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LIVELIHOOD ANALYSIS OF SMALLHOLDER IRRIGATION FARMERS IN NIGERIA

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ABSTRACT

The study assessed the smallholder irrigation farmers' welfare by examining their irrigation practices and factor affecting their production outputs in Nigeria. Cross sectional survey was conducted and primary data were collected from 198 smallholder farmers across selected three major agro-ecological zones using a multistage sampling technique. The results revealed thatthe highest proportion of farmers using motor pump with groundwater (71%) and surface water (62%) irrigation system for farming live in houses made of cement and bricks compared to 59.1% for farmers who practice rainfed agriculture. About 81.5% of the tube wells are found among the motor pump irrigators, 30% respondents have hand dug wells. The percentage of farmers with motor pump and associated piping accessories ranges from 30% among gravity flow irrigators to 70% and 80% among surface and groundwater irrigators respectively. The analysis of factors affecting farmers productivity suggest that in order to increase productivity, the manual pump users, should be discouraged from excessiveuse of fertilizer and large farm size while access to other inputs such as agrochemicals, education, association with social groups, capital formation should be strengthened. The motor pump users require large farm size to further increase their output level, while the gravity flow irrigators need to join farmers association. Furthermore, extension services across the agro-ecological zones should be resuscitated in order to increase agricultural productivity.

Keywords: Crop yield; Irrigation; livelihood; productivity; water management.

INTRODUCTION

There are many indications that water is becoming an increasingly scarce resource ((Falkenmark, 1997; Viala, 2008). Access to water is now recognized as a prerequisite for povertyreduction (Sullivan *et al*., 2003) and the most important determinant of increase in agricultural output and rural livelihood. The concept of 'sustainable rural livelihoods' is increasingly central to the debate about rural development, poverty reduction and environmental management; a livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living (Chambers and Conway, 1992). The ability to pursue different livelihood strategies is dependent on the basic material and social, tangible and intangible assets that people have in their possession, such livelihood resources may be seen as the 'capital' base from which different productive streams are derived out of which livelihoods are constructed.

In rural areas, it is made up of a range of farm and off-farm activities, which together provide a variety of procurement sources for food and cash. Within the sustainable livelihoods framework, three broad clusters of livelihood strategies are identified. These are: agricultural intensification / extensification, livelihood diversification and migration. Broadly, these are seen to cover the range of options open to rural people. Either you gain more of your livelihood from agriculture (including crop cultivation, livestock rearing, aquaculture, forestry etc.) through processes of intensification (more output per unit area through capital investment or increases in labour inputs or irrigation in the dry season) orextensification (more land under cultivation), or you diversify to a range of off-farm income earningactivities, or you move away and seek a livelihood, either temporarily or permanently, elsewhere. Or, morecommonly, you pursue a combination of strategies together or in sequence.

Crop production in Nigeria is predominantly rain fed as many farmers are engaged mostly in the wet season while they pursue other means of livelihood in the dry season, those who do not have other sources of income are entrenched in deep poverty. The vagaries of the weather and the impact of the climate change phenomenon have however shortened the length of wet season making the need for irrigation more crucial than ever. Irrigation in the dry season is a veritable means of keeping the rural farmers busy with extra strings of income that contribute in no small way to enhance their livelihood. In Nigeria, rainfall and temperature are the most critical agro-climatic parameters that define the different agro-ecological zones for the purpose of irrigation practices. Agriculture that relies only on direct rainfall is referred to as rain-fed farming while those that utilize irrigation are irrigated farming system. Traditionally, sources of irrigation water include rivers, lakes or reservoirs and groundwater extracted from wells and/or springs. In addition, non-conventional sources like treated wastewater, desalinated water or drainage water are also on the increase nowadays in many parts of the world. Nonetheless, successful agriculture is dependent upon farmers having sufficient access to water (Smith, 2007; Snyder and Melo-Aberu, 2005; Williams, *et al*. 1990).

Economic development and population increase in Nigeria for instance, is putting great demand on water resources, for both domestic and agricultural uses, thus requiring concerted strategic actions to increase the country's agricultural production. There is physical water scarcity characterized by environmental degradation and declining groundwater resources, economic scarcity characterized by lack of investment in water or insufficient human capacity to satisfy the demand for water. As a result of lack of infrastructure, people in many times have to fetch water from rivers for domestic and agricultural uses (WHO, 1983; Dougherty and Hall, 1995). In order to avoid a global water and food crisis, farmers strive to increase productivity to meet growing demands; communities and industry are also devising ways of efficient water use (Frenken, 2005).While data sets relating to surface water resources, land-cover and areas equipped for irrigation are said to be available (FAO, 2008), the relative contribution of groundwater irrigation to agricultural production is still subjective in Nigeria. Although a number studies on rural livelihood in Nigeria abound in literature, there is little that has been done to evaluate the relative contribution of different modes of smallholder irrigation farming to rural livelihood. However, it should be pointed out that despite the relatively small productivity extent of groundwater irrigation compared to conventional rainfed farming and surface/gravity flow irrigation, especially in the rain forest and guinea savannah region of Nigeria, it represents a unique alternative for management of scarce water resources in support of small scale agricultural production and rural livelihoods.

The objective of this paper is to evaluate different modes of small-holder irrigation farming systems in Nigeria and their implications on water resource use, production outputs and farmers' livelihoods. The outcome of the study is expected to guide the thinking and discussion on irrigation development strategy and policy most appropriate for small holder agriculture in Nigeria.

MATERIALS AND METHODS

The study was carried out in three agro-ecological zones of Nigeria, namely: i) Rain forest zone in the south, ii) Guinea savannah zone in the middle belt and Sudan savannah zone to the northern part of the country. Data collection for the study took place between June and September, 2011 in the three main agro-ecological zones across Nigeria for a good representation (Figure 1). The study mainly employed primary data, collected through the use of a structured questionnaire and augmented by scheduled interview. Secondary information was also elicited from the internet, books from library, Ministry of Agriculture and Water Resources.

In order to explore the choices and preferences of small-holders operating within different Water Control Classes (WCC), a reasonable number of farming households from each WCC in the three agro-ecological zones were interviewed with the standard questionnaire. In order to collected the required data from the selected zones in the country, multistage sampling technique was employed. The first stage was the random selection of two states within each of the selected three agro-ecological zones based on the presence of irrigated agriculture and the presence of small-holder private irrigation with or without pump facilities. The second stage was the purposive selection of irrigation areas within the selected states. The selected Local Government Areas (LGAs) and villages within the selected states were based on the concentration of smallholder irrigation farmers where relevant information on the study can be obtained. These areas were purposively selected. In the northern part of the country which is characterized mainly by the Sudan savannah, data were collected in the two randomly selected states of Kano and Zamfara especially in Birni Tudu and Talata Mafara Local Government Areas (LGAs) of Zamfara; Pankuru Yanaba and Sanbo Kaura of Garum Malam LGA of Kano State. In the Guinea savannah zone which is made up of parts of the middle and western belt of Nigeria, villages such as Afon, Otte in Asa LGA and Ajase of Irepodun LGA in Kwara and Sepeteri, Saki in Saki LGA, Iganna, Olaiya in Iwajowa

LGA, Ilero and Karun Village in Kajola LGA were selected;whilein the Rain forest Zone, villages such as Odoguyan, Ijede of Ikorodun LGA in Lagos State were selected. The third stage was the random selection of smallholder irrigation farmers across the selected areas, based on the availability of the different water control classes and small-scale irrigators and willingness of the respondents to supply the requested information.

Total sample size taken for the analysis was 205 but only 198 (96.5%) gave fairly good representation sufficient to draw robust inferences about the central behavioral tendency of a population group and at the same time permitting comprehensive analysis of small-holder farming systems (Table 1).

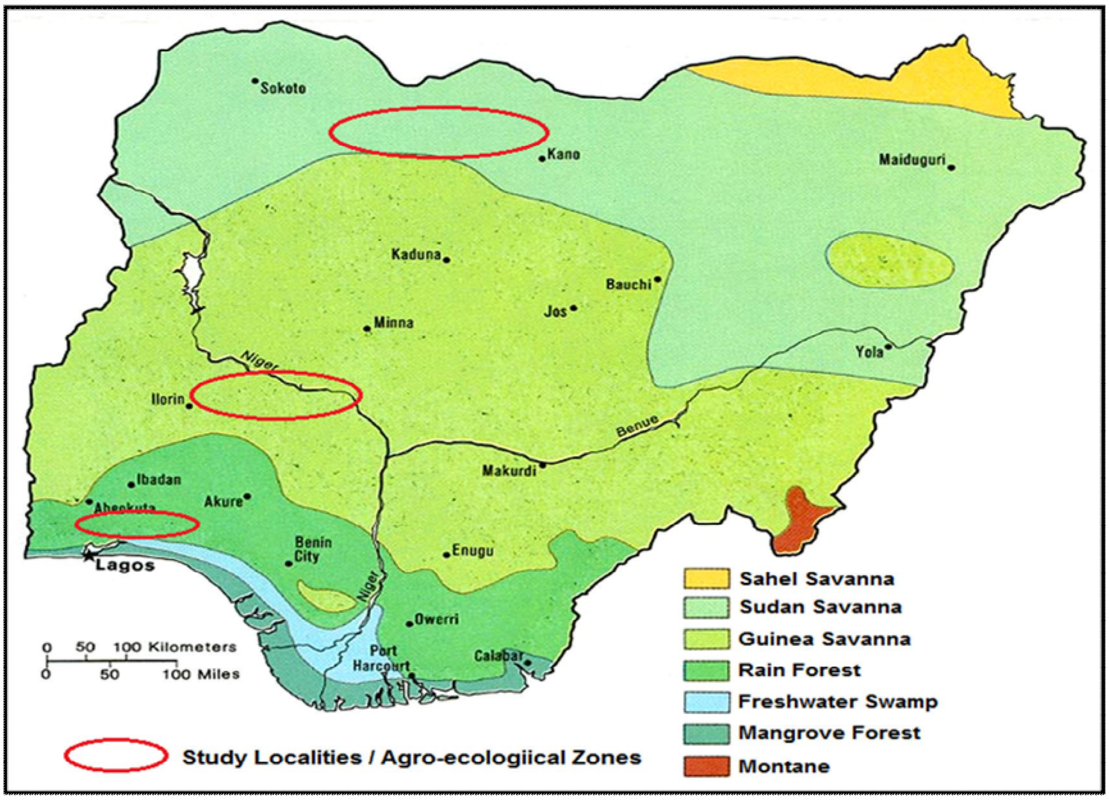

Figure 1: Location of selected study sites within the Agro-ecological zones of Nigeria

Source of the production data

The dataset used in the analysis of the production function comprises of four separate data files on the sampled small-holders. These include production data on rainfed farmers who do not irrigate their farms, and farmers who use gravity flow, motor pump as well as manual pump irrigation. Output is measured as the value of output from production in N/acre of the crops grown by the smallholders. The fixed inputs are cultivated land (acres) and capital representing the cost of fixed investments in irrigation infrastructure (for those who used irrigation in farming). Notably,capital for gravity flow, motor and manual pump irrigators consists of costs of investment in naira of motor pumps and manual pumps respectively. Capital for rain-fed farmers was measured as the cost of investments in bullocks in naira. The variable inputs are seed and labour. Seed is measured in kg/ acre. The labour inputs are family and hired labour both measured in man-days/acre, chemicals is measured in litres/acre, and fertilizer in kg/acre. The family and hired labour inputs are made up of male and female labour inputs. The chemicals used by the farmers include insecticides, herbicides and fungicides. Commercial inorganic fertilizers used by the smallholders are nitrogenous fertilizer (NPK) and sulphate of ammonia. Other endogenous variables used in the models are, farm size (acre), level of education of respondents, membership of associations and extension contact.

Table 1: Distribution of respondents in selected Agro-ecological Zones

Water Control Class	Sudan Savannah	Guinea Savannah	Rain forest	Total
WCC I: Motor pump Irrigation with groundwater	10	07	18	35
WCC II: Motor Pump irrigation from surface water	18	27	05	50
WCC III: Manual irrigation from surface or groundwater	-	13	03	16
WCC IV: Gravity flow	14	09	08	31
WCC V: Rainfed farming	07	27	32	66
*Total	49	83	66	198

* = Total per AEZ

Source: Field Survey, 2011

Data analysis

The analytical tools employed for the evaluation of the data were descriptive statistics and inferential statistics - Cobb-Douglas form of the production function. Cobb-Douglas function was employed to know the determinants of smallholder production output under the different WCCs in the study areas in line with Picazo -Tadeo and Reig-Martínez (2005).

The t-statistic was used to test the significance of the difference in means of hired labor of manual devices (manual pump irrigators) and non-adopters of manual devices (motor pump irrigators).

RESULTS AND DISCUSSIONS

Smallholder Irrigation System in Nigeria

Irrigation is an age-old science of artificial application of water to the land, allows for cultivation in dry areas and in the dry season. However, according to a paper published by the International Food Policy Research Institute (IFPRI), "only about three percent of the cultivated area, in Nigeria use water management techniques, of which approximately 0.2 million hectares are irrigated with equipment such as pumps and tube wells" (Yu *et al*., 2010). This essentially means that most farmers in Nigeria depend on rainfall as the primary source of water for their crops. In addition, 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. This also implies that most of the irrigation activities are based on small holder agriculture.

On empirical basis, a key observation from the field survey in this study revealed that all the hypothesized modes of irrigation technologies or Water Control Classes (WCCs) are practiced by smallholder farmers in the selected states of rainforest zone and Kwara State in the Guinea Savannah as shown in Table 2. However, in selected states in Sudan Savannah zone (Kano State and Zamfara) none of the sampled farmers are lifting irrigation water with private manual pump (WCC-III) while only few farmers are practicing the gravity flow (WCC-IV) and rainfed irrigation (WCC-V). In addition, rainfed irrigation is more commonly practiced in the Guinea savannah zone with 27 out of 83 and in the rainforest zone with 32 out of 66. Nonetheless, private motor pump irrigations either with surface or groundwater sources (WCC-I and -II) are commonly practiced in all the three (3) AEZ studied.

Further empirical findings from the study showed that aside from rainfed farming, the main irrigation systems adopted by the smallholders in the sampled AEZ are the gravity flow, manual/bucket and motor pump.

Livelihood of the smallholder farmers by Water Management Options

Alivelihood comprises the capabilities, assets (stores, resources, claims and access) and activitiesrequired for a means of living.In general 40.9% of the respondents live in houses with thatched roof, while 59.1% of respondents live in homes made with cement and bricks. However, with respect to the different WCCs, 9 respondents have homes with thatched roof compare to 6 that have homes made with cement and bricks under manual irrigation (WCC-III) while 10 and 19 respondents, for motor pump with groundwater (WCC-I) and surface water (WCC-II) respectively, have homes with thatched roof compare to 25 and 31 respectively with homes made of cement and bricks. However, 27 respondents have homes with thatched roof compared to 39 respondents with homes made of cement and bricks among the rainfed farmers (WCC -V). Equal numbers of respondents (15) have homes with thatched roofs and with cement and bricks among the gravity flow irrigators.

The study also revealed that only 38 out of 198 (19.2%) of the respondents across the WCC have tube-wells for irrigation, the depth of the tube-wells however range between 15–30 m across the WCC. However, about 81.5% of the tube wells are found among the motor pump irrigators using either surface or groundwater sources. It was also observed that 59 out of 198 (30%) of the respondents have hand dug wells with depth range of 10–15 m while about 60% of the dug-well are in use for irrigation (especially for vegetables) among the manual bucket and motor pump irrigators. Nonetheless, the presence of dug-wells among other category of WCC implies that the dug-wells are not in all cases meant

Table 2: Response of sampled smallholder farmers by different WCCs

Sampled AEZ	Sampled States	Sampled farmers under different WCCs					Total
		WCC I	WCC II	WCC III	WCC IV	WCC V	
Sudan	Kano	05	14	-	06	03	28
	Zamfara	05	04	-	08	04	21
Guinea	Kwara	07	12	10	09	10	48
	Oyo	-	15	03	-	17	35
Rainforest	Lagos	10	02	02	05	19	38
	Ogun	08	03	01	03	13	28
Total		35	50	16	31	66	198

Note: WCC I denotes small scale private motor pump irrigation with groundwater,
WCC II denotes private motor pump irrigation from surface water,
WCC III denotes private manual pump irrigation from surface/groundwater,
WCC IV denotes gravity flow, and WCC V denotes rain-fed.
Source: Field survey, 2011;

for irrigation but rather as sources of domestic drinking / household water supply.

The percentage of respondents with motor pump and associate piping accessories ranges from 30% for gravity flow irrigators to 70% and 80% for surface and groundwater irrigators respectively. This, in addition to the high percentage of respondents (>65%) across the WCC with pesticide spray pumps is an indication of level of farm-input useage by the farmers. It should be noted that across the WCC more than 70% of respondents have transistor radio, >60% with mobile phones and 50-80% with colour TV set. This is an indication of the relative high level of awareness in parts minimal literacy level of the farmers, especially in the rainforest AEZ.

Worthy of note from the study is the fact that none of the respondents have a formal title to their land; this was probably due to the land administration regime in the country in addition to the fact that a large percentage of the respondents may not be able to afford the cost of obtaining a formal title for the land. Apart from the land under the formal irrigation schemes (gravity flow irrigators) which is controlled and regulated by the government, many of the respondents relied on the traditional land tenure system and some have lands administered by inheritance.

Land holdings and family labour endowments

The study revealed that agricultural land holdings in Nigeria are divided into two categories: upland farms and lowland farms. The upland farms are predominantly committed to rainfed cropping while the lowland farms are committed to irrigation cropping due to their location in low lying topographic area in proximity to surface water and groundwater. Figure 2 shows the land holdings based on the water control classes (WCC) considered in this study.The total land area cultivated by the 198 farmers sampled was 2,219.87 acres, out which 1,101.17 acres representing about 50.4% is owned by farmers who practice rainfed cropping; the remaining 49.6% of the land holdings belong to farmers who practice irrigation cropping, out of which 11% and 19% are owned by motor pump groundwater and surface water irrigators respectively. The low percentage (5%) land holding by the manual irrigators is a confirmation of limited and subsistence productivity associated with this WCC.

With respect to land holding distribution, rain-fed farmers and those that use gravity and motor pumps to lift surface and groundwater water for irrigation also own quite sizeable acreages for farming (Table 3).The surface water motor pump irrigators, for instance, own an average area of 411 acres while groundwater motor pump irrigators have 246 acres. The groundwater bucket irrigators, however, have the least acreages under irrigation. However, it was also observed that farmers who practice irrigation using any of the water control classes did not completely irrigate the entire land holdings in their possession, apparently due to lack of capital; only 70.3% of the land holding for irrigation cropping was actually irrigated as reported by the farmers. In addition, the rainfed and groundwater bucket users were endowed with an average of three family labour while the remaining irrigators were only endowed with an average of two (2) family labour. To complement this labour endowement, the farmers under the various categories of water control methods also hired labour which varies by various methods used. The average number of family workers, counting part-time workers as half-full workers, is generally 2, while average number of 3 for rainfed and groundwater bucket irrigators can be attributed to the relatively large acreage and level of manual inputs respectively. This low involvement of family members can be attributed to the use of hired labour in a number of the agricultural activities, especially at land preparation and harvesting stages.

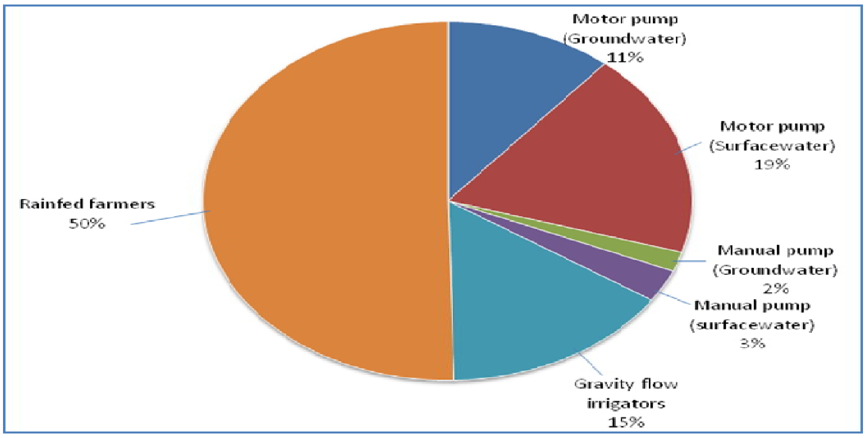

Figure 2: Agricultural land holdings based on water control classes (WCC)
Source: Field survey, 2011.

Worthy of note from the study is the fact that none of the respondents have a formal title to their land; this was probably due to the land administration regime in the country in addition to the fact that a large percentage of the respondents may not be able to afford the cost of obtaining a formal title for the land. Apart from the land under the formal irrigation schemes (gravity flow irrigators) which is controlled and regulated by the government, many of the respondents relied on the traditional land tenure system and some have lands administered by inheritance as a stable method of land arrangement although with some limitations on the farmers decision on what type of infrastructure to establish on the land.

Crop choice and Land area under ranked crops by the smallholder farmers

Crops grown and annual crop calendars were hypothesized to differ significantly across the different WCCs. Based on field investigation, the crops grown are generally similar for the irrigation farmers most of whom cultivate leafy vegetables, tomato, pepper and okra in the decreasing order of importance unlike the rainfed farmers who cultivate mostly maize, millet, yam and cassava. Thus it can be inferred that most irrigation farmers prefer crops with rather lower planting cycle which can at times be cultivated more than once within the year.

The total area under maize cultivation as the highest ranked crop is about 704.3 acres followed by millet (615.3 acres) and cassava (357.9 acres). The lower acreage (312.2 acres) under yam cultivation as the third most important crop compared to cassava can be attributed to the fact that cassava requires less tendering before maturity. Following the rainfed is the surface motor pump irrigators that put higher acreage (118 to 33 acres) compared to the gravity flow and the groundwater motor pump with 63 to 18 acres and 71 to 20 acres respectively. In general, farmers using the various irrigation lifting devices put more acreage under the most important crop, i.e. the area under cultivation decline from the most important ranked crop to the least important crop with the exception of the rainfed farming.

Irrigation frequency and Input use in crop production

In general, water needs of plants varies, depending on a number of plant specific factors and climatic environments. However, watering of crops depends either on the system used for irrigation or the type of soil on which crops are grown. Due to the nature of crop, maize grown under rainfed system is watered through rainfall that normally commences by April in the southern and May/June in the northern part of the which are usually sufficient enough for planting season (3 months).

Data evaluation in this study revealed that gravity flow irrigators did not have much control over their watering activities. Although the farmers are able to control the volume of water that enters their fields, they are not able to control the water that is supplied to the entire irrigation field. Nonetheless, rice popularly grown under the gravity and motor pump irrigation require frequency of irrigation of between 25-30 times per crop cycle while vegetable crops (tomatoes, lettuce, onions, pepper) mostly grown by those using manual pump / buckets require between 15-20 irrigation times per crop cycle (Table 3). Furthermore, field observation revealed that manual water pump and surface water motor pump operators apply more irrigation water than the gravity operators, apparently due to the intensive nature of farming and possible multiple crop cycles.

However, it should be pointed out that unlike other private motor pump irrigation, the maintenance of the irrigation system under gravity flow system is usually covered from the water user fee payments by farmers. Apart from irrigation water usage, the level of input usage in crop production was hypothesized, in this study, to increase significantly from WCCI and II to WCC IV. Table 4 indicates differences in variable input use by farmers across the different water control classes; WCC1, WCCII, and WCCIII. This variability could be attributed to the different crops grown by the farmers which require different variable inputs.Seeds application and hired labour requirement, for example, are higher in gravity flow compared to the other water control classes, apparently due to seed loss as well as higher labour demand while using this method. Consequently, gravity flow irrigators spend more on farm equipment/implement compared to the surface water motor and manual pump operators. However, chemical and fertilizers inputs for surface water motor and manual pump operators are relatively higher than those of the gravity flow irrigators apparently due to the intensive nature of the farming.

Table 3: Irrigation frequency for specific crops

Water source/ Irrigation types	Most important / popular crop	Av. no. of watering times untill harvest*
Rainfed farmers	Maize	3 months of rainy season
Gravity flow irrigators	Rice	25-30
Manual Pump / Bucket Irrigators	Vegetable (Tomatoes, Lettuce, Onions, Pepper, Okro)	15-20
Motor Pump Irrigators	Rice	25-30
All categories of Irrigation	Vegetable (Tomatoes, Lettuce, Onions, Pepper, etc.)	15-20

*Note: Irrigation times per crop cycle; Source: Field survey, 2011

Hired Labour Input of Adopters and Non-Adopters of Manual Devices

As part of further data evaluation, this section investigates the proposition that smallholder adopters of manual devices have larger hired labour endowments compared to non-adopters. Consequently, t -test of significance on hired labour input by adopters of manual devices (manual pump irrigators) and non-adopters of manual devices (motor pump irrigators) was investigated. Basically, the test is to highlights whether there is a significant difference between the hired labour input by adopters and non-adopters of manual devices for irrigation.

The test of significance shown in Table 5 show that adopters of manual devices employ less hired labour (mean value of 2.3) during irrigation than the non-adopters of manual devices (motor pump of mean value of 4.7), probably because of the higher access of manual irrigators to family labour (with an average number of 3) compared to motor pump irrigators (with an average number of 2). However, the t-statistics of 1.197 which is less than 1.95 confirms that, there is no significantly difference in hired labour endowments by the smallholder adopters of manual devicescompared to the non-adopters (motor pump irrigators) at any levels. This clearly negates the hypothesis that smallholder adopters of manual devices have larger hired labour endowments compared to non-adopters in the study area. The overall implication is that the smallholder adoptor of manual devices are endowed with labour of household/family members, thus warrant no need or very low demand of hired labour.

Results of Cobb-Douglas Production Functions

The results in Table 6 show that the Cobb-Douglas regression model is significant as shown by F-statistic for all the various WCCs systems analysed with rainfed (1% level), gravity flow (10% level), motor pump (10% level) and manual pump (10% level). This implied that the whole equation under the different system is at best fit. The coefficient of determination (R^2) of 0.515 (under rainfed), 0.425 (under gravity flow), 0.866 (under the motor pump) and 0.405 (under the manual pump) indicated that 52%, 43%, 87% and 41% variations in rainfed, gravity flow, motor pump and manual pump farmers outputs respectively, were explained by the various independent variables used in the analysis.

The positive sign of the coefficient of age, extension contact, membership of association, hired labour, quantity of seed used, agrochemical and capital formation showed that increase in the quantity of these variables were directly related to rainfed smallholder farmers output. However, the negative sign of the coefficient of education level, fertilizer and farm size contrary to expectation implied that, these variables were indirectly related to rainfed farmers output. Thus the statistical significance variables affecting rainfed farmers in the study areas were age ($P<0.05$), education ($P<0.01$), quantity of hired labour ($P<0.1^{o}$), quantity of seed used ($P<0.05$) and fertilizer level ($P<0.01$).

The regression coefficients in the model show the elasticities of the variables. The results as presented in Table 7 shows that rainfed smallholder farmers output is inelastic with respect to farm size, number of extension contact, membership of association, quantity of seed planted, quantity of fertilizer applied, quantity of agrochemical used, capital formation and farm size. This implies that a change in the level of use of any of these variables will result in less than proportionate change in farmers output. Age and educational level of rainfed farmers that are elastic implies that change in the level of farmers education and age results in more than proportionate change in farmers output.

Table 4: Inputs use under the different WCCs

Variable inputs	Groundwater motor pump (WCC I) and Manual lift (WCC III)		Gravity Flow (WCC IV)		Surface Water Motor Pump (WCC II)	
	Mean	S.D	Mean	S.D	Mean	S.D
Seeds (kg)	6.08	5.78	24.13	28.28	13.16	23.40
Fertilizer (Kg)	150.00	217.94	7.60	3.16	152.88	189.26
Chemicals (litre)	2.96	1.33	0.81	1.39	8.08	10.01
Area of land irrigated (acre)	2.19	1.41	3.38	2.84	8.05	6.35
Hired labour (man days)	2.35	4.02	14.00	19.95	4.73	6.80
Equipment (in N)	5776.40	6172.77	128760.0	499116.0	8513.90	10062.66
Water Charges (N)	-	-	2,500	-	-	-
Fuel Cost (N)	2,820.50	628.20	-	-	3,110.00	756.15

Note: Chemicals includes the herbicides, herbicides and fungicides;

S.D. = Standard Deviation.

1 US Dollar (USD) = 150 Nigeria currency as at October 2011.

Source: Field survey, 2011.

Table 5: t-test of significance on hired labour inputs

Variable	Manual pump irrigators (N = 23)		Motor pump irrigators (N = 85)		Mean difference	t-statistic
	Mean	Standard deviation	Mean	Standard deviation		
Hired labour	2.3077	4.0494	4.7273	6.7974	2.4196	1.197

Source: Field survey, 2011

The Return to Scale (RTS) was calculated as the sum of individual production inputs elasticities. Under the rainfed system, RTS was found as 0.56 (less than unity) indicating a decreasing return to scale. That is, rainfed farmers output increases by less than that proportional change in input. An increase of 1% by rainfed farmers in any of the factor inputs would lead to a decrease of 5.6% in output in the study area.

In the case of gravity flow farmers, age, educational level, membership of association, hired labour and capital formation have positive coefficients implying that increase in the quantity of these variables were directly related to gravity flow smallholder farmers output while extension contact, quantity of seed used, agrochemical, fertilizer application and farm size have negative coefficient contrary to expectation showing that, these variables were indirectly related to farmers output. The results further show that, in the study areas, the age of the farmers ($P<0.05$), farmers educational level ($P<0.01$), membership of social groups ($P<0.05$), fertilizer application ($P<0.05$), level of capital formation ($P<0.05$) and farm size ($P<0.1^o$) were the statistical significance variables determining gravity farmers outputs. The results of production elasticities in Table 10 shows that, the gravity flow smallholder farmers output is elastic with respect to with respect to the age of the farmers, level of education, number of extension contact, membership of social groups, fertilizer application and farm size.

Table 6: Descriptive statistics of the variables used in the Cobb-Douglas production functions

Symbols / Variable		Unit	Rainfed (N= 66) Mean	SD	Gravity (N= 31) Mean	SD	Motor pump (N =85) Mean	SD	Manual pump (N=16) Mean	SD
Q	Output	Kg (Grain equiv)	1076.20	2365.43	1524	144.72	3523.60	2583.50	4622.60	6535.41
H1	Age	Years	32.36	11.17	33.13	10.73	33.15	12.94	34.52	11.60
*H2	Education	Educated =1, otherwise 0	-	-	-	-	-	-	-	-
*H3	Ext. Contact	Contact = 1, otherwise 0	-	-	-	-	-	-	-	-
*H4	Member of Assoc.	Member =1 otherwise 0	-	-	-	-	-	-	-	-
Z1	Hired labour	Man days	22.73	18.31	14.00	19.95	2.35	4.02	4.73	6.80
Z2	Seed	Kg/ acre	17.53	35.57	24.13	28.28	6.08	5.78	13.16	23.40
Z3	Chemicals	Litre/acre	5.38	8.70	0.81	1.39	2.96	1.33	8.08	10.01
Z4	Fertilizer	Kg/acre	300.64	163.63	7.60	3.16	150.00	217.94	152.88	189.26
Z5	Capital	N	16667.0	87201.9	499,116.0	128,760	6172.8	5776.40	10062.7	8513.9
Z6	Farm size	Acre	7.85	7.05	3.38	2.84	2.19	1.41	8.05	6.35

Note: * Are dummy variables (0 and 1) so their mean and SD are omitted.

Source: Field survey, 2011

This implied that a change in the level of any of these variables will result in more than proportionate change in farmers output while other variables such as hired labour, quantity of seed used, agrochemical and level of capital which are inelastic indicating that, a change in the level of any of these variables will result in less than proportionate change in farmers output. The estimated value of Return to Scale (RTS) of - 0.62 which is less than one, like for the rainfed farmers, implied that an increase of 1% in any of the factor inputs would lead to a decrease of 6.2% in gravity flow farmers output in the study area.

Further analysis of the farmers with motor pump in the study areas with Cobb-Douglas function showed a direct relationship of motor pump farmers output with number of extension contact, hired labour, agrochemical and farm size as a results of the positive coefficients of these variables and indirect relationship between output with farmer's age, level of education, membership of social group, amount of seed, fertilizer application and level of capital formation. Only level of education, fertilizer application and farm size were found as significant variables (all at P<0.01) affecting farmers out under this system of irrigation in the study. Production elasticity values in Table 8 shows that, the motor pump smallholder farmers output with respect to all the variables is inelastic showing that, a change in the level of any of these variables will result in less than proportionate change in motor pump farmers output. Estimated value of return to scale of -0.84 (less than unity), as the case with the other previous systems, implied that an increase of 1% in any of the factor inputs would lead to a decrease of 8.4% in the output of farmers using the motor pump in the study area.

On those using the manual pump irrigation system, the Cobb-Douglas production results show that the age of the farmers, educational level, membership of social group, quantity of seed, agrochemical, fertilizer application, capital formation and farm size were directly related to farmers output while access to extension contact, fertilizers and farm size have indirect relationship due to their negative coefficient values, though contrary to expectation. The only significant determinants of the manual users output in the study were fertilizer application (P<0.05) and farm size P<0.01). Also observed from the result was the fact that, farmers output under this system with respect to the variables is inelastic indicating that, a change in the level of any of these variables will result in less than proportionate change in output of farmers using this system just as we observed in the case of the motor pump. The RTS of those using manual pump of 1.037 unlike the rainfed, gravity flow and motor pump implies that an increase of 1% in any of the factor inputs would lead to an increase of 10.4% in output in the study area.

Determination of Wage of hired Labour under the Different WCCs

The wages were evaluated at the unconditional means of the variables. On the average, the computed prices for hired labour equal N1,350/manday/acre, N7,516.67/man-day/acre, N5,750.00/man-day/acre and N6,640.86/man-day/acre respectively for rainfed farmers, gravity flow, motor pump and manual pump irrigators. The high standard deviations also indicate that hired labor wages differ significantly among the different WCCs. The lower means in the rainfed and standard deviation may not be unconnected with little or no labour required for irrigation under this farming system.

Table 7:Parameter estimates of the Cobb-Douglas production function

	Rainfed		Gravity flow		Motor pump		Manual pump	
Variables	Coefficient	T-value	Coefficient	T-value	Coefficient	T-value	Coefficient	T-value
Constant	1.36	0.35	3.07	1.08	10.99**	2.19	7.22***	4.35
Age	2.06**	2.47	1.91**	1.99	-0.66	-0.67	0.34	0.71
Education	-2.26***	-3.14	1.37***	2.63	-0.63***	-2.45	0.45	1.35
Extension	0.37	0.60	-1.02	-1.52	0.63	0.80	-0.30	-0.83
Association	0.31	0.43	1.47**	2.19	-0.29	-1.10	0.30	1.04
Hired labour	0.14*	1.85	0.07	0.56	0.14	1.30	0.02	1.02
Seed	0.32**	2.19	-0.17	-0.50	-0.22	-0.93	0.04	0.35
Chemicals	0.00	-0.06	-0.03	-0.29	0.11	1.19	0.01	0.54
Fertilizer	-0.40***	-2.63	-1.24**	-2.17	-0.04***	-3.67	-0.06**	-2.34
Capital	0.04	0.48	0.08**	2.17	-0.17	-0.67	0.307	1.17
Farm size	-0.02	-0.13	-3.06***	-2.37	0.29***	3.12	-0.07***	-2.83
Number of observation	66		31		80		16	
Adjusted R2	0.515		0.425		0.866		0.405	
F-stat (P value)	4.39 (p<0.002)		2.050 (p<0.077)		8.623 (p<0.10)		2.010 (p<0.081)	

***, **, * are 1%, 5% and 10% significant levels respectively; *t*-values are in parentheses.

Source: Field survey, 2011

Table 8: Estimated Production Elasticities and Return to Scale of Smallholder Farmers under the different WCCs

Variables	Production Elasticities (EP)			
	Rainfed	Gravity Flow	Motor Pump	Manual Pump
Age	2.06	1.91	-0.66	0.34
Education	-2.26	1.37	-0.63	0.45
Extension Contacts	0.37	-1.02	0.63	-0.3
Association membership	0.31	1.47	-0.29	0.3
Hired labour	0.14	0.07	0.14	0.02
Seed	0.32	-0.17	-0.22	0.04
Agrochemicals	0	-0.03	0.11	0.01
Fertilizer	-0.4	-1.24	-0.04	-0.06
Capital	0.04	0.08	-0.17	0.307
Farm size	-0.02	-3.06	0.29	-0.07
Return to Scale (RTS)	0.56	-0.62	-0.84	1.037

Note: Ep = Production elasticities; Source: Field Survey, 2011

CONCLUSION AND RECOMMENDATIONS

Empirical findings from the study showed that aside from rainfed farming, which is mostly practiced by about 33.3% of the smallholders' farmers, the main irrigation systems adopted by the farmers are the gravity flow, manual/bucket and motor pump. Also, about 50.4% of land holding belong to farmers who practice rainfed cropping, 11% and 19% are owed by motor pump groundwater and surface water irrigators respectively. However, across the WCC more than 70% of respondents have transistor radio, over 60% with mobile phones and 50-80% with colour TV set.Worthy of note from the study is the fact that none of the respondents have a formal title to their land; this was probably due to the land administration regime in the country. Apart from the land under the formal irrigation schemes (gravity flow irrigators) which is controlled and regulated by the government, many of the respondents relied on the traditional land tenure system and some have lands administered by inheritance.

Based on this field investigation, the crops grown are generally similar for the small holder irrigation farmers most of whom cultivate leafy vegetables, tomato, pepper and okra in the decreasing order of importance. Thus it can be inferred that most irrigation farmers prefer crops with rather lower planting cycle which can at times be cultivated more than once within the year.

In general, given the overall evaluation as presented in this study, improvement in the availability of irrigation water and other farm inputs in enhancing the livelihood of small holder irrigation farmers in Nigeria are indispensable. However, understanding the dynamics of the problems associated with irrigation water management and landholding systems as well as the underlying constraints are the necessary measures to ensure increasing food security through agricultural productivity of rural smallholder farmers in Nigeria.

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