11. Aspects of Water Management in the Badeggi Rice Irrigation Scheme: Problems and Prospects

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11.1 INTRODUCTION

In operational terms, irrigation covers the task of finding, developing and distributing suitable water supplies to the soil to supplement the natural sources of water for crop production. In Nigeria, because of economic constraints and topography, most irrigation systems in the developed inland valley swamps are of the diversion type. The first irrigation scheme in Nigeria was built around Shella stream in 1929 but was later washed off by floods in 1946 (Singh and Maurya, 1979). In 1949 the Northern Regional Government established the first irrigation Division in Nigeria in the Ministry of Agriculture with responsibilities for development of small-scale irrigation schemes. At that time (and up till now) the Niger province (Niger state) was the largest producer of rice in the Federation. Therefore, in order to take advantage of the potential for rice cultivation in the province, a number of medium and small scale irrigation schemes were initiated in the early 1950's and the Badeggi Rice Irrigation Scheme was one of them (Table 11.1).

The Badeggi Rice Irrigation Scheme is located 12km East of Bida town in the River Gbako flood plains, which is one of the many tributaries of the River Niger which passes through the State. Irrigation water is supplied by gravity from headworks on River Musa to irrigate about 800ha of land. In 1978 engineering work started on the improvement of the drainage system and was continued from 1980 - 1983 by the World Bank assisted Niger State Agricultural Development Project. Government intention for initiating the scheme was that double cropping of rice would be encouraged, but since the inception of the scheme it has not been possible for the farmers to produce two rice crops a year. The objectives of this paper are to examine the problems and prospects of the rice scheme.

Table 11.1 Irrigation schemes in Niger State

Name of Scheme and LGA	Location	Gross Hectarage Planned	Water Source(s)	Area Under Cultivation (ha)
1. Edozighi (Gbako LGA)	Kaduna left bank flood plain, Wuya Bridge	1000	R. Kupanko R. Ejiko	920
2. Badeggi (Gbako LGA)	R. Gbako right bank flood plain east of Bida	880	R. Musa	690
3. Guzan (Lavun LGA)	Niger flood plain, west of Bida	1440	R. Yiko	80
4. Baba (Lavun LGA)	Niger flood plain, south of Mokwa	1000	R. Niger	72
5. Gbakogi (Gbako LGA)	Gbako/Niger flood plain	2800	R. Gbakogi	5
6. Edo-Lapai (Lapai LGA)	Niger Valley near Baro	920	R. Etswan	30
7. Tungan Kawo (Mariga LGA)	R. Kpabugi fadama	800	R. Kpabugi	Nil
8. Loguma (Agaie LGA)	Niger flood plain west of Baro	120	R. Emi	60
9. Toroko (Gbako LGA)	Tributary of R. Kaduna, north of Bida	80	R. Kanko	24
10. Wawu (Magama LGA)	Kainji Lake shore	40	Kainji Lake	-
11. Baratsu (Lavun LGA)	Right bank of R. Kaduna, west of Bida.	72	R. Ije	20
12. Sugar Estate, Sunti (Lavun LGA)	Niger valley, east of Mokwa	1600	R. Niger	Nil

Table 11.1 contd.

Name of Scheme and LGA	Location	Gross Hectarage Planned	Water Source(s)	Area Under Cultivation (ha)
	Small Schemes and Market Gardens			
13.Zara (Rafi LGA)	Near Pandogari North, Niger state	140	R. Mando and tributary	40
14. Lioji (Mariga LGA)	Tributary of R. Malendo	80	R. Lioji	40
15. Kuta (Chanchaga LGA)	South-west of Shiroro	70	R. Kuta	60
16. Lemu (Gbako LGA)	North of Bida, on Bida-Zungeru Road	1	Well	1
17.Chanchaga (Chanchaga LGA)	South of Minna	8	R. Chanchaga	8
18.Lanzu (Bida LGA	In Bida	-6	R. Lanzu	6
19. Abuja (Abuja LGA)	East of Abuja town (Suleja)	6	R. Yiku	6
20.Masuga (Mariga LGA)	5 kms from Kontagora	-	-	-

Source: (Max Lock Group, 1980)

11.2 THE ENVIRONMENTAL SITUATION

11.2.1 CLIMATE

i. Rainfall:

Among the climatic elements in the area of the irrigation scheme, rainfall shows more annual fluctuations than any other climatic factor. Although most of the rainfall is from April to October, the rivers which feed the irrigation scheme are still flooded past the main rainfall months. This is because of the porous nature of the geologic formation (Cretaceous sandstones) on which these rivers flow. Often the peak of the rainfall is in the months of August and September preceded by an earlier smaller peak in the month of June (Fig. 11.1). The annual rainfall averages 1129.9mm (1956- 1992). Generally the months of November to March have no rainfall.

ii. Temperature:

The temperature range more than any other factor is very consistent over the years during the period from January until the onset of the rains. Both daily maximum and minimum temperatures rise to their annual peak just before the beginning of the rains. During the rainy season, daily maximum temperature drops to its lowest level of 28°C about August, but the drop in minimum temperature is negligible. Both the maximum and minimum temperatures continue to ascent gradually until the rise after January. The effect of these temperature conditions have not been assessed in this area, but Best (1959) reported that optimum temperature for grain yield is between 29°C to 32°C, although higher temperature of 37° generally accelerate the growth and heading for rice, they have been found to decrease grain yields.

iii. Relative Humidity:

In the dry months of November to March, the relative humidity is lowest in February although decreases appear in November and continue to the harmattan months of December and January. The relative humidity is high during the rainy season between May and September rising to more than 80% in August.

iv. Solar Radiation:

The trend of the solar radiation follows closely that of the air temperature. It is lowest during the month of heaviest rainfall (27gm - cal, cm in August) when the sky is overcast with clouds.

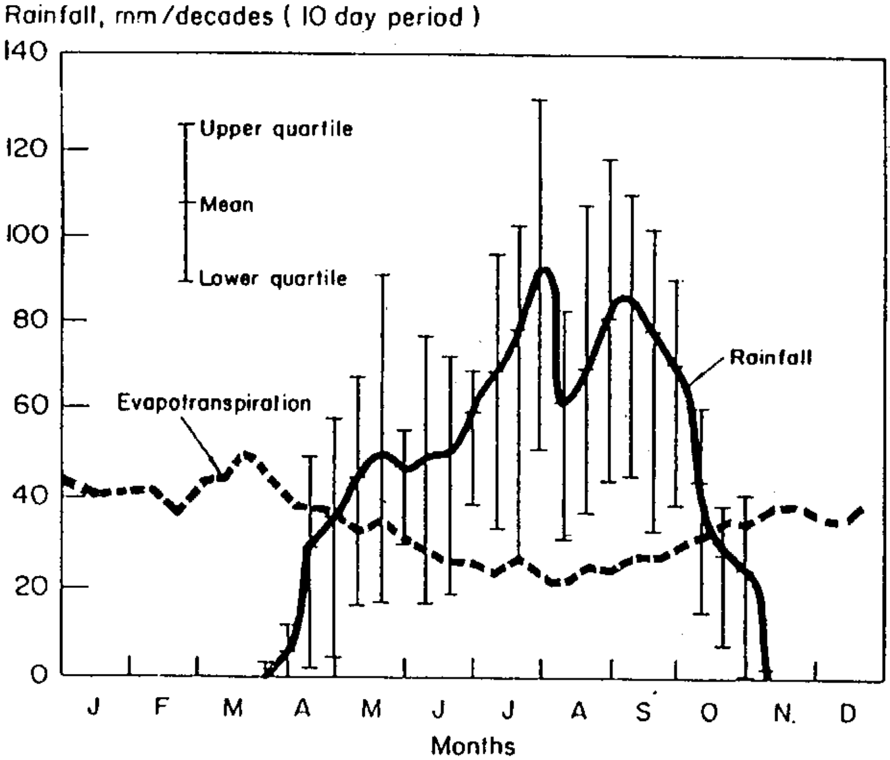

Figure 11.1 Rainfall for 10-day periods (decades) at Bida, Nigeria (1961-83)

v. Evaporation:

The evaporation from an open sunken water surface shows a relatively close pattern with air temperature. Although there are annual fluctuations from month to month, the lowest evaporation is in August. The average daily evaporation is maximum between March and April with 6mm, decreasing to the lowest again in August, to 3mm per day.

According to Williams (1968) the ratio of evapotranspiration of the rice plant to evaporation of water from an open water surface was found to be 1.2 in the wet season and in the dry season in the Phillipines. Therefore in terms of evapotranspiration of the rice plant under Badeggi conditions, the estimated value would probably fall between 800mm (8000m/ha) in the dry season and 600, (6000m/ha) in the wet season for a crop of 120 days growth duration.

11.2.2. GEOLOGY AND PHYSIOGRAPHY

The Badeggi Rice Irrigation Scheme is sited in cretaceous rock of mesozoic origin. The sandstone is generally known as Nupe sandstones of the Niger-Kaduna-Gbako river system.

Physiographically the site is located within the Gbako flood plains. The soils of the Badeggi irrigation scheme are considerably complicated. This is due to the fact that at Badeggi the frequent changes in course of River Gbako have caused the various textures of recent alluvium to be laid down in an intricate pattern of sandy alluvium where the river flowed fairly rapidly, clayey where it is sluggish or stagnant, and very clayey where it was left in Lakes as the river course changed (Moss, 1954). In addition the older alluvium (which is clayey and was probably laid down a considerable time ago by a river flowing in the present Gbako basin, during a previous period of geological time) is often only covered by about a meter of the more recent alluvium and sometimes protrudes through it.

The soil series found in the scheme vary in texture from pure sand through clayey sand to sandy clay soils in the surface layer and through the profile. These differences in texture determine their suitability for rice cultivation in terms of water retention and ease of drainage and land preparation.

11.2.3 HYDROLOGY

Generally in April/May, the main river in the scheme area shows a rise followed by a single peak in September and subsequent decline thereafter. As the area is underlain by the Nupe sandstone, river Gbako shows a smaller seasonal variation in flow and the small rivers and streams are very often perennial. The seasonal flows of the Gbako River become more attenuated owing to the lower direct runoff after rainfall and the consequent inflow of groundwater to the river throughout the season to the extent that in March around Badeggi and down stream, the flow is high and it is directly pumped for the water works which supply both Bida and Badeggi towns.

11.3 THE EXISTING FARMING SYSTEMS

Most farmers have both upland and wetland farms varying in sizes from 0.4ha to 2.0ha in the wetland and from 1.2ha to 4.0ha in the upland. According to Ward (1983) the average farm size of farmers using fertilizer was 0.83ha and the average size for non-users was 0.39ha in 1980. Land ownership in the area is based on the 'fief' holder system where land rights are not heritable. Tenants pay rents or tributes to land owners which are only symbolic.

The principal crops grown in the area are sorghum, millet, rice, maize, sweet potato, groundnut, melon, cassava and yam. Intercropping is the common farming practice for most crops except rice which is a sole crop 100% of the time and yam 84% of the time. The average area allocated to major crops is shown in Table 11.2. In each household, the area under sorghum is the largest (0.87ha) followed by melon. The average acreage under millet, groundnut, rice and yam is almost equal (0.21ha). On the other hand, almost all farmers grow sorghum (97%) followed by groundnut (48%), millet (40%), rice (35%), melon (34%) and maize (32%) (Ward, 1983). Except for rice, more than 50% of the other major crops are planted in April and during the first half of May. The situation with rice is different as more than 90% is planted after the first half of May or more than 40% still remain to be planted after August when most of the other crops have been planted (Table 11.3).

Table 11.2 Crop areas, cropping systems and yields

	Guinea Corn	Millet	Melon	Groun-dnut	Yam	Rice
Average area per household (ha.)	0.87	0.21	0.44	0.21	0.19	0.21
% of household growing	87	44	63	40	57	58
Intercropping %						
Sole crop	32	21	0	49	84	100
2 crop mixture	56	39	56	36	13	0
3 crop mixture	11	34	42	13	3	0
4^+ crop mixture	1	3	2	1	0	0
Average output per household (kg)	1459	231	13	260	1113	577
Yield (kg/ha.)						
Sole crop	1968	1086	0	1202	4942	1702
2 crop mixture	1353	1189	41	1057	3509	0
3 crop mixture	1498	763	26	922	2428	0
4^+ crop mixture	1372	768	19	538	0	0
Overall	1518	1030	38	1119	1583	1702

Source: Ward, 1983

Crop production practices depend largely on manual labour and use of hand tools such as hoes and cutlasses. Farm labour consists of family labour and hired labour. Hired labour contributes a high proportion (40%) of total labour use without tractor. This situation makes labour shortage a common occurrence during peak periods of land preparation, planting, weeding and harvesting. Table 11.4 shows that female labour is utilized for about 25% of the time of family labour for farm cropping activities. It is shown that women are involved with planting, threshing and winnowing and transportation of crops, from farm to homestead and transportation of inputs to the farm. Female labour is also involved with the harvesting of groundnut. The women may also have independent farms in which case they depend on hired labour for land preparation and weeding.

Table 11.3 Planting time of major crops in 1981/82 (%)

	Guinea corn	Millet	Melon	Ground-nut	Maize	Rice
Before April	19	16	24	14	18	0
April 1st half	17	24	24	26	14	0
2nd half	12	20	12	16	8	0
May 1st half	26	24	29	29	34	2
2nd half	8	3	5	6	15	8
June 1st half	8	9	5	6	15	8
2nd half	5	2	3	3	2	15
July 1st half	4	2	0	3	0	11
2nd half	0	0	0	1	0	8
August 1st half	0	0	0	0	0	16
2nd half	0	0	0	0	0	21
After August	0	0	0	0	0	13
Total	99%	100%	102%	105%	99%	100%

Source: Ward, 1983

In Table 11.4 it is also shown that weeding is the most demanding activity followed by land preparation, both of which amount to 143 mandays/ha on an average size farm (Gebremeskel an de Vries, 1985). Figure 11.2 shows that for the rice - based farming system average house hold labour input is substantially below labour supply during February and March and considerably above labour supply during May and June, but almost equal to supply during July through December.

Yields of major crops are low owing to a number of interrelated factors as low soil fertility, erratic rainfall which leads to drought stress and heavy infestation of the parasitic weed Striga on maize and sorghum on upland farms. In rice production, major constraints are poor water control, inefficient land preparation, weeds, iron toxicity, low soil fertility (Tables 11.5 and 11.6), low plant population and low yielding varieties. Also farming activities in the upland farms result in delays of rice planting in the wetlands. Likewise, harvesting of major upland crops like sorghum coincides with rice harvest. Consequently establishment of upland crop or a second rice crop after rice harvest has to be delayed or neglected all together because farmers allocate much of their labour to post harvest activities.

The major socio-economic constraints revolve around the following (Ayotade and Okereke, 1984).

- Land fragmentation related to increasing population pressure;

- Poor infrastructure in terms of road and transport systems, and marketing facilities resulting in high transport costs and low farmer's prices;

- Unavailability at the time required and/or the high costs of modern inputs, such as improved seeds, fertilizer, insecticides and machinery;

- High costs and low productivity of labour;

- Lack of credit, poor pricing structure and low incomes;

- Lack of research with farming systems approach to technology development and use; and

- Little effective technology transfer through extension services.

Table 11.4 Labour use by labour activity and labour type for five crops in mandays per ha.

	Guinea corn	Rice	Yam	Gound-nuts	Maize
Labour activity+					
Land preparation	26	38	22	22	30
Planting	7	17	9	7	7
Fertilizer application	9	12	9	7	5
Weeding	30	41	17	34	27
Harvest	13	27	12	20	14
Transport + store	12	22	8	5	9
Threshing	9	17	-	3	20
Labour type					
Male	48	102	54	37	62
Female	7	10	3	6	17
Total family	55	112	57	43	79
Hired	45	57	18	49	23
Total Labour	100	169	75	92	102

Source: BADP farm management survey, 1980

+Labour averages for all labour activities are calculated only from cases where the activity was reported. So, if fertilizer is applied on rice, it required an average of 12 mandays. But since fertilizer was not applied on all rice farms, the average total labour use on rice (169) was less than the sum of activities (174).

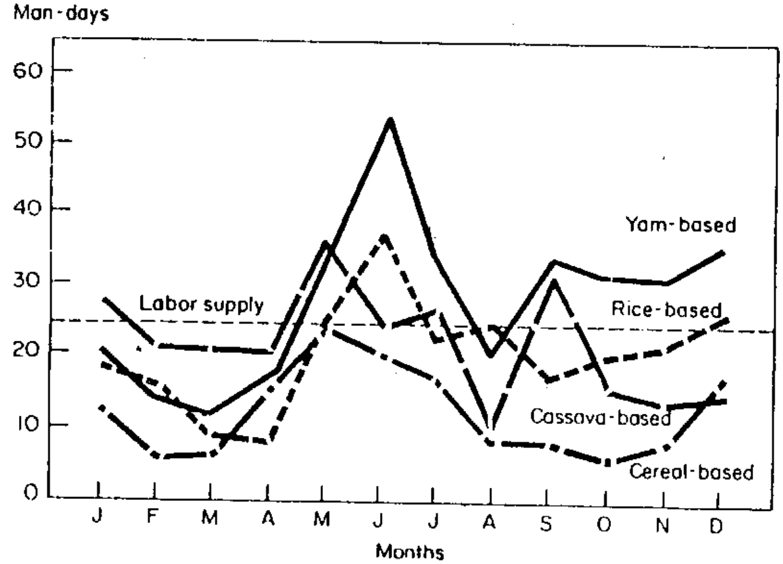

Figure 11.2 Average household labour input (man-days) for agricultural activities in various cropping systems, Bida ADP 1983

Source: Ashraf et al., 1985.

Table 11.5 Physico-chemical properties of a representative surface soil in the Badeggi irrigation scheme, Bida area, Niger State, Nigeria

	Mean	Range	Sample No.
<u>Physical properties</u>			
Sand (%)	71.7	56.4 - 85.6	48
Silt (%)	18.5	7.4 - 29.6	48
Clay (%)	9.8	6.0 - 16.2	48
<u>Chemical properties</u>			
pH	4.2	3.6 - 4.8	48
Qrs carbon (%)	1.22	0.12 - 2.9	48
Total N (%)	0.087	0.02 - 0.15	48
Avail P (ppm)	6.84	0.43 - 12.05	48
<u>Exch. Cations (Meq/100g soil)</u>			
Na	0.02	0.01 - 0.02	48
K	0.21	0.09 - 0.70	48
Ca	0.87	0.63 - 0.86	48
Mg	0.31	0.16 - 0.46	48
Exch. Acidity	0.42	0.23 - 0.97	48
CEC	1.83	1.29 - 2.53	48

Table 11.6 Some chemical characteristics of soil developed over alluvium in Niger state, Nigeria.

Depth (cm)	pH (H_2O)	Ca	Mg	K	Ma	CEC	BS	OM	Av.P (ppm)
		Meq./100g of soil							
Shega Series									
0-42	6.8	2.3	0.2	0.5	0.34	5.1	65	n.d	n.d
Sogi Series									
0-31	6.6	1.9	0.2	0.6	0.56	5.3	76	n.d	n.d
Efoghi Series									
0-48	5.8	6.0	0.4	0.9	1.30	18.0	43	n.d	n.d
Ezun Series									
0-20	5.7	8.5	0.6	1.6	0.34	27.0	46	n.d	n.d

Source: Electro Watt Consulting Engineering and Planners Nigeria 1980. Semi-detached soil survey in Kaduna River Flood Plains.

11.4 OPERATION OF THE SCHEME

The Badeggi Rice Irrigation Scheme covers an area of about 800ha divided into eight (8) blocks which vary in size from 70ha to as large as 159ha. It depends on the available stream flow of the Musa River which is diverted into a main canal that branches out into eight (8) laterals and field canals and to a limited extent into farm ditches. Water distribution is by rotation in the main canal on five (5) day-basis. The system also supplies water for domestic use of villagers around the scheme through the laterals.

The present practice of irrigation is to irrigate fields far from the lateral canal by allowing water to flow across neighbouring farms upstream. The dry season stream flow is usually not sufficient to meet irrigation and domestic water requirement from January to May. All farmers allocated land in the scheme pay a fee of ten Naira/ha only and this fee has not been collected since 1990.

11.5 EXISTING PROBLEMS

The introduction of improved water management under irrigated agriculture is a complex problem involving the whole of rural society and agricultural administration. Any loose link in the chain causes problems. Therefore measures to accelerate benefit from the water development project must necessarily be grouped around the farmers fields. The farming practices and social structure of the farmers in the scheme have developed on subsistence agriculture and their priority is therefore food production. The government objectives on the other hand is to take advantage of the potential for rice cultivation in the flood plain to produce two rice crops a year by providing water for irrigation and for domestic uses. It appears that the needs of the farmers were not properly identified by the authorities and this has led to inefficiency and malfunctions of the scheme.

As can be seen in Table 11.2, sorghum is the major staple crop of the rural population in the scheme. It is cultivated by more than 90% of the households on about 66% of the total area under crops. Almost all farmers who cultivate rice in the scheme have upland crops as their priority. Before the end of May, about 50% of the upland crops have been planted. Thus, it is only after sowing and weeding of upland crops that the farmer comes to prepare land for rice by which time the probability of having more than 75mm of rain still to fall is less than 50%. Therefore only one crop of rice can be grown instead of two rice crops a year.As the scheme is also to supply water for domestic uses of the surrounding villagers, the main canal and laterals are at full capacity when the rice fields are still fallow during the rainy season. Therefore, flat fields and the foot of slopping areas are waterlogged although all outlets in the distribution canal are closed. The waterlogging is the result of losses of irrigation water due to leakages from the canals and percolation from the fields. This water adds to the groundwater reservoir thereby raising the watertable and with consequent iron toxicity problems in these areas.

Also at this time, the 32ha research farm of the National Cereals Research Institute is being supplied with water through a distributary canal carrying water to irrigate 159ha of rice fields. Therefore water supply to the farm is in excess of its requirements because the farmers' fields upstream and surrounding the research farm are yet to be cultivated. The result is waterlogging and sometimes flooding of low-lying fields.

Besides the distribution related problems, the poor performance of the scheme is also affected by engineering, agronomic, institutional and socio-economic factors.

There is poor performance of the scheme because of engineering problem even after rehabilitation of sections of the main and distribution canals in 1983. The irrigation and especially the drainage network are below standard. All the collector drains from each irrigation block are designed to empty into a depression (Lake) near the bank of the Gbako River.In most cases the approach to the lake is higher than the drain level.The result is inefficient drainage of fields with consequent flooding of low lying fields during peak rainfall in August or September. Also the Gbako River often overflows its banks during this period and the flood water fills up the lake into which the drains empty.Thus the irrigated fields are sometimes waterlogged or flooded from backfilling of the drains.This unforeseen feature and faulty design result in loss of about 25% of the land during the cropping season.

The uneven topography which was not taken care of by the engineering works resulted in inefficient water distribution. Less than 30% of the 90ha of Block 2 receives irrigation water.This is because the DC2 irrigation canal was designed to rise with the land with consequent deficit water supply at the end of the canal.The primary objective of government in initiating the scheme which is that of producing two crops of rice a year has not been achieved because of agronomic problems.This is mainly due to the late maturing rice varieties planted by farmers in the scheme.Two rice crops can be produced in one year if early maturing rice varieties are planted in June which can be harvested in September while the second rice crop is planted before the end of September.

Another contributary factor to low crop intensity is competition between irrigated and rainfed crops.It often happens that at the peak of labour requirement for rice(Nursery preparation,Land preparation and Transplanting) a lot of time is devoted to rainfed crops on the upland fields.Also related to this is the failure of farmers to master the techniques of double crpping which implies tackling various problems of adjusting cycles of threshing the harvest,promoting land preparation under water and transplanting.

The institutional constraints also lead to under utilization of the scheme.The staff of the managing authorities lack managerial and technical experience in irrigation,drainage and irrigated crop production.

Further, if water is to be effectively used by the farmer without long-time deterioration,he must have adequate means to do so and must also have incentives to sustain his efforts.In this scheme,socio-economic constraints are overwhelming.Often farmers can not pay for the input associated with irrigation,especially now that subsidies have been removed on all farm inputs with increased cost of transportation that kill farmers' incentives.

11.6 PROSPECTS FOR IMPROVEMENT

Although irrigated farming is supposed to eliminate the risk of water shortage and guarantee crop production, it should not be taken as a purely technical solution to a technical problem because it represents a new way of life for the people in the project area. There is therefore a need to raise local awareness for a successful development of the water project.It is clear that the many problems encountered in this scheme stem mainly from the neglect of the sciological and human factors of the new way of life brought about by the scheme.Therefore in order to increase the performance of the scheme,the following short and long term solutions must be implemented.

The short term solutions will include:

- Repairs to broken irrigation canals and continuous clearing of the drainage channels.

- Reducing the gradient of the approach of collecting drains into the lake.

- Provision of pumping facilities to reduce volume of water in the lake whenever necessary.

- Provision of unrestricted shallow drainage to enable cultivation of upland crops during the wet season.

- Provision of independent storage structures at the level of the laterals to extend growing season for crop diversification.

- Promotion of village associations to take greater responsibilities in the management of the scheme.

- Provision of in-service training to technical staff of the authority in irrigation and drainage techniques to enable them provide information,guidance and training on continuous basis to farmers in the correct use of water, such as how to prepare fields for the application of water and how to remove excess water.

The socio-economic and human factors involved in irrigation schemes imply that the long-term solution for improving the performance of the scheme should rely on the farmers to develop cropping systems adapted to their needs and given access to market economy.In order to achieve this goal;

- Machinery stations are to be provided with tractors and implements or animal power needed to undertake timely land preparation for both upland and irrigated crops,

- Provision of collection and service centers to facilitate marketing of produce,

- Provision of credit facilities to support the purchase of farm inputs such as seeds, fertilizer, and other agrochemicals.

The above solutions must be accompanied by engineering works on land leveling, reconstruction of irrigation canals and drainage channels.However,as the main problems in this scheme are also found in the other schemes in the state,it is proposed that in the interval between the application of the short and long-term solutions a comprehensive study of the local situations in all schemes should be conducted. The analysis of the results will identify the point of intervention and whether same solutions are applicable to all schemes in the state.

11.7 RESEARCH NEEDS

The implementation of the rehabilitation programme will not be effective or possible without increased emphasis on research into irrigation and drainage technology development, of appropriate cropping systems for irrigated agricultrure and the socio-economic impact of irrigation. Therefore, some of the research needs are:

1. To study the influence of irrigation on natural and social environments.

2. To evaluate the operational performance of small-scale irrigation schemes in Niger state

3. To study the effect of drainage methods on the performance of upland crops during wet season.

4. To evaluate land preparation methods for submerged conditions.

5. To determine the optimum soil moisture conditions for rice land preparation by animal traction.

6. To screen rice varieties for tolerance to flood.

7. To determine the effect of land preparation methods on turnaround time for double cropping system.

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