Farmers' Perception of Factors Affecting Productivity in Yau Irrigation Scheme, Nigeria.

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ABSTRACT

A survey of the farmers in the Yau irrigation scheme, Borno State, Nigeria was conducted in the 2005/2006 irrigation season on their views concerning the factors contributing to the declining productivity of the scheme. A structured questionnaire was used to interview 256 randomly selected farmers to obtain information on demography, cropping and farmers' scoring of six categories of factors on a 0 to 3 Likert-type scale denoting no effect, small, big, and very big effect respectively. The factors were grouped into climatic/ecological, socio-cultural, economic, competition, management/administrative and technological categories. The frequencies of the scores were subjected to chi-square analysis. The factors in the management/administrative category; high price of inputs in the economic category; unexpected drying up of the river water in the climatological/ecological category, and damming of the river upstream in the competition category were the most adversely rated by the farmers with over 80% of the respondents in each case considering them as having big to very big effects. They expressed willingness to pay economic rates for services if provided in a timely manner. Despite their low level of formal education the farmers demonstrated good understanding of their operation environment and most possess considerable experience on the scheme. Their views should therefore form valuable input into formulation and implementation of any irrigation-agency-farmer joint management programme. Such management option which includes farmer-participation is suggested in this study as an improved and sustainable management option to meet the expectation of the farmers and encourage their commitment.

Keywords: Irrigation, farmers, productivity, factors, Nigeria.

1. INTRODUCTION

Almost all the formal irrigation projects in Nigeria are owned and managed by agencies of state and federal governments. Nwa (2003) listed 187 small-scale and 117 medium and large scale irrigation schemes existing in Nigeria. Only two of the small-scale and one of the large-scale schemes were not directly owned by governments. The three schemes constituted only 19 290 ha or 4.45% of the total 433 363 ha proposed to be irrigated under all the existing schemes. The role of government in the irrigation sector is therefore dominant. The development of irrigation projects in Nigeria witnessed expansion in the 1980s. Some of the schemes were hurriedly constructed probably without adequate technical and environmental considerations. It has been observed that proper attention was not paid to management issues and steps required to ensure sustainable growth in irrigated crop production (Musa, 2001). As

a result, the performances of many government-owned schemes have fallen short of expectations due to low productivity.

One of the typical government irrigation projects is the Yau irrigation scheme. It was started in 1957 by the Irrigation Division, Department of Agriculture of the then colonial government of Northern Nigeria with a pilot scheme at Yau, in the present day Borno State of Nigeria. Rice and wheat were originally grown as the main crops. At the peak of its development in the 1987/88 season, it comprised of the original scheme with projects at three additional locations with a combined total irrigated area of 3336 ha constituting 95.8 % of the total area of 3483 ha developed. An earlier report (Agrar-und Hydrotechnik GMBH, 1973) had however determined that during the time of its operation, the scheme had run into a series of problems and shortcomings resulting in reduced output. The identified deficiencies included inadequate administrative structure for guiding and training farmers, inadequate land tenure making more land to be cultivated than would be cropped and drop in yield leading to the abandonment of certain areas. Decline in output was attributed to the inclusion in the project of areas too saline or too sandy for successful cropping. The other reported reason was the inability of the farmers to compensate for declining soil fertility caused by continuous wheat cropping and weed problems in rice by increased application of fertilisers and pesticides. Based on social profitability considerations, investment of additional capital in rehabilitation under an improved management structure was recommended in the report.

The recommendations were not faithfully carried out leading to further deterioration of the scheme. Exacerbating the problems of the scheme is reduced water supply after the completion of two large dams namely Tiga dam in 1975 and Challawa Gorge dam in 1992. Both dams in Kano State and several other medium and small ones listed by Nwa (2003) were across the tributaries of the Yobe River on which the Yau irrigation scheme depends for water. Currently wheat is no longer grown due to lack of water to sustain the crop to maturity. Lack of consistent support by the owner-state government in terms of adequate and timely release of budgeted funds for operation and maintenance and establishment of an improved management structure has also contributed to the continual decline of the project. By the 2005/2006 season, only 400 ha representing less than 18% of the developed area was irrigated. Experiences from Nigeria (Abubakar et. al., 2002) and other countries (Clyma, 2002) have however demonstrated the potentials for improved project performance under improved management structure incorporating well articulated participatory input by farmers as stakeholders.

The objective of this work therefore is to study the perception of farmers in the Yau irrigation scheme of the factors of the operating environment adversely affecting the scheme. The result of the study is hoped to form part of the vital inputs to the formulation and design of participatory or joint management programme incorporating the farmers for improved project performance.

2. THE STUDY AREA

The Yau irrigation scheme is near Yau located on latitude 13^{o} $33^{/}$ N and longitude 13^{o} $15^{/}$ E at an elevation of 286.5 m above mean sea level in Borno State, Nigeria (Figure 1.) It is near Lake Chad and is about 256 km northeast of Maiduguri the state capital. In addition to the one near Yau the project headquarters, it comprises three additional irrigation projects at Abadam,

Arege and Daya. In relation to Yau near the River Yobe bank, Abadam and Daya are respectively 8 km downstream and 11 km upstream while Arege is 4 km south of Abadam. The maximum developed areas for irrigation were 416 ha, 1613 ha, 760 ha and 947 ha, for Abadam, Arege, Daya and Yau respectively. At all the locations water is obtained by pumping from Yobe River except Arege where water is diverted under gravity.

The climate of the area is characterised by a short rainy season between June and September with a mean annual rainfall of about 279 mm. April to October with average daily temperature of 30.2^{o} C is hottest period of the year. November through March is cooler with average daily temperature of 23.0^{o} C. The wind is frequently strong and dusty especially during the harmattan months of October to February when the dry northeasterly winds blow from the Sahara desert. The rain-bearing winds are the southwesterly winds.

The catchment of River Yobe of about 147.8×10^3 km^2 is located mostly within Nigeria. It discharges into Lake Chad near Malamfatori some 19 km upstream of Yau. In its lower 160 km it forms the international boundary between Nigeria and Niger Republic. The tributary system extends southwest through the highlands of north-central Nigeria and covers Kano, Jigawa, Bauchi, Yobe, Borno, Gombe and Plateau States. The southwestern part of the catchment has higher rainfall and contributes the major portion of the surface runoff to the Yobe River. This makes the river discharge pattern at Yau uncorrelated with the semi-arid climate of that locality.

The irrigation depends on seasonal flood which arrives at Yau around mid July and peaks between mid November and early December before recession. The river water is normally available for pumping for irrigation from the time of arrival of the flood to about seven to eight weeks after the flood peak. Complete dryness of the river occurs from about 10 weeks after the flood reaches its crest.

The irrigation agency of the scheme is the Department of Irrigation and Water Conservation of the Borno State Ministry of Agriculture and Natural Resources.

3. METHODOLOGY

A structured questionnaire was administered to farmers. The questionnaire was made up of five sections numbered A to E. The first two sections contained a total of 13 questions mainly on demographic information. The third section comprised 24 questions on years of scheme experience, farm sizes and inputs, crop yield, frequency of crop failures, relative position of field along distribution canal membership of co-operative and water user associations. In the fourth section the respondents were required to assess six categories of factors indicating the extent which they affected the scheme. The factors were grouped into climatic/ecological, socio-cultural, economic, competition, management/administrative and technological categories. The effect of each factor was rated on a 0 to 3 Likert-type scale to depict no effect, little, big, and very big effect respectively. In the fifth section, there were 23 question to which only 'Yes' or 'No' response was required to questions dwelling on farmers' wishes in respect of water supply, allocated land area, and preferred roles for farmers and for government in operation and maintenance. Questions on willingness to pay economic rates for inputs and services were also included.

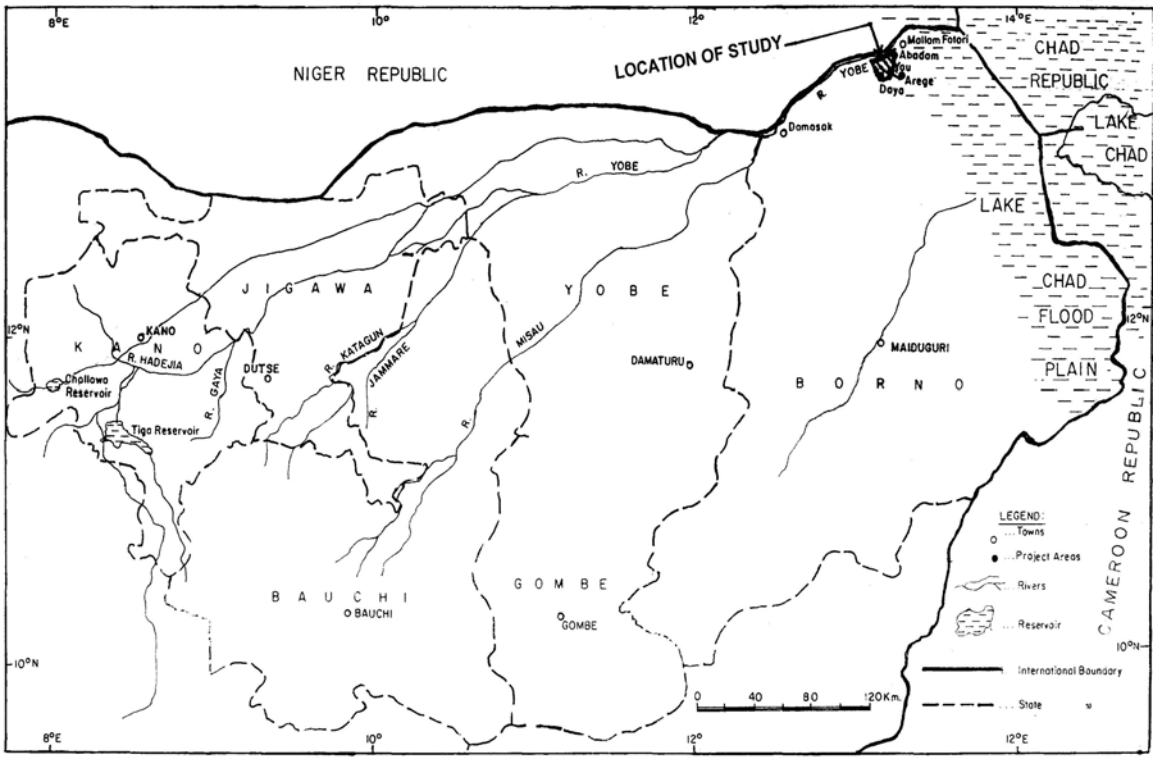

Figure 1. The Yobe River system and location of the project area

The questionnaire was administered on 256 randomly selected farmers from the project area with 115, 64, 50 and 25 of them from Daya, Yau, Abadam and Arege respectively. The sampling aimed at achieving fair representation in terms spatial distribution of fields and the total farming population estimated to be 1140. For purposes of control, five special respondents with good knowledge of the scheme were also interviewed. Two of them were retired civil servants while three were senior civil servants in the state Ministry of Agriculture. Information provided by all the respondents constituted the primary data for the study while published information and those gleaned from project files of the state agriculture ministry were the secondary data. The ratings of the effects of the six categories of factors by the farmers were subjected to chi-square analysis.

4. RESULTS

The meteorological water balance of the locality is indicative of an irrigation project in an environment under continual water stress. Using the classification of Pereira (2005), the water scarcity regime of the locality could be described as permanent arising from the semi-arid nature of the locality. The precipitation in the locality does not meet potential evapotranspiration demand in any month of the year (Table 1). Rice is planted about the first week of August and harvested from mid December and requires a growing season of 130 to 140 days. Wheat cropping which no longer takes place due to water scarcity is suited to the cooler harmattan period with planting staring early November and harvesting between late

February and early March. The short rainy season imply that the rainfall does not supplement the water requirement of the rice crop beyond the germination and early establishment stages after which total irrigation is required to raise the crop.

Figure 2 illustrates the annual precipitation input into the wetter part of the catchment of the Yobe River system using the observed annual rainfall series for Kano from 1956 to 2005. The figure also shows the estimate from available data for each year the number of days the river water was available for pumping at Yau. The plotted number of days for each year was estimated from available records of dates of flood crest assuming that recession below pumpable water level occurred 42 days after the flood crest. The plotted data for 1959 to 1972 represent the period before the completion of Tiga dam while those for 1993 to 2005 illustrate the situation after the completion of the Tiga and Challawa gorge dams. In addition to the reduction of flows downstream of the dams (Aminu-Kano, 1994), the demand from increasing human population and other competing water uses (Musa, 2006a; Musa, 2006b; Aminu-Kano, 1994) have combined to reduce the available pumping days at Yau from a pre-1972 average of 230 days to a current average of 195 days with CVs of 9.3% and 12.4% respectively. Generally recession of river water below pumpable levels now occur earlier than was the case for the periods preceding 1972. In the 2005/2006 season, the river water virtually dried out by mid January.

Table 1. Average values of daily temperature, daily relative humidity, monthly rainfall and monthly reference crop evapotranspiration at Malamfatori (1989 – 2000)

Month	Average daily temperature (^{o}C)	Average daily relative humidity (%)	Rainfall (mm /month)	*Reference crop evapotranspiration (mm /month)
Jan.	20.6	33.9	0.0	121.3
Feb.	21.7	28.5	0.0	123.6
Mar.	25.7	29.8	0.0	163.6
Apr.	31.6	33.3	1.5	169.2
May	32.7	37.3	4.5	158.7
Jun.	31.9	46.0	13.3	123.9
Jul.	27.6	60.3	84.3	129.2
Aug.	28.3	69.1	103.3	125.8
Sept.	29.6	58.0	53.9	126.5
Oct.	29.9	39.0	1.3	148.6
Nov.	25.2	35.3	0.0	131.7
Dec.	21.9	33.1	0.0	122.3

* Estimated by the method of Hargreaves (1985) corrected for aridity (Jensen et al., 1997) and elevation (Allen, 1995 as cited by Smith et al., 1996)

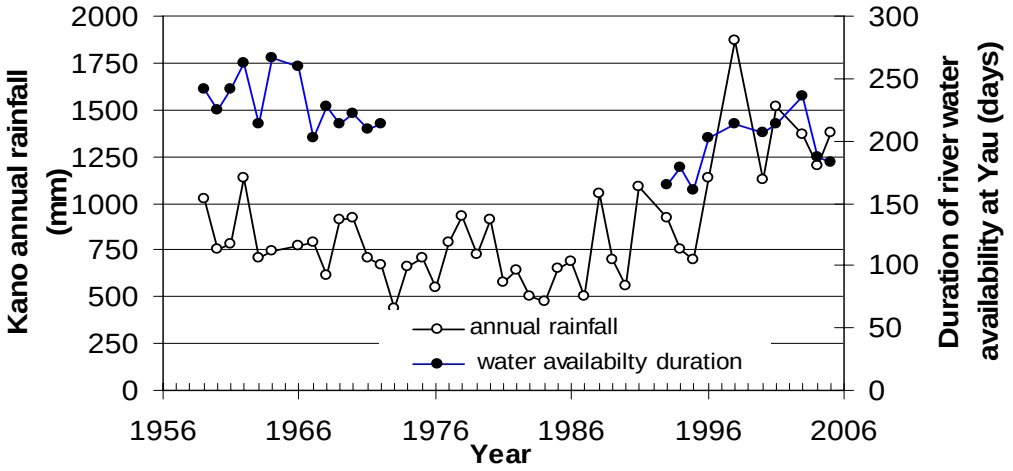

Figure 2 Annual rainfalls at Kano (1959 – 2005) and the estimated number of days the Yobe River water was available for pumping for irrigation at Yau (1959 – 1972; 1993 – 2005).

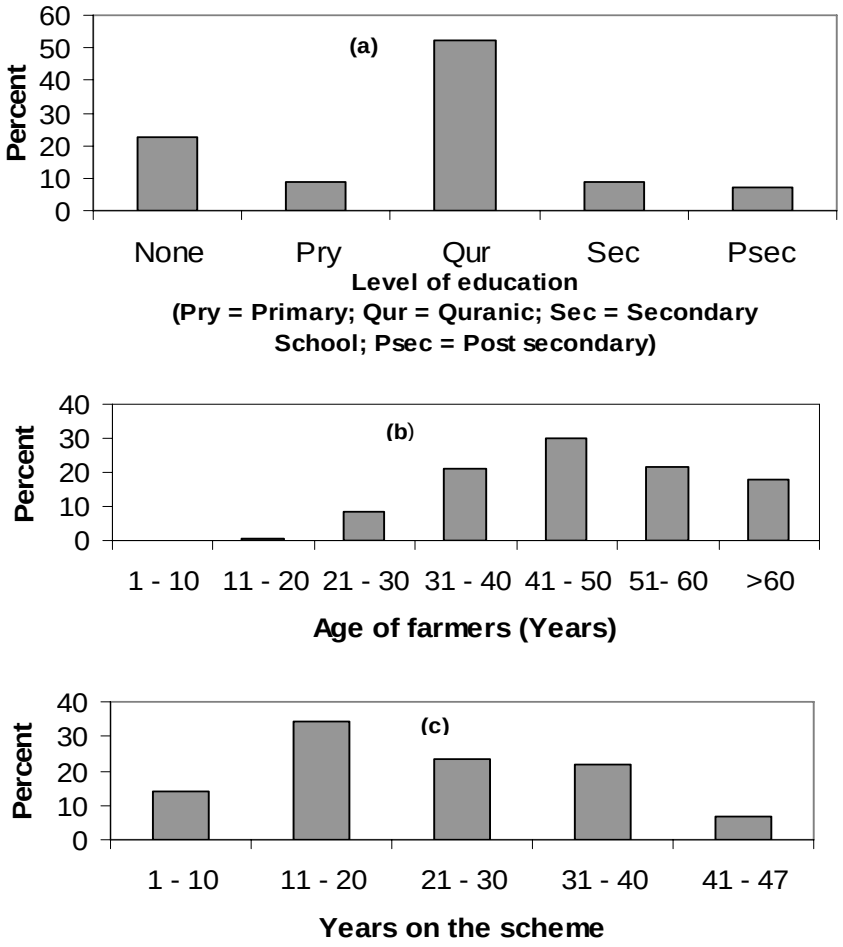

Figure 3. Distribution (%) of interviewed farmers by (a) level of education, (b) age and (c) years of experience on the scheme.

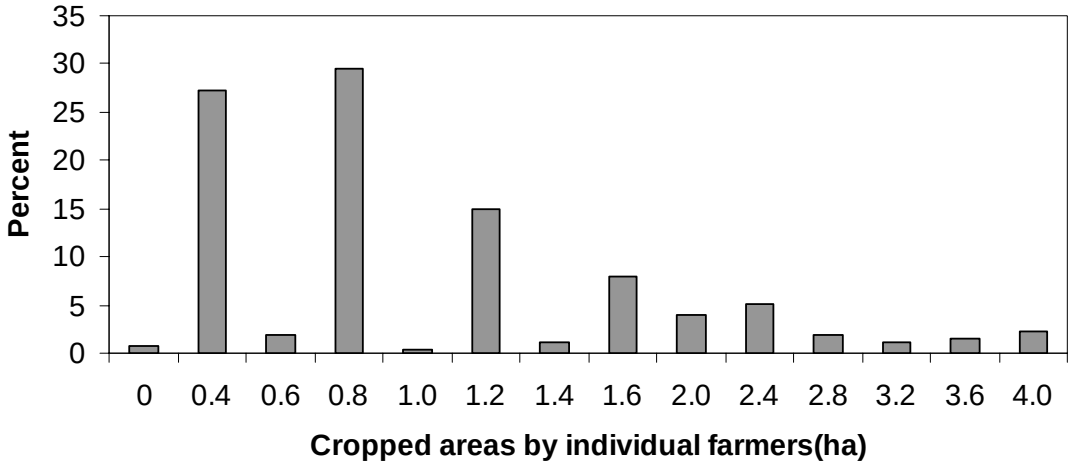

Figure 4. Distribution of areas cropped by individual farmers in the 2005/2006 season.

The farmers in the schemes were almost entirely male constituting 98.0% of the respondents with 69.7% of them aged 40 years and above. Over 89.0% of the interviewed farmers were natives of the locality. Their level of education was generally low with 22.8% of the respondents having no formal education (Figure 3a). They however have considerable experience of farming in the scheme with 86.2% of the respondents having been on the scheme for more than ten years (Figure 3c). The cropped area for rice by individual farmers ranged from 0.4 to 4 ha with 58.1% of them having areas of 0.4 to 0.8 ha (Figure 4).

The five special respondents on the other hand had university education. Their ages ranged from 40 to 65 years and their cropped areas ranged from 0.4 to 1.2 ha.

Most of the farmers cropped less than half of the areas which they were used to during the era of peak developmental activities in the scheme (Figure 5). The total cropped areas at the four locations of the scheme during the season of study were 220 ha, 120 ha, 40 ha and 20 ha for Daya, Yau, Abadam and Arege respectively. The farmers reported their paddy yields in bags per acre (1 bag ≈ 66.67 kg). The reported average yields was equivalent to 6034.9 kg/ha while the maximum and minimum yields ever record in the past were, according to the respondents the equivalents of 6523.4 kg/ha and 2473.2 kg/ha respectively. The corresponding yields reported by the special respondents were 3792.2 kg/ha for the average yield and, 4946.4 kg/ha and 2473.2 kg/ha for past maximum and minimum yields respectively. The farmers and the special respondents were of the opinion that yields were declining. The number of incidences of crop loss experienced by the individual farmers had significant linear correlation of 0.393 ($p \lll 0.001$) with their respective number of years on the scheme (Figure 6). The frequency of crop loss averaged one incidence per eight years of experience. In this study, crop loss was taken to have occurred in any year if due to water scarcity the farmer could not recover his cost on account of low yield or crop failure.

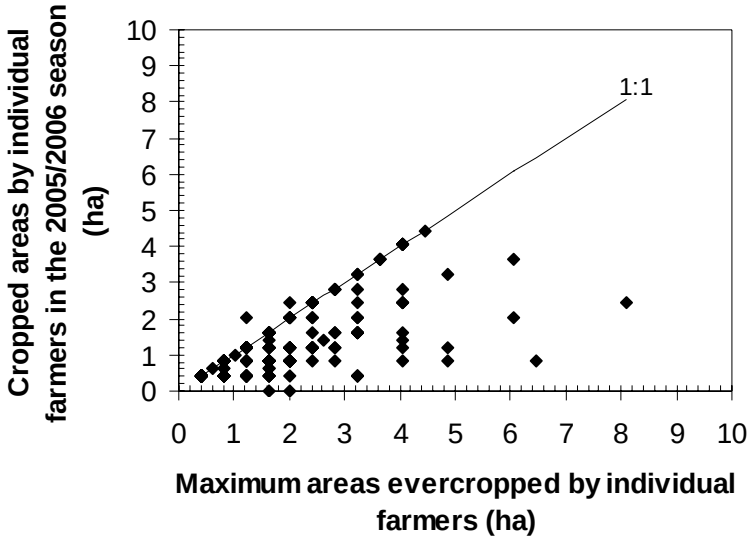

Figure 5. Comparison of the maximum area ever planted by individual farmers and their individual cropped areas in 2005/2006 season.

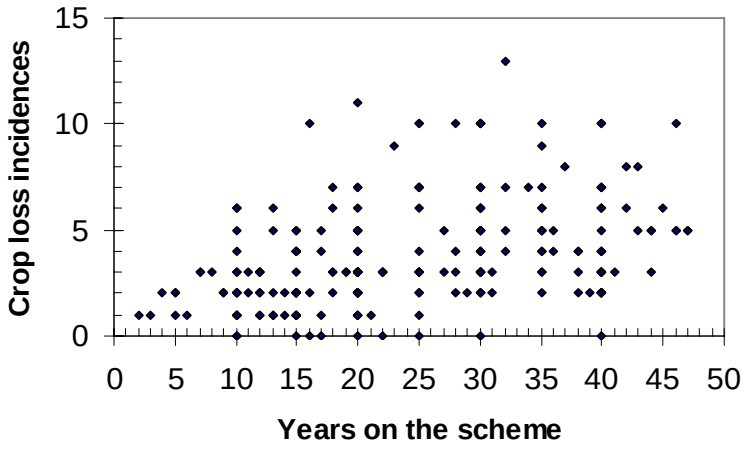

Figure 6. Number of years spent on the scheme by individual farmers and their respective numbers of times of experiencing crop loss.

An analysis of production costs and return based on information from the respondents showed that rice production at the scheme was profitable (Table 2). The net returns shown in the table could however be lower if the cost of herbicides was included. This was not considered because manual weeding was used by majority of the farmers.

The factors identified by the farmers as adversely affecting their enterprise are listed by category in Table 3 while those they considered as having no adverse effect are presented in Table 4. Also shown are in the Tables are the relative frequencies of the respondents' rating

of the factors and the chi-square values which are all significant at 0.05 level. For brevity of presentation, relative frequencies of 0 and 1, and, 2 and 3 ratings respectively (i.e. no effect and little effect, and, big effect and very big effect, respectively) have been pooled. In Table 3, all but one of the factors in the management/administrative category; high price of inputs especially fertilizer in the economic category; unexpected drying up of the river water in the climatological/ecological category and damming of the river upstream in the competition category were the most adversely rated by the farmers with over 80% of the respondents in each case rating them as having big to very big effects. Under the climatological/ecological category, soil salinity was adversely rated only at Yau and Arege with 60% and 96% of the respondent respectively rating it as having big to very big effect. This rating is similar to those by four out of the five special respondents. Seasonal rainfall amount was rated as having no adverse effect only by 26.4% of the farmers who have reconciled themselves to low seasonal rainfall of the locality with its high temporal and spatial variability.

Table 2. Estimated annual costs and returns per hectare of rice crop at the scheme (2005/2006 season).

	Item	Unit	Cost /Price per unit (₦)	Quantity	*Total Cost / Price per hectare (₦)
1.	Production cost items				
(a)	Land cultivation charge	*ha	2473.2	1.0	2473.2
(b)	Water charge	ha	2473.2	1.0	2473.2
(c)	Seeds	kg	40.0	92.7	3709.8
(d)	Fertilizer	kg	32.0	123.7	3957.1
(e)	Hired labour	man-day	500.0	149	74 500.0
(f)	Transportation (inputs)	km-kg	0.1	5 × 216.4	108.2
(g)	Transportation (output)	km-kg	0.1	5 × 3792.3	1896.1
(h)	Packaging of produce	kg	1.0	3792.3**	3792.3
	Total of specified items' costs				92 909.9
2.	Returns				
(a)	Gross return from produce sale	kg	40.0	3792.3**	151 692.0
(b)	Net return above specified costs				58 782.1

*Fields are in 1 acre units. Charges and costs/prices were obtained from farmer interviews on per acre basis and converted to equivalent values per hectare (1 ha = 2.4732 acres).
[One Naira (₦1.0) ≈ US $ 0.08]

** Average paddy yield value of 23 bags per acre obtained from the special respondents was assumed (1 bag ≈ 66.67 kg).

Table 3. Factors having adverse effects

Factors by category	*χ^2-value	Relative frequency of scores (%)	
		0 &1	2 & 3
Climatic/Ecological Factors			
Seasonal rainfall amount	14	50	50
Unpredictable dry spells during rainy part of the growing period	26	27	73
Unexpected river water dry-up leading to crop failure	111	14	86
Low crop yield in the scheme	9	45	55
Pests during the growing season	12	48	52
Economic Factors			
High cultivation charges by government	41	24	76
High price of inputs (fertilizers)	60	14	86
Better returns from farming and other activities outside the schemes	58	48	52
Competition Factors			
Advantageously located farmers over-appropriating water	13	50	50
Water not reaching tail end of the schemes	54	23	77
Damming the river upstream	114	4	94
Management/Administrative Factors			
Non-timely cultivation of the schemes	86	4	96
Non-timely supply of fertilizers	60	12	88
Non-timely pumping of water	53	18	82
Non-maintenance of irrigation structures	79	13	87
Non-maintenance of pumps	52	20	80
Non-supply of diesel and lubricants	176	12	88
Non-supply of fertilizers	94	3	97
Poor accessibility of the schemes	12	34	66
Technological Factors			
Manual weeding instead of chemical or mechanised methods	10	42	58

* all the χ^2-values are statistically significant at 0.05 level

0 and 1, and, 2 and 3 scores respectively denote, no effect, and little effect; and; big effect, and very big effect.

The expectations of the farmers with respect to desirable improvements in their operating environment are summarised in Table 5 as reflected in the 'Yes' or 'No' responses to the questions in the last section of the questionnaire. Essentially, the farmers overwhelmingly desire improvement in the quantity, duration and reliability of water supply from the state government agency responsible for operation and maintenance including land preparation and

water allocation. They would prefer at least a doubling of their current cropped areas. Majority of them expressed willingness to pay economic rates for services as long as they were provided in a timely manner (Table 6).

Table 4. Factors having no adverse effects

Factors by category	*χ^2-value	Relative frequency of scores (%)	
		0 &1	2 & 3
Climatic/Ecological Factors			
Seasonal sunshine amount	160	90	10
Growing season temperatures	139	90	10
Variations of onset and duration of harmattan	171	91	9
Economic Factors			
Level of water charges	31	76	24
Market for produce	212	92	8
Price of produce	78	76	24
Competition Factors			
Fishing activities	234	97	3
Watering of livestock	216	92	9
Management/Administrative Factors			
Work attitude of irrigation agency staff	12	64	36
Socio-cultural Factors			
Land tenure system	232	95	5
Level of formal education	219	96	4
Technological Factors			
Type of irrigation system	239	96	4
Seeding by broadcasting	154	92	8
Seeding by transplanting	111	87	13

* all the χ^2-values are statistically significant at 0.05 level

0 and 1, and, 2 and 3 scores respectively denote no effect, and little effect; and; big effect, and very big effect.

Table 5. Summary of response to questions on desired improvements to the scheme management

Aspect Questioned On	Relative frequency of responses (%)	
	Yes	No
Increase in both quantity of, and duration of water supply	98	2
Local water impoundment to extend water availability yearly to March	100	0
Government only being in charge of daily water allocation.	56	44
*WUA only being in charge of daily water allocation.	5	95
Government only being in charge of repairs and maintenance of conveyance systems.	100	0
WUA only being in charge of repairs and maintenance of conveyance systems.	1	99
Government only being in charge of repairs and maintenance of pumps	100	0
WUA only being in charge of repairs and maintenance of pumps.	0	100
Government to be in charge of operation of pumps	100	0
WUA only being in charge of operation of pumps	0	100
Government only being in charge of land preparation.	81	19
Land preparation being done by privately by individual farmers	49	51
Desirability of cropping areas of individual farmers to be increased	100	0
on any increase of allocated area being by 50%	9	91
on any increase of allocated area being by 100%	33	67
on any increase of allocated area being by 200% and above	62	38

*WUA = Water User Association

Table 6. Summary of farmers' response to questions on willingness to pay economic rate for services

Aspect Questioned about	Relative frequencies of responses (%)	
	Yes	No
Land preparation	99	1
Repairs and Maintenance of conveyance systems	89	11
Repairs and maintenance of pumps	83	17
Operation of pumps	83	17
Inputs (seeds, fertilizers and chemicals)	98	2

5. DISCUSSION

The declining rainfall trend of annual rainfall which is noticeable in Figure 2 between 1961 and 1985 has also been observed in some studies (Olaniran, 1991; Jimoh and Webster, 1996; Ejieji, 2003). There however seem to be a noticeable reversal of the trend after 1987 with increasing annual rainfall amounts being observed for Kano. This trend reversal has however not translated to increased river water availability for irrigation at Yau as shown in the yearly available pumping days from 1995 to 2005. The situation is a reflection of the increasing competition for water of the Yobe River system. There is therefore a need for the states within the system to cooperate and develop a sustainable framework for equitable utilisation of the water resources. The farmers, despite their low level of formal education, demonstrated good knowledge of their operating environment. The average number of years of experience per crop loss incidence is within the 8 to 10-year recurrence interval of droughty years which has been observed from the results of a study of the statistical properties of droughts in Northern Nigeria [Mustafa, S. "Statistical characteristics of droughts in Nigeria". (Inter-Departmental Seminar Paper, Department of Civil Engineering, Ahmadu Bello University, Zaria, Nigeria, 18 June 1984.)]. Their experiences and opinions should therefore form valuable inputs to the formulation of any participatory irrigation management program for the scheme.

A maximum paddy yield of 3964 kg/ha was reported in an irrigation trial study in the sudano-sahelian ecological zone of Nigeria (Hussaini et al., 1998). An average yield of 4500 kg/ha for irrigated rice has also been reported for the zone (Usman and Ado, 1998). The average and maximum yields reported by the farmers in this study are therefore exaggerated while those by the special respondents could be considered to be reasonable. The average yield obtained from the special respondents was therefore used in the analysis presented in Table 2. The profitability indicated in table notwithstanding, the smallness of the holdings of majority of the farmers mean that they could not rely solely on the income from rice growing for sustenance. They therefore grow other crops mainly millet outside the scheme and also engage in other occupations like trading, livestock farming, and tailoring to augment their income. The economic activities outside the scheme draw labour away and, according to the farmers, adversely affect the scheme. Both price of produce and the marketing are no hindrances to the performance of the scheme (Table 4). The poor prospect of achieving fully sustaining income from the scheme and poor accessibility however combine to make the scheme unattractive to the younger generation hence the skewing of the farmers' age distribution towards the over-forty-year olds (Figure 3b).

The farmers fully appreciate that timeliness in the provision of inputs and improved water supply reliability translate to higher crop yields which would lead to more returns and increased ability to pay economic rates for such services where provided by the irrigation agency of the government. The factors relating to the quality of the services are considered in the administrative/management category (Table 3) and have been most adversely rated by the farmers. The services are primarily the responsibility of the irrigation agency under the present management arrangement of the scheme and are correctly perceived by the farmers as dependent on the political expediencies of the state government.

The on-going programmes of economic reforms, restructuring and liberalisation in Nigeria deemphasise both government subsidies and government direct involvement production enterprises (Asoegwu and Asoegwu, 2007). Therefore, participatory irrigation management (PIM) in which costs and responsibilities are shared between farmers and the government

would be necessary in a new sustainable management structure to meet farmers' expectations. Given however the apparent unwillingness of the farmers to take charge of aspects of operation and maintenance (Table 5), an advocacy programme on the benefits of PIM would be necessary. The prospects of a positive outcome are good because despite the absence of water user associations in the scheme the farmers belong to cooperative societies with good records of problem solving. In the 2005/2006 season for example, the farmers at Arege on their own repaired a 5 km-reach of the main canal to get water to their fields.

Considering the increasing competition for water in the Yobe River system, the efficient use of available water by minimising avoidable wastes would be key to addressing the farmers' needs for increased hectarages. The rehabilitation of the conveyance and distribution infrastructure from the current dilapidated state and reclamation of some abandoned salt-affected fields would also be essential in this respect. Equity issues (Easter, 1993) would need to be addressed in any new management structure in view of the undue advantage perceived by the farmers as being enjoyed by those in the upper reaches of the distribution system.

6. CONCLUSIONS AND RECOMMENDATIONS

Relating agro-climatological records with the farmers perception of the climatological environment showed that the farmers, despite their low level of formal education, were not ignorant of their environment. They could perceive and describe it qualitatively. Majority of them also had considerable experience of farming on the scheme. The farmers identified categories of factors they perceive as adversely affecting the scheme. Management/administrative factors dependent on government agency were the most adversely rated as contributing to the decline of the scheme. The current national programme of economic reforms and liberalisation however emphasise reduction in subsidies and government direct participation in production enterprises. Participatory Irrigation Management to enable the sharing of cost and responsibilities between the farmers and government would therefore be necessary in a new management structure that would meet the farmers' expectations. Information from farmers relating to their experiences and opinions as expressed in this study should be valuable inputs in the formulation of any sustainable PIM programme for the scheme. An advocacy programme would however be necessary for aspects of the programme likely to be resisted by the farmers.

7. REFERENCES

Abubakar, S. Z., Lido, B. and O. J. Mudiare. 2002. Field testing of agency-farmer joint irrigation management concept and its institutional impacts in Hadejia Valley Irrigation Project, Nigeria. In *Proc. 2nd Int. Conf.,* eds. K. C. Oni, M. O. Faborode and A. P. Onwualu, 346 – 359. Abuja, Nigeria.: West African Society for Agricultural Engineers.

Agrar-und Hydrotechnik GMBH. 1973. Yobe irrigation scheme study. A report submitted to Ministry of Natural Resources, North-Eastern State, Maiduguri, Nigeria. Agrar-und Hydrotechnik GMBH (Consulting,Engineers), Essen, Germany.

Asoegwu S. and A. Asoegwu. 2007. An overview of agricultural mechanization and its environmental management in Nigeria. *Agricultural Engineering International: the CIGR Ejournal*. Invited Overview. No. 6. Vol. IX. May, 2007.

Aminu-Kano, M. 1994. Sustainable water resources development in the Komadugu-Yobe basin. Paper presented at the National Symposium on Water resources and Rural Development, Kano State House of Assembly, Kano, 5 – 10 June.

Clyma, W. 2002. Management strategies for sustainable irrigated agriculture with organizational change to meet urgent needs. *Agricultural Engineering International: the CIGR Journal of Scientific Research and Development*. Invited Overview Paper. Presented at the Special Session on Agricultural Engineering and International Development in the Third Millennium. ASAE Annual International Meeting/CIGR World Congress, July 30, 2002, Chicago, IL. USA. Vol. IV. September, 2002.

Easter, K. W. 1993. Economic failure plagues developing countries' public irrigation: An assurance problem. *Water Resources Research*, 29(7): 1913 – 1922.

Ejieji, C. J. 2003. Comparative analysis of the distribution of daily rainfall amounts at three stations in northern Nigeria. *Journal of Agricultural Research and Development*, 2: 70 - 86.

Hussaini, M. A., Falaki, A. M. and A. A. Ramalan. 1998. Performance of rice under irrigation as affected by date of planting in the Sudano-Sahelian Region of Nigeria. In *Proc. 12th Nat. Irrig. and Drain. Seminar on Irrigation in Sustainable Agriculture*, ed. A. A. Ramalan, 38 - 44. Zaria, Nigeria, 14 – 16 April.

Jensen D. T., Hargreaves, G. H., Temesgen, B. and R. G.Allen. 1997. Computation of ET_O under nonideal conditions. *Journal of Irrigation and Drainage Engineering*, 123(5): 394 – 400

Jimoh, O. D. and P. Webster. 1996. Optimum order for a Markov chain model for daily rainfall in Nigeria. *Journal of Hydrology*, 185: 45 – 69.

Musa, I, K. 2001. Challenges and opportunities for sustainable irrigation development in Nigeria. *Proc. of the Nigerian Institution of Agricultural Engineers* 23: 13 – 22.

Musa, N. 2006a. Yobe, Bauchi, others plan 2. 1 Billion Naira trust fund for rivers' basin. In *The Guardian Newspaper*, 6. The Guardian Newspapers Limited, Lagos, Nigeria. (website: http://www.ngrguardiannews.com) 12 June.

Musa, N. 2006b. Government, Six States, others pledge 850 Million Naira to restore Hadejah basin. In *The Guardian Newspaper*, 47. The Guardian Newspapers Limited, Lagos, Nigeria. (website: http://www.ngrguardiannews.com) 12 June.

Nwa, E. U. 2003. *History of irrigation, drainage and flood control in Nigeria (from pre-colonial time to 1999)*. Spectrum Books Limited, Ibadan, Nigeria.

Olaniran, O. J. 1991. Evidence of climatic change in Nigeria based on annual rainfall series of rainfall of different daily amounts (1919 – 1985). *Climatic Change* 19: 319 – 341.

Pereira, L. S. 2005. Water and agriculture: Facing water scarcity and environmental challenges. *Agricultural Engineering International: the CIGR Journal of Scientific Research and Development*. Invited Overview Paper. Vol. VII. February 2005.

Smith, M, Allen, R. and Pereira, L. (1996). Revised FAO methodology for crop water requirements. In *Evapotranspiration and Irrigation Scheduling*, 116 – 123. American Society of Agricultural Engineers.

Usman, A. S. and Ado, S. G. (1998). Crop production at the Hadejia Valley Project. In *Proc. 12th Nat. Irrig. and Drain. Seminar on Irrigation in Sustainable Agriculture*, ed. A. A. Ramalan, 74 - 81. Zaria, Nigeria, 14 – 16 April.