FARM INCOME INEQUALITY IN SMALLHOLDER IRRIGATION SYSTEM IN WETLANDS OF NORTH-EASTERN NIGERIA

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ABSTRACT

Smallholder irrigation system in Nigeria is characterised by an integration of cash cropping and subsistence food cropping activities. In the wetlands of North-eastern Nigeria, the system is dominated by the production of cereals and vegetables. In this study, we use survey data from 182 randomly selected farmers to determine income inequality using Gini coefficient. Furthermore, the income levels were regressed on a set of explanatory variables. Results revealed that overall, income inequality is high in the study area. Further decomposition based on cropping system recorded a higher income inequality value for mixed cropping system than for sole cropping system. Farm size, farmers' age, farm investment, cropping system and household size, were found to be important determinants of farmers' income levels. The results suggested policies aimed at increasing technical and financial support to improve farmers' productivities which could be derived from improved irrigation development.

Keywords: Smallholder, irrigation, Gini coefficient, wetlands and inequality.

INTRODUCTION

In recent years, factors like increasing population, income growth and enhanced purchasing power of people has pressured agriculture to produce more to meet food requirements (Tanwar *et al.,* 2014). This could be achieved either by putting more area under cultivation or by increasing the productivity through irrigation, cropping intensity and soil fertility enhancements (Tanwar *et al.,* 2014). Since water is a crucial input for improving agricultural productivity, and is essential for all human, animal and plant life as well as for most economic activities (Meinzen-Dick and Rosegrant, 2001), it is expected that more efficient utilization of available water resources has the potential to improve food security, especially in rural areas where majority of the food insecure population depend on rain-fed agriculture for their livelihood (Liu *et al.,* 2008).

Historically, irrigation originated as a method for improving natural production by increasing the productivity of available land and thereby expanding total agricultural production—especially in the arid and semi-arid regions of the world (Bhattarai *et al.,* 2002). Irrigated agriculture is one of the critical components of world food production, which has contributed significantly to maintaining world food security and to the reduction of rural poverty (Bhattarai *et al.,* 2002). Furthermore, irrigated agriculture significantly contributes towards generating rural employment, thereby maintaining and improving rural livelihoods. In Nigeria, smallholder agriculture, being the dominant occupation of rural communities is mainly rain fed, characterized by rudimentary technologies, vagaries of weather, poor capital formation and low productivity. Yet, Nigeria has a potential comparative advantage in irrigated agriculture, using under-ground and surface water, which are underdeveloped (World Bank, 2001). According to NINCID (2009), 39% of Nigeria's land mass is potentially suitable for agriculture and out of this, between 4.0 and 4.5 million ha (approximately 4.5 to 5.0%of the land) are judged suitable for irrigated agriculture but only 1.1 million ha can be supported fully by the water available, the remaining 3.4 million ha being Fadama. Fadamas are flood plains and lowly areas underlined by shallow aquifers and found along Nigeria's river systems (Blench and Ingawa, 2004). From an agricultural standpoint, most floodplains/wetlands have good potential for expanding and intensification of agriculture, their major advantages being water availability and relative fertility of their soils. In recognition of the importance of irrigation and Nigeria's potential, the Federal Government launched an investment program in the 1970s to support the formal irrigation sector by establishing various public irrigation schemes around the country (FAO, 2004). Unfortunately, these large irrigation schemes were short-lived and unsuccessful due to a number of factors, including the lack of a coherent irrigation subsector, development policy and strategy and inadequate funding (FAO, 2004). As a result of the failure of most formal irrigation schemes in Nigeria, it was suggested that irrigation development planners should pay more attention to the improvement of small-scale irrigation schemes, building on simple technology, low capital investments and application of proven indigenous knowledge (Baba *et al.,* 1998). Consequently, the Nigerian government initiated 'National Fadama development Projects' in the early 1990s. The first Fadama Development Project (Fadama I) was implemented between 1993 and 1999. The project was to develop small-scale, simple, low-cost, farmer managed irrigation scheme under the World Bank financing (Dauda *et al.,* 2009). Following the widespread adoption of the Fadama technology, farmers realized income increases of up to 65% for vegetables, 334% for wheat and 497% for rice (Adesoji *et al.,* 2006). As a result of the overall positive impacts of the project, the Nigerian government continued to gain the support of the World Bank in implementing further "Fadama" development projects (Van koppen *et al*., 2005).

Globally, poverty and income inequality have been identified as major limitations to economic development and growth (Awotide *et al.,* 2015). In Nigeria, incomes and productivity in rural areas are low (**Simonyan and Omolehin, 2012)**, hence, poverty and income inequality appear to be a rural phenomenon. For instance, in 2006 the Gini coefficient was 0.5541 for the urban areas and 0.5187 for the rural areas, while the national Gini-coefficient was 0.4882 (NBS, 2006), indicating a high level of uneven distribution of income in the country. This finding is quite worrisome because one of the consequences of high income inequality in the opinion of Aigbokhan (2000), is that it may generate social conflict over dimensional issues that diminish the security of property rights, thereby lowering investment and economic growth. The analysis of income inequalities in agriculture usually takes place at country levels (Keeney, 2000). However, income inequality within and across regions, i.e. the spatial distribution of income inequality, is relevant for policy makers and other stakeholders (Finnie, 2001; Lynch, 2003; Mishra *et al.*, 2009). Understanding farmers' income levels as well as income inequality and its consequences on agricultural production may provide insight in formulating agricultural and rural policies which could help improve the statuses of poverty stricken individual farmers and farming households. Governmental interventions in agriculture have a wide range of economic, social and environmental objectives (Finger and El-Benni, 2011). Among these, many countries have typically framed income objectives of agricultural policies in terms of distribution or equity (OECD, 1998; Moreddu, 2011). This is because a particular goal of agricultural policies is the support of low income groups or disadvantaged areas to reduce inequality and ensure sufficient incomes for all farmers (Finger and El-Benni, 2011). Evidence has shown that Irrigation has contributed significantly to increasing farm income, reducing income inequality and reducing poverty in irrigated agriculture in Asia (Bhattarai *et al.,* 2002).

The Gini Coefficient is the most widely used measure of income and wealth inequalities, and several authors have studied income inequality in the context of agriculture using this technique. Bhattarai *et al.,* (2002) conducted a comprehensive study of **irrigation impacts on income inequality and poverty alleviation in Asia**. Their study revealed that on average, income inequality in irrigated agriculture is much less than in rain-fed agriculture. For more studies on income inequality, see Hemaratne *et al.* (1991); Hossain *et al.* (2000); Ogunniyi *et al.* (2011); Ayinde *et al.* (2012) and Agwu and Oteh, (2014). Against this backdrop, this study was aimed at examining the socio-economic characteristics of irrigation farmers in the study area, identifying cropping systems in the study area, and to determine farm income inequality including its contributing factors among smallholder irrigation farmers in the study area.

METHODODOLOGY

The study area

The study was conducted in the Hadejia-Nguru wetlands located in the middle part of the Komadugu-Yobe basin in the north-eastern Sahel zone of Nigeria. Occupying an area of approximately 3,500km^2, it is located between latitudes 12^{0}15'N to 13^{0}00'N and longitudes 10^{0}00'E to 11^{0}00'E (Ezra *et al.,* 1992). Rainfall in most cases starts from May and extends to September over October, with average rainfall ranging from 500mm to 700mm per annum (Okali and Bdliya, 1998). The dry season usually extends from October to April, average temperature ranges from about 45^{0}C between April and May and about 19^{0}C during the extreme cold season (Okali and Bdliya, 1998). Available population estimate for the wetlands based on an aerial census by Chiroma and Polet (1996) is 1,235,754 with the rural population of 873,690 constituting 71 percent of the total wetlands populations. The wetland's economy is based on crop cultivation in form of rainfed, irrigation or 'Fadama' cropping and recession farming, pastoralism and fishing. According to Hollis *et al.* (1993) total cultivated area in the Hadejia-Nguru floodplain is estimated at about 230,000 hectares, of which approximately 77,500 hectares occurs in the dry season.

Source of data

Multi-stage sampling technique was adopted for this study. In the first stage, ten villages were purposively selected from the wetlands shared by Jigawa and Yobe states, Nigeria. The villages were selected based on the intensity of irrigation farming. In the second stage, a random selection of 20 irrigation farmers were selected from each of the ten communities, making a total of 200 respondents. Lists of members of irrigation farmers associations obtained from all participating villages served as the sampling frame. Primary data were collected through the administration of structured questionnaires. However, some questionnaires were discarded due to inconsistencies, so, only 182 questionnaire were considered for analyses.

Data Analysis and Models specification

Gini Concentration ratio was used to measure income inequality. The Gini index ranges from zero to unity. The closer to zero, the more equal is the distribution of income and unity as it tends to extreme inequality. Following Dogondagi and Baba (2009), the Gini concentration ratio is specified as follows:-

$G = 1 - \sum XY$--(1)

Where;
G = Gini Coefficient
X = Percentage of farm income recipients
Y = Cumulative percentage of aggregate farm income
Linear multiple regression analysis was used to identify determinants of income inequality. Linear functional form was chosen due to its simplicity and flexibility. The implicit functional form of the equation is specifies as:-

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, e)$--(2)

Where;
Y = Total farm income (N)
X_1 = Farm size (Hectares)
X_2 = Age of farmer (years)
X_3 = Highest educational attainment
X_4 = Farming Experience (Years)
X_5 = Household size (Number of persons)
X_6 = Extension Contact (Number of contacts in the season)
X_7 = Credit Access (Dummy; Yes = 1 and No = 0)
X_8 = Cropping System (Dummy; Mixed system = 1 and sole system = 0)
X_9 = Farm Investment (N)
e = Stochastic error term.

RESULTS AND DISCUSSION

Socio-economic characteristics of smallholder irrigation farmers

A summary of socio-economic characteristics of the sampled farmers is presented in Table 1.

Table 1: Socio-economic characteristics of smallholder irrigation farmers in wetlands of North-eastern Nigeria. (N = 182)

Characteristics	Mean	Mode	Standard Deviation
Gender	-	Male	-
Age	49.20	50	10.91
Marital Status	-	Married	-
Highest Educational attainment	-	No basic education	-
Farm Size	1.21	0.81	0.68
Household size	11.75	8	4.89
Farming Experience (yrs)	24.85	30	10.50
Cropping System	-	Sole	-

Source: Field Survey, 2009.

The study revealed that male farmers dominated the study area, with an average age of 49 years and had spent at least 25 years cultivating 0.81 ha of farmland. Therefore, it could be assumed that most of the farmers were still in their active ages, and have the strength to carry out the laborious activities involved in agricultural production as well as having positive mindsets to make rational decisions and choices regarding their farm responsibilities. Sole cropping was the dominant system in the study area.

Cropping systems identified in the wetlands of North-eastern Nigeria

The crops and their total areas cultivated during the 2009 irrigation season are presented in Table 2.

Table 2: Distribution of cropping system by smallholder Irrigation farmers in wetlands of North-eastern Nigeria (N = 182)

Sole Enterprises			Mixed Enterprises		
Enterprise	Area cropped (ha)	Proportion of Total Area cropped (%)	Enterprise	Area cropped (ha)	Proportion of Total Area cropped (%)
Maize	71.30	28.5	Hp/O/P/T	10.53	10.2
Onion	5.52	2.2	Hp/M/Wm	6.07	5.9
Pepper	29.67	11.9	Hp/P/T	35.60	34.3
Rice	107.72	43.0	M/P/T	5.67	5.5
Tomato	18.07	7.2	Hp/P	7.85	7.6
Watermelon	5.84	2.3	P/T	21.41	20.6
Others	12.34	4.9	Others	16.58	15.9
Total	250.46	100.0	Total	103.71	100.0

Source: Field survey, 2009.

Note: Hp – Hot pepper, M – Maize, O – Onion, P – Pepper, T – Tomato and Wm – Watermelon.

The cropping systems identified in this study were sole cropping and mixed cropping. Crop outputs are subject to changes due to factors like pests, disease and weather. A common practice adopted by farmers in order to minimize risks and losses so as to achieve the objective of income generation and food security is mixed cropping. Mixed cropping is the practice of cultivating more than one crop on a piece of farmland at the same time.

The farmers cultivated various crops under both systems, however, only predominant ones are considered, for ease of presentation. It can be observed from Table 2 that at least 6 different enterprises were identified in both systems. The predominant crops, based on their total areas cultivated, included sole Rice and Pepper-based plots for mixed system. Farmer planted as many as four different crops in a plot.

Income distribution in smallholder irrigated system in Hadejia-Nguru Wetlands.

Table 3. Descriptive statistics of Income distribution in smallholder irrigation systems in the Hadejia-Nguru wetlands.

Overall Irrigation System	(N = 182)	Mixed System (N = 52)	Sole System (N = 130)
Statistics	Income (₦)	Income (₦)	Income (₦)
Mean	196373.21	267500.97	167922.11
Minimum	-65806.18	- 1636.12	-65806.18
Maximum	798463.89	674752.46	797463.89
Standard Deviation	144839.09	144149.96	135516.16
Gini Coefficient	0.60	0.66	0.58

Source: Field survey, 2009.

Results in table 3 reveal that smallholder irrigation farming generated a mean net farm income of N196,373.21. Highest income earned was N798,463.89. Some farmers experienced losses as revealed by the negative net farm income values. Possible reasons could be due to yield losses and inefficiency in the use of resources. These results indicate that it is quite possible, but not inevitable for irrigation farming to be unprofitable. Income inequality measured using Gini Concentration Ratio revealed that the overall income inequality was as high as 0.60, which means that income from smallholder irrigation is unequally distributed in the study area. This finding is higher than values of 0.30 and 0.52 reported by past studies (Janaiah *et al.,* 2001 and Dogondaji and Baba, 2009). A further decomposition of income inequality revealed that revenue from sole system was more equally distributed than it was for mixed system. The explanation for this result could be due to factors like types of crops cultivated, farm size and variations in efficiency of input use. These factors can result in different productivity levels thereby justifying reasons for the disproportionate shares of monetary benefits from irrigation. The study observed that majority of the farmers in the Hadejia part of the wetlands cultivated cereals and watermelon, mostly under sole systems, in contrast, most of the farmers in Nguru part cultivated vegetables, which are regarded as high value crops, and mostly under mixed systems. Therefore, some farmers are likely to have higher incomes than others. In addition, locations of the sampled farms might have contributed to this finding. While some farms are located close to the river and use water pumps for irrigation, others are further from the river and use tube wells to access water. Therefore, unequal water distribution could also be a factor. The findings of this study support the explanation offered by Bhattarai *et al.,* (2000) who stated that irrigation induced inequality depends on several locally specific factors like the structure of irrigation—whether it is surface systems (canal or tank), or groundwater systems (deep tube well, or micro pump sets). Also, Sampath, (1990) in his study, stated that several studies have reported that surface flow irrigation has produced higher inequality in the distribution of benefits across farms than lift irrigation. The high income inequality in the study area can result in overall poor performance of the smallholder irrigation system.

Factors influencing income distribution in smallholder irrigation farming system in the wetlands of North-eastern Nigeria.

Table 4: Factors determining income distribution among smallholder irrigation farmers in wetlands of North-eastern Nigeria (N = 182).

Variables	Coefficients	Standard Error	T-values
Constant	171772.53	50272.70	3.42***
Farm size	104847.70	15423.92	6.80***
Age	-1197.76	1157.87	-1.03
Highest education	-8463.45	6168.05	-1.37
Farming experience	1340.95	1153.89	1.162
Household size	6.33	1485.54	0.004
Extension contacts	18400.01	18611.75	0.99
Access to credit	-44654.68	22413.26	-1.99*
Cropping system	-113760.51	19085.12	-5.96***
Farm investment	2.591	0.10	5.96***
R^2	**0.54**		

Source: Field Survey, 2009.

Note: *** = Significant at 1%.

Results of the linear multiple regression analysis are presented in table 4. Farm size and farm investment showed positive but insignificant influences on farm incomes of the respondents. Similar to Ibekwe *et al.* (2010), farm investment is positively correlated with farm income. Higher farm investments can lead to improved productivity through employment of modern farm technologies and adequate availability of farm inputs at the right time. Contrary to a priori expectation, credit and cropping systems had negative influences. The dummy variable for credit accessibility was found to be negatively related to farm income. In the study area, very few of the sampled farmers had access to credit, it could be that the farmers with access to credit used the credit in other income generating activities other than irrigation farming. Overall, the independent variables entered in the model explained 54% variation in farm incomes.

Conclusion and Recommendations

In this paper, we tried to determine the income inequality in smallholder irrigation farming system and attempted to identify the determinants of income level. Income inequality was high in the study area. The implication of high income inequality in the study area is that it can result in poor performance of the smallholder irrigation system which can lead to increased poverty and food insecurity. We found that, among all the individual characteristics, farm size, age, cropping system and farm investment are the most influential factors that determined the farmers' incomes. Interestingly, cropping system had unexpected effects on the farmers' income. Analysis revealed that mixed cropping had a negative and significant influence on farm income. In line with our findings, we provide policy suggestions that could narrow and minimise this revealed income gap. The policy recommendations are related to investment in irrigation development infrastructures. First, water channels should be constructed to ensure a more reliable and equal water distribution across users. Government should provide more technical and financial supports to improve the productivities of farmers. Farm fragmentation is peculiar to rural areas where the bulk of agricultural output is produced and this presents a challenge for farm mechanisation. Therefore, farm consolidation should be encouraged so as to enable specialised crop production for cereals under mechanised agriculture.

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