequate government support	33	35	60	32	1.78	5th
Unfairness of water distribution	32	81	53	42	2.31	4th
Enforcement of cropping pattern	20	50	30	15	1.27	6th

Source: Data Analysis, 2017;

CONCLUSION AND RECOMMENDATIONS

From the empirical evidences of this research work, it can be safely inferred that small scale irrigation scheme in the study area is of great impact on food security of the farming households. However, to achieve food security in Nigeria through irrigation interventions;

- There should be proper sensitization of farmers on the benefit of irrigation scheme.
- Government should subsidize irrigation cost and make available irrigation equipment and facilities at affordable cost.

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