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COMPARING PROFITABILITY AND EFFICIENCY OF RESOURCE USE IN VEGETABLE PRODUCTION UNDER PRIVATE AND GOVERNMENT CONTROLLED IRRIGATION SCHEMES IN NIGERIA

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ABSTRACT

This study compared resource allocation, yield, net farm income and resource use efficiency under private and government controlled vegetable irrigation schemes. Production data covering three vegetable enterprises were collected from 280 respondents. This consisted of 141 from private and 139 from government irrigation schemes, in the Kwanar-Are irrigation areas of Katsina State, Nigeria. Descriptive and econometric analyses were used to analyze the sample data. Our results indicated that though more purchased inputs are allocated in government scheme, the private scheme was more efficient in terms of resource use. Average net farm incomes per hectare were N373,040, N427,070 and N285,975 for pepper, tomato and onion enterprises respectively under the private irrigation schemes. They were N210,045, N325,891 and N244,748 for pepper, tomato and onion enterprises respectively in the government irrigation schemes. Similarly, average returns on naira investment were higher under the private irrigation scheme. They were 2.0, 2.3 and 1.7 for pepper, tomato and onion enterprises respectively under the private irrigation schemes and 1.2, 2.3 and 2.0 for pepper, tomato and onion enterprises respectively in the government irrigation schemes. To correct the general inefficiency in the use of resources, farmers should be trained on appropriate resource allocation techniques that would guarantee optimal performances of irrigation schemes. It is suggested that irrigation policy efforts should focus on encouraging private as opposed to government irrigation scheme if the country is to be self sufficient in terms of food and vegetable production.

Key words: Private irrigation scheme, government irrigation scheme, net farm income, resource use, vegetable production

INTRODUCTION

Inadequate food and vegetable intake is one of the causes of hunger and malnutrition in the world. Almost 1 billion people worldwide are undernourished; many more suffer from malnutrition, and the absolute numbers tend to increase further, especially in Sub-Saharan Africa (FAO, 2008). Obviously, agricultural production is very crucial for reducing hunger and malnutrition. Agriculture depends on water availability and rain-fed agriculture is common in many countries of the World. However, the problems of insufficient and uneven distribution of rainfall have limited the potential of rain-fed agriculture in food production. Irrigation has provided remedy against this problem in many regions of the World. Irrigation is particularly important in drier regions where annual rainfall is often less than 1000mm. Even in rain forest areas, irrigation has provided succour during the dry season when water availability is at the lowest level.

Over the years irrigation agriculture has become very popular in Nigeria as a result of inadequate rainfall (Babatunde, Fakayode and Obafemi, 2008). It is more important for food production in the Northern regions where there is long period of drought. In this region, it has been practiced extensively for dry season vegetable production. For instance, the Northern Nigerian regional government established the first irrigation division in 1947 to oversee the development of irrigation resources in the region (Galadanci, 2000). This effort culminated in the establishment of eleven River Basin Development Authorities (RBDAs) in 1976, which are mandated to develop irrigation farming through the construction of large irrigation schemes (Abduallahi and Phillip, 1989). The irrigation potentials of the country have not been fully utilized in spite of the establishment of RBDAs. For instance, out of 2.5 million hectares of irrigation farmland, only 220,270 hectares were cultivated in 2002 (CBN, 2003). Faulty conception, administrative and technical problems, among others has been cited as responsible for the sub-optimal performances of irrigation schemes in Nigeria (Blench and Ingawa, 2004).

In spite of the contribution of irrigation farming to the socio-economic development and poverty reduction in Nigeria, empirical studies so far offered mixed results about the profitability and efficiency of resource use under private and government controlled irrigation schemes, especially for vegetable production (Olofin, 1993). This lack of agreement in empirical literature calls for more studies to analyze the situation in the specific context. This is especially important in the light of the ongoing debate on whether to encourage privately-owned or government-controlled irrigation schemes in Nigeria. The purpose of this paper was to compare resource allocation, yield, net farm income and resource use efficiency under private and government vegetable irrigation production schemes in Katsina State of Nigeria. Katsina State was selected for this study because the State has one of the largest irrigable land area in Nigeria with about 46,000 hectares of irrigated land planted to vegetable (KTARDA, 2001). The

State also has numerous private and government irrigation schemes operating side by side.

This paper contributes to empirical literature by using a recent survey dataset from Katsina State to carry out a comparative analysis from a broader perspective also taking into account apart from output, income and resource use efficiency between the two types of schemes. This is an area that has not been fully researched into before. Our hypothesis is that yield, income per hectare and returns on investment are higher in government controlled than in private irrigation scheme. Results of this study can provide valuable insight that can guide policy formulation on the direction of investment in vegetable irrigation farming in Nigeria. It would be useful in decision making on whether to concentrate effort on large-scale government controlled irrigation scheme or small-scale private scheme.

The remaining parts of this paper are arranged as follows. Section 2 discusses the data collection techniques and methodology adopted in the study. Section 3 presents and discusses the results, while section 4 concludes the paper with a discussion of the policy implications of the results.

Data and methodology

Data collection

The primary data used in this study were collected from a survey of irrigation schemes in Katsina State of Nigeria, which was conducted during the 2005 farming season. Katsina State was chosen because it has one of the largest irrigation schemes in Nigeria (KTARDA, 2001). Besides, the State has several small-scale private and large-scale government irrigation schemes to ensure that adequate comparison can be made possible with minimal cost. The State has a total population of about 5.8 million people, 65% of which can be classified as smallholder farmers (NPC, 2006). The State occupies a total land area of about 24,192 square kilometer and it is located within the sahel savannah region where annual rainfall ranges between 500 mm and 850 mm (KTARDA, 2001). The rainfall peaks in August with about 1000 mm. Temperature is generally high and likewise evaporation and evapotranspiration. Soils are predominantly light in texture and cereal based is the dominant cropping pattern in the State. Fadama soil is mostly found along the River banks and this encourages the development of Fadama irrigation system in Katsina State, especially during the dry season (KTARDA, 2001).

The study area covered a stretch of private Fadama farmland and the Kwanar-Are government irrigation scheme located along River Tagwai. The area is situated about 40 km from the capital city of Katsina. The study employed random sampling technique in selecting 280 respondents comprising of 141 farmers from private and 139 farmers from government controlled irrigation scheme. Personal interviews combined with field observations and focus group discussions were used in collecting data from the respondents. A standardized questionnaire that covered information on inputs, output, revenue, costs, socioeconomic characteristics and various institutional and

infrastructural variables was used for data collection. Respondents were asked to specify in detail, all inputs used, output obtained and prices of all input and output for vegetable production in the 2005 farming season. The study concentrate mainly on three enterprises namely; pepper, tomatoes and onion, which are the most common in the study area.

Descriptive and econometric analyses were carried out on the sample data. The comparative analysis focused on three main indicators namely; resource allocation and yield, costs and returns, and resource use efficiency. The comparative analysis was combined with t-tests, to determine significant differences between the two schemes. Econometric analysis of production model and determination of optimal resource efficiency were carried out in the two types of irrigation schemes.

Characteristic Features of Irrigation Systems in the area

Table 1 showed the distinguishing features of private and government controlled irrigation schemes in the study area. Table 1 indicates certain similarities between private and government irrigation schemes in terms of major crops grown and cropping patterns. Vegetable crops and maize are the dominant crops grown in the irrigation area. Wheat is only grown as additional crop in some cases under the government scheme. The crops are either grown as sole or in mixture with other crops. Land is fragmented into several plots of 0.5 hectare size under government scheme, however, there is no specific order and farm size is determined by the individual farmers under the private irrigation scheme. Water supply and frequency of irrigation are controlled by government representative under the government scheme, but they are controlled by the individual farmers under the private irrigation scheme.

Table 1: Characteristics of the Private and Government Irrigation Schemes

Variable	Private scheme	Government scheme
Management and land size		
Management of the scheme.	Managed by individual farmers.	Managed by the government through an Irrigation Engineer.
Estimated Land Area.	1000 Hectares	100 Hectares
Land ownership.	Land is owned by the individual farmers	Land is owned by the government.
Average plot (farm size).	Determined by individual farmers access to land.	Land is parceled into plots of 0.5 hectares for fixed fees.
Water Supply		
Source of Water.	Dam, ponds and tube wells.	Dam
Method of water Supply.	Through the use of Small motorized (Honda, Yamaha, Kubota, Robin) petrol irrigation pumps coupled to the dam, pond or tube well.	The water is pumped into a large sump by two large diesels Lister irrigation pumps located about 500m away from the dam. The water is then distributed through a network of primary, secondary and tertiary canals
Control on Water Supply.	Water supply wholly controlled by the farmer.	Water supply controlled by the Irrigation Engineer.
Frequency of irrigation on farmlands.	Determined by the farmer and crop need.	Determined by the Irrigation Engineer based on agreed schedule.
Average period of irrigation water supply to crops.	Throughout the Dry season (usually about 7 months)	Water is supplied for a maximum of five month.
Cropping pattern		
Major crops grown.	Pepper, tomato, onion, spinach, carrots, water melon, cowpeas, garden egg and maize.	The major crops grown include pepper, tomato, onion, spinach, carrots, water melon, cowpeas, garden egg, wheat and maize.
Nature of cropping.	The maize, melon and cowpeas are usually grown as sole crops, while the pepper, tomato, onion, and are either grown as sole crops or in mixtures. The garden eggs	The wheat maize, cowpeas are grown as sole crops while the pepper, tomato, onion, are either grown as sole crops or in mixtures.
Source of inputs.	Farmers purchased all inputs from open market though they sometimes get fertilizer on subsidy.	Water and land is supplied to the farmer at about ₦2000 per plot. Some fertilizer is also supplied at a subsidized price.

Source: Survey data (2005).

RESULTS AND DISCUSSION

Resource allocation and yield under private and government irrigation schemes

The results of the pattern of resource allocation and yield in private and government irrigation schemes are presented in table 2. The study considers average resource allocated per farmer in production of pepper, tomatoes and onion, as a whole. In terms of yield, however, it considers average yield in kilogram per hectare of pepper, tomatoes and onion between the two types of schemes. The results showed that vegetable farmers in the two schemes generally cultivate farm land that is less than 0.5 hectare on average, nevertheless, farmers under the private scheme cultivated less farm land than their counterpart in government controlled scheme. However, the difference is not statistically significant at 10% level.

Table 2: Resource Allocation and Yield under Private and Government Irrigation Schemes

	Private scheme	**Government scheme**
Resources		
Land (ha)	0.30	0.34
Labour (man-hour/ha)	2,739.3	2,131.3**
Fertilizer (kg/ha)	22.83	35.67*
Pesticides (litres/ha)	622.83	804.29*
Irrigation time (hour/ha)	151.1	121.2*
Yield (kg/ha)		
Pepper	8,948.2	6,542.2**
Tomatoes	4,152.4	4,109.4
Onion	7 559.9	4 606.0***

Source: Survey data (2005).
*, differences between private and government scheme are statistically significant at 10% level.
**, differences between private and government scheme are statistically significant at 5% level.
***, differences between private and government scheme are statistically significant at 1% level.

Table 2 further shows that labour input per hectare is significantly higher at 5% level, in vegetable production under the private than in the government scheme. This is perhaps because the private operators tend to devote more time to working on their

irrigation farm than farmers in the government controlled scheme. As oppose to labour use, more fertilizer and pesticides are used on vegetable farms under government scheme. The differences between fertilizer and pesticides use in private and government scheme are significant at 10% level. Irrigation time which is use as proxy for irrigation water, is significantly higher under private scheme than in government scheme. The bottom parts of table 2 reveals that yield per hectare of vegetable crops are generally higher under private scheme than in government scheme. Overall, the results suggest that more purchased inputs (fertilizer, pesticides and irrigation water) are allocated in government scheme than in the private scheme. On the other hand, more irrigation time and labour inputs are allocated under private irrigation scheme.

Costs and Returns under Private and Government Irrigation Schemes

The previous section has shown that whereas yield are higher in private scheme, more resources are allocated to government irrigation scheme in our sample data, we analyze in this section, farm income and returns on investment under the two schemes. Table 3 shows costs and returns in vegetable production under private and government schemes. It can be shown from table 3 that vegetable outputs are generally higher under the private irrigation scheme and consequently higher gross income for farmers under the scheme. Though farmers under the private scheme incurs higher fixed costs mostly due to higher land charges and depreciation, net farm income is still higher when compared to those of the government scheme.

With respect to the individual enterprises, we found that tomato has the highest net farm income per hectare under the two irrigation schemes. This result implies that tomato enterprise is the most profitable of the three activities, and it is more profitable under the private irrigation scheme. This finding is consistent with those of Babatunde et al (2007) in different context. The bottom parts of table 3 shows returns on investment in the two types of schemes. With the exception of onion enterprise, returns on naira investment are higher under the private than in government scheme. Likewise, the returns on labour input in are generally higher for the three enterprises under the private than in government scheme. On the contrary however, returns on land are higher under the government than on private scheme. This is probably due to cheaper land rent under the government scheme, where farmers are made to pay only one tenth of what their counterpart in the private scheme are paying. The results further shows that irrigation vegetable production is profitable in Katsina State with an average of two naira and one naira eighty kobo on every one naira investment in private and government scheme respectively.

Table 3: Comparison of Costs and Returns in Naira per hectare under Private and Government Irrigation Schemes

		Private irrigation scheme			Government irrigation scheme		
		Pepper	Tomato	Onion	Pepper	Tomato	Onion
A	*Revenue*						
	Quantity of output/hectare (kg)	18,654.55	20,328.96	22,956.64	12,884.03	15,591.45	18,479.00
	Price (N/kg)	30	30	20	30	30	20
	Total Revenue (₦)	559,636.50	609,868.80	459,132.80	386,520.79	467,743.50	369,580.00
B	*Variable cost*						
	Seedlings cost (₦)	13,040.16	13,683.44	35,321.14	16,800.88	13,328.37	37,480.00
	Labour cost (₦)	79,694.63	104,441.72	89,809.26	67,455.87	83,624.56	62,053.33
	Fertilizer cost (₦)	52,948.65	26,073.62	14,402.49	71,881.84	32,763.53	16,000.00
	Pesticides cost (₦)	8,825.62	7,926.38	1,946.20	14,459.52	5,204.18	2,308.00
	Water supply cost (₦)	2,371.63	1,322.39	1,784.35	2,242.89	2,212.73	2,000.00
	Total variable cost (₦)	156,880.69	153,447.55	143,263.44	172,841.00	137,133.37	119,841.33
C	*Gross farm income (₦)*	402,755.81	456,421.25	315,869.36	213,679.79	330,610.13	249,738.67
D	*Fixed cost*						
	Land (₦)	20,000.00	20,000.00	20,000.00	2,000.00	2,000.00	2,000.00
	Depreciation (₦)	9,715.10	23,285.16	15,894.20	1,634.57	2,718.90	2,990.50
	Total fixed cost (₦)	29,715.10	43,285.16	35,894.2	3,634.57	4,718.90	4,990.50
E	*Net farm income (₦)*	373,040.71	427,070.75	285,975.16	210,045.22	325,891.23	244,748.17
F	*Returns on investment*						
	Returns per Naira invested	2.0	2.3	1.7	1.2	2.3	2.0
	Returns per man-hours	298.8	391.7	336.8	253.0	313.6	232.6
	Returns per hectare of land	18.7	21.4	14.3	105.0	162.9	122.4

Source: Survey data (2005).

Resource Use Efficiency under Private and Government Irrigation Schemes

In this section, we compare resource use efficiency and returns to scale in both the private and government irrigation schemes. This is to assess whether available resources are optimally utilized or not in vegetable farming. In terms of efficiency of resource use, Olayide and Heady (1982) stated that a given resource is optimally utilized when there is no difference between its marginal value product (MVP) and the unit factor cost (UFC). In other words, resource efficiency is measured by calculating a ratio *R*, defined as the ratio of marginal value product to the unit factor cost. A resource is efficiently allocated when *R* equals 1, under-utilized when *R* is greater than 1 and over-utilized when *R* is less than 1. The marginal value product of the resources was derived from their geometric means in the Cobb-Douglas function (Deaton, 1997). The unit factor cost is taken as the unit cost of the resource in the local market at the time of the study. While the regression estimates of the Cobb-Douglas production functions are shown in the appendix table A1, the estimated efficiency ratios and returns to scale in the two schemes are shown in table 4.

Table 4 indicates that irrigation time proxy for irrigation water and pesticides are under utilized in vegetable production under the two types of schemes. The same is also true of land: efficiency ratios of land under the two schemes are greater than one. Comparing land use efficiency ratios in the two schemes however, reveals that, the efficiency ratio of land was higher in the government irrigation scheme, suggesting that land resource is allocated with less inefficiency in the private scheme. With respect to labour resource, our results indicate that labour is under-utilized on tomato farm under the two schemes. But in contrast, labour is over-utilized in onion farm in the two schemes. The under utilization of labour in the onion and pepper enterprises under the government scheme, and onion enterprise under the private scheme, points to the need for labour re-adjustment by application of labour saving measures, such as the use of machineries and herbicides to reduce excessive labour inputs. Under the private irrigation scheme, fertilizer was under-utilized in pepper and onion enterprises. In the government scheme, fertilizer was over-utilized in onion enterprise, but under-utilized in pepper and tomato enterprises. The results suggest that though fertilizer is not being used at efficient level under the two schemes, it is more inefficiently applied under the government irrigation scheme. The last row of table 4 shows the returns to scale in vegetable production under the two schemes. The returns to scale are derived from the sums of elasticities of the resources in the Cobb-Douglas function. Returns to scale is constant if the sums of elasticities equals 1, decreasing if less than 1 and increasing if greater than 1 (Deaton, 1997). Our result suggests increasing returns to scale in pepper production under the two schemes. On the contrary, it shows decreasing returns to scale in tomato and onion enterprises under the two schemes.

Table 4: Comparison of Resource Use Efficiency and Returns to Scale under Private and Government Irrigation Scheme

	Private irrigation scheme			Government irrigation scheme		
	Pepper	**Tomato**	**Onion**	**Pepper**	**Tomato**	**Onion**
		Efficiency ratios (MVP/UFC)				
Land	11.44	4.13	8.3	157.1	47.4	59.2
Labour	1.12	1.13	0.89	0.36	1.79	0.08
Fertilizer	1.37	0.95	1.54	3.03	3.6	0.57
Pesticides	10.9	1.94	9.7	2.99	8.4	12.5
Irrigation water	9.92	11.39	12.8	9.34	8.9	1.6
Returns to scale	1.45	0.70	0.95	1.60	0.98	0.99

Source: Survey data (2005).

CONCLUSION

There is an ongoing debate on the profitability and efficiency of resource use in private and government irrigation scheme. Empirical studies have so far offered mixed results about the two schemes. In this paper, we compare resource allocation, yield and net farm income, as well as resource use efficiency under the private and government vegetable irrigation schemes in Nigeria. Production data covering pepper, tomato and onion enterprises were collected from 280 farmers in the Kwanar-Are irrigation areas of Katsina State. The respondents are made of 141 farmers from the private and 139 from government controlled scheme. Descriptive and econometric analyses were use to analyze the sample data. Test of significant differences were performed on the estimated sample means, to determine whether they are significantly different under the two schemes.

Descriptive results indicate certain management differences between the private and government controlled schemes. For instance, water supply and frequency of irrigation are controlled by government representatives under the government scheme. In contrast, they are controlled by the individual farmers in the private scheme. This has implications for output, resource allocation and efficiency in vegetable production. In the private scheme, farmers irrigate their farms continuously for about seven months and determine the appropriate amount of water to be applied during this period. Government Engineers supplied water for about five months and strictly regulate water supply to government controlled irrigation scheme.

In terms of resource allocation to vegetable farm, we found that while more purchased inputs (fertilizer, pesticides and irrigation water) are allocated in government scheme, less are available for farmers in the private scheme. This is because purchased inputs are usually supplied at subsidized rate to farmers operating under the government scheme. On the other hand, more labour inputs are allocated under private irrigation scheme. This is perhaps because the private operators tend to devote more time to

working on their irrigation farm than farmers in the government controlled scheme. With respect to yield and income, we found that average yield and net farm income per hectare are higher in private scheme than in government controlled scheme. This leads to higher rate of returns on naira and labour investment in private scheme. This result tends to reject our earlier hypothesis and confirms that yield, income per hectare and returns on investment are higher in private controlled irrigation scheme. Result of the resource productivity analysis indicates that with few exceptions, all the resources used in vegetable production under the two schemes are under-utilized. Nevertheless, we find that the degree of inefficiency in resource use is higher under the government than in the private scheme. Even for resources that are over-used, the degree of over utilization appears to be higher in government controlled scheme.

The findings of this paper have important policy implications for irrigation development in Nigeria. First, the fact that resources are generally inefficiently utilized in irrigation vegetable production, suggest lack of adequate information and skills by the farmers on modern irrigation farming techniques. Therefore, in addition to provision of inputs to irrigation-practicing farmers which is currently the focus of irrigation policy agenda in Nigeria training programmes should be conducted for vegetable irrigation farmers. This would give the farmers opportunity to learn appropriate resource allocation techniques that can guarantee optimal performances. Second, our results have shown that the private controlled scheme is more profitable, offers higher returns on investment and is less inefficient in terms of resource use; therefore efforts should be directed at promoting the development of small-scale private irrigation scheme in Nigeria. At the onset of irrigation development in the country, the emphasis was on the establishment and duplication of large-scale government controlled irrigation schemes. Many of such schemes are still in existence today. However, to achieve self sufficiency in terms of food and vegetable production, the private irrigation scheme should be focused upon.

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Appendix

Table A1: Regression estimates for the Cobb-Douglas Production Function in Private and Government irrigation schemes

	Private irrigation scheme			Government irrigation scheme		
	Pepper	Tomato	Onion	Pepper	Tomato	Onion
Farm size	0.37***	0.11***	0.35***	0.74***	0.17***	0.32**
	(4.35)	(2.73)	(4.08)	(5.40)	(3.49)	(2.42)
Labour	0.42***	0.18***	0.15***	0.064	0.28***	0.014
	(2.66)	(2.68)	(2.75)	(0.68)	(5.38)	(0.11)
Fertilizer	0.13	0.033	0.05	0.38***	-0.15***	0.016
	(1.53)	(1.09)	(1.14)	(3.52)	(-2.86)	(0.32)
Pesticides	0.20	-0.015	0.042	-0.13	0.087*	0.08**
	(1.62)	(-0.45)	(1.19)	(-0.67)	(1.67)	(2.15)
Irrigation	0.33**	0.36***	0.35***	0.29	0.29**	0.55***
hour	(2.35)	(4.60)	(4.93)	(1.62)	(2.47)	(8.20)
Constant	6.91***	5.19***	5.90***	8.12***	6.28***	5.70***
	(6.25)	(10.77)	(10.11)	(5.32)	(12.8)	(5.48)
F-value	272.7	163.8	937.5	455.5	149.5	553.5
Adjusted R^2	0.970	0.950	0.992	0.981	0.950	0.980

Source: Survey data (2005)
Notes: Figures in parentheses are *t*-values. *, **, ***, indicate statistically significant at the 10%, 5%, and 1% level, respectively.