THE IMPACT OF IRRIGATION PROJECT ON KADAWA AND ITS ENVIRONMENT UNDER THE KANO RIVER PROJECT PHASE I (KRPI)

BY

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BEING A THESIS SUBMITTED TO THE POST GRADUATE SCHOOL FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, IN PARTIAL FULFILMENT OF THE AWARD OF POST-GRADUATE DIPLOMA (PGD) IN ENVIRONMENTAL MANAGEMENT

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CERTIFICATION

This thesis entitled the impact of irrigation projects in Kadawa and its environments, under the Kano River Project phase I (KRPI), meets the regulations governing the award of Post Graduate Diploma, Environmental Management of the Federal University of Technology Minna.

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DEDICATION

This work is being dedicated to God Almighty for sparing my life throughout the period of study. And also, to my late mum.

ABSTRACT

This study is aimed at finding the impact of irrigation in the Kano River Project phase 1 (KRPI) on Kadawa area and its environments. An attempt was made as outlined in the objectives of the study, to identify areas adversely affected as to the result of irrigation activity and equally make an assessment of some of the positive impact of the scheme to the beneficiary community. The importance of impact assessment of developmental project for a sustainable development is therefore seen as necessary and important.

TABLE OF CONTENT

Certification i

Dedication ii

Acknowledgement iii

Abstract iv

CHAPTER ONE

1.0 Introduction

1.1 The significance of Environmental Impacts

1.2 Description of the study area

1.2.1 Brief on Kano River project phase 1 (KRPI)

1.2.2 Climate

1.2.3 Rainfall

1.2.4 Temperature, Relative Humidity and other meteorological data

1.2.5 Geology

1.2.6 Topography

1.2.7 Soil

1.2.8 Hydrology

1.2.9 Vegetation

1.3 Aims/ Objectives of the study

1.4 Scope and limitation of the study

1.5 Justification

CHAPTER TWO

2.0 Literature review

2.1 Environmental Development at the global level

2.2 Nigerian National Environmental Development

2.3 Environmental impact of irrigation

2.4 Water uses problems

2.5 Erosion and sedimentation problems

2.6 Water and Biogeo-chemicals problems

CHAPTER THREE

3.0 Methodology (Data collection)

3.1 Reconnaissance surveys

3.2 Administration of questionnaires

3.3 Persnal interview

CHAPTER FOUR

4.1 Result discussion/analyses

4.2 Socio economic impact

4.3 Aquatic/Agricultural weeds impact

4.4 Sediments/waterlogging/salinisation impacts

CHAPTER FIVE

5.1 General Observation

CHAPTER SIX

6.1 Recommendation and conclusion

6.2 Recommendation

6.3 Conclusion

References

Appendix

CHAPTER ONE

1.0 INTRODUCTION

1.1 The Significance of Environmental Impacts

The need to increase agricultural production is regarded as an important national goal in Nigeria today. This is to satisfy the needs of the ever increasing population and to provide materials for processing and export which will boast national revenue. In most part of the country, irrigation supports only a small proportion of agricultural out put, but the land area under irrigation has continue to increase and further expansion being envisaged.

Against this back ground, the performance of irrigation in Nigeria is being disappointing especially in respect of larger capital intensive schemes. Although there are various reasons for this poor performances, factors of an environmental nature has been prominent in many instances: In other words, many irrigation systems/schemes have not provided environmentally sustainable output. Sedimentation effects, soil salinisation, waterlogging, deteriorating quality of water source and biological effects such as agricultural pest and weeds or the establishment of aquatic vegetation in the water storage, distribution and drainage systems have all been responsible for the fall in production. These environmental problems have not been adequately foreseen at the project design stage and often go unrecognized for the few years of the of the study are existence when their impacts begins to have a serious effect on production, the resources available for remedial action may be inadequate and the decline in productivity continues to the point where a major rehabilitation of the

project may be considered as the only solution to preventing complete failure.

In addition to the environment effects described above, which directly influence project performance, there are a number of other important changes brought about by irrigation projects which may adversely affect either the vicinity of the project or areas further afield prominent amongst these side effects are changes which affect human health, Land degradation leading to erosion of hinter land and downstream effects causing changes in the quality or quantity of the surface and groundwater system. Also it has been discovered that, irrigated agriculture under good management practices enhances the social economic status of the operators.

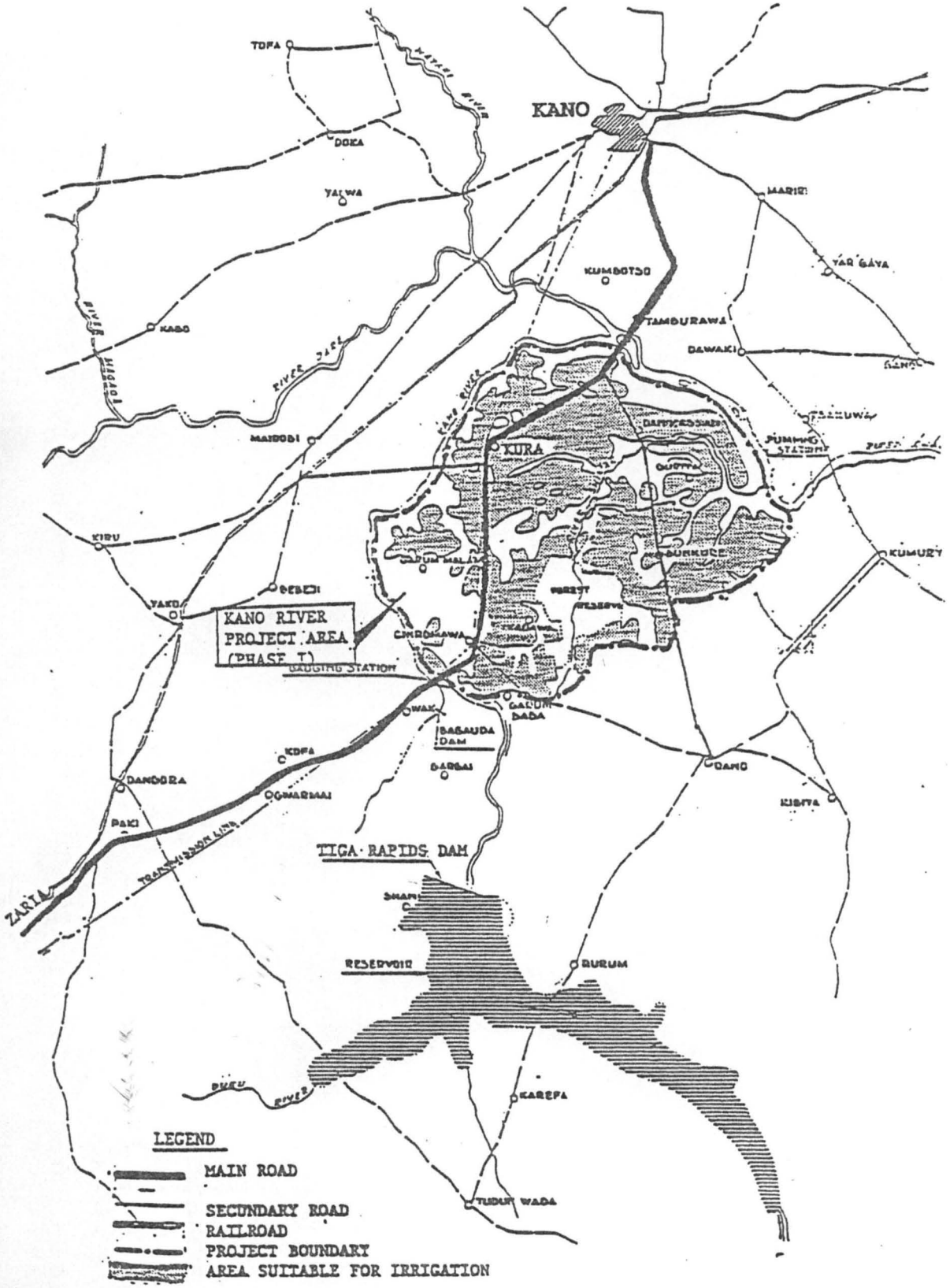
From the definition of Environmental Impact Assessment (EIA) Heer, et al (1997) can be seen as the evaluation of various aspects of the environmental effects (both adverse and beneficial on a proposed development) which could be before inception or after some operational period of time, including the identification of measures for mitigating the adverse effects. Hence, for a sustainable development, an Environmental Impact Assessment (EIA) of irrigation schemes becomes necessary.

1.2 DESCRIPTION OF THE STUDY AREA

1.2.1 Brief on Kano River Projects Phase 1 (KRPI)

Kano River Project Phase I, is one of the largest and successful irrigation projects, notonly in Nigeria, but in West African region. It is unique in its design, with the entire water distribution network operating on a gravity system. The project has all the irrigation structures constructed and

FIGURE 1.1
KANO RIVER IRRIGATION PROJECT
LOCATION MAP



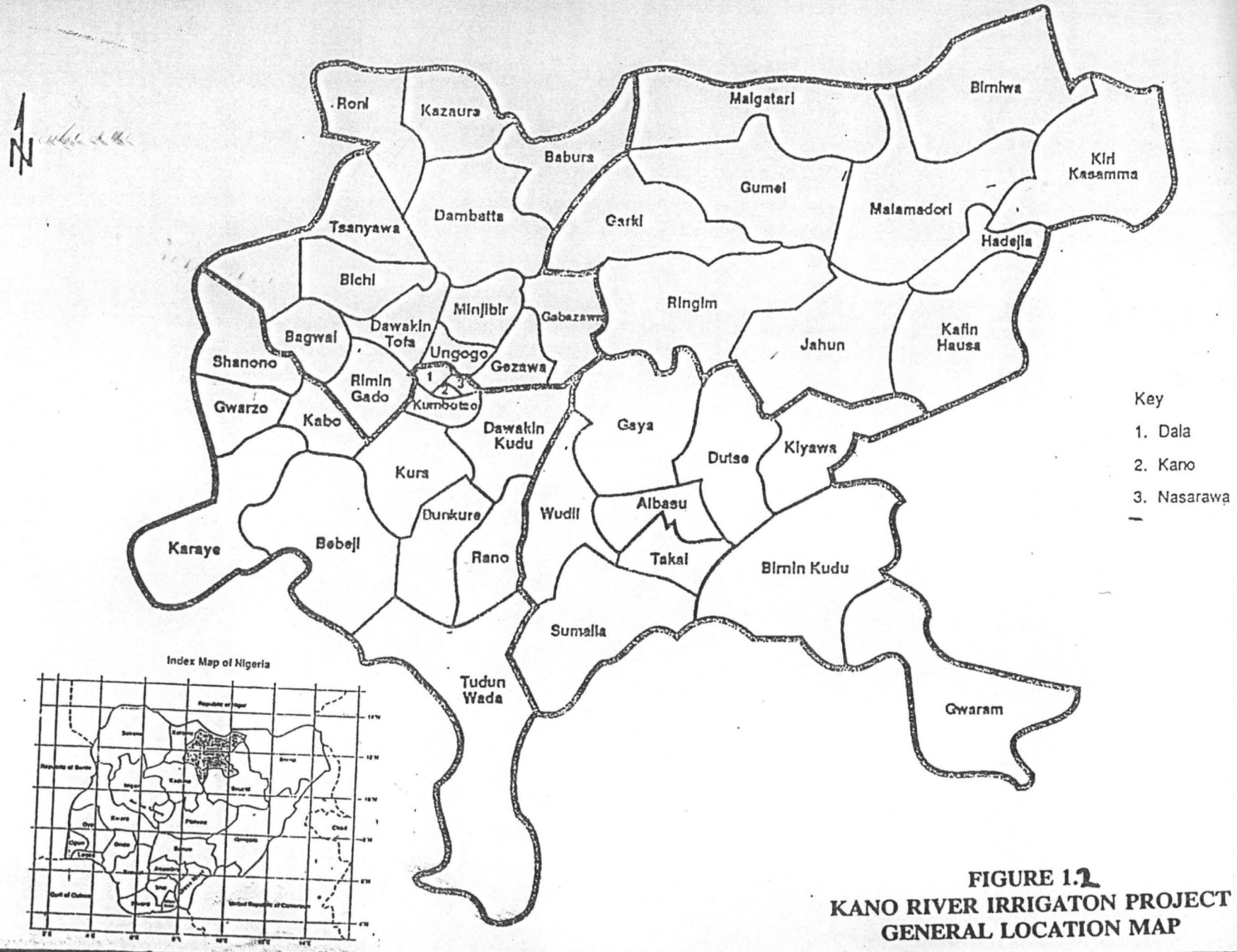


FIGURE 1.2
KANO RIVER IRRIGATON PROJECT
GENERAL LOCATION MAP

completed. It has a provision for Night Storage Reservoirs, located within the entire scheme at different point locations.

The project is located in Bebeji Tudun Wada, Bunkure, Kura and Rano LGA's of Kano State, with the project headquarters at Kura. KRPI lies between Latitudes 11'45 ' and 12' 05' north and longitudes 8"45' and 9'05' East. It is about 35km South-West of Kano City, on both side of Kano - Zaria express road. The elevation of the project area is about 440 metres above sea level, with the minimum storage level of Tiga Dam at 506.50 metres, which provides a perfect settings for a gravity system of irrigation. Studies on the project was commission in 1965 and the design and construction works for both the upstream and downstream irrigation components was completed in 1975. Below are some highlights on irrigation field and the Dam.

- Total irrigable area - 22,000ha
- Fully developed irrigable area - 15,000ha
- Length of main canal - 18 km
- Length of branch canal - 478km
- Length of Secondary canal - 320km
- Length of field canals - 1,120km
- Number of field structures - 16,000 nos

b) **FEATURES OF THE DAM**

- Type of Dam	-	Zoned Earth Fill
- Crest Length	-	6,000m
- Crest Elevation	-	530.96 Amsl
- Top Width (max)	-	7.62m
- Structural heights	-	48m
- Hydraulic height	-	42.68m
- Max base width	-	274.30m
- Total Storage Capacity	-	1,968 million m3
- Active storage capacity	-	1,845 million m3
- Surface area of reservoirs	-	18,900 ha
- Total volume of fill materials	-	9.18 million m3
- Spillway type	-	Free overflow concrete Ogee (4.57m)
- Emergency spillway width	-	200m

The Dam is equipped with three outlets as follows:

i. The main outlet is a 3.65 dia. Conduit supplying a 2.2 dia. Howell Burger regulating value.

ii. 2 Nos 90cm dia. Conduit with 60cm regulating value

iii. The main outlet, comprising of bulkhead gates, Butterfly value, etc. installed in the outlet chamber which is submerged 16m below the full supply level.

1.2.2 Climate

Generally, Kano region is being characterized by a climate which exhibits some definite Seasons. It is commonly noted with three principal seasons.

a. Hot dry season ranging from March - May,

- The occurrence of perched water - tables in some impervious subsoils
- High percolation losses resulting in a rise of the groundwater table.

1.2.7 Hydrology

Within the project catchment area there are two main reservoirs. Viz: Tiga Reservoir and the challawa Gorge Reservoir, with Kano river supplying Tiga Reservoir and river challawa supplying challawa reservoir, with both being supplemented by the flow from river Hadejia and Jama'are rivers.

1.2.8 Vegetation

The environmental assessment of habitats and changes in the terrestrial and aquatic ecology is well documented, in the sub-sahara belt of African, for the major dams eg volta, Kainji and others. Smaller dams (like Tiga Rapids Dam have however much less pre-construction records if any.

The natural vegetation of the area is typical of an open cultivated part land. Common tries are parkia clappertoniana, Buty rospermum peredocum, Acacia albida and vite doniana. Low shrubs are found in bad land areas, along water courses and natural drains. Dominant Shrub are Acacia seyal, Guira senegfalensis and piliostigma retinlata. The areas are commonly used as grazing land for local cattle.

The study area is situated in the Sudan Savannah Zone of West Africa. By cultivation, grazing, cutting and burning, man has strongly influenced the original natural vegetation of the area. The original savannah woodland has been - altered into a degraded savannah in which secondary species are

dominant. Only useful trees are left sanding or being planted. Very typical trees are the left standing or being planted. The average density of the trees is 2 - 3 tress/acre. This is an indication for scattered trees. In and near villages, Adansoniu digitata (Kuka) Phoenic nucifera ((Dabino) and Borassus athiropum (Giginya) are commonly found. Along the tracks, Acacia painata, Ziziphus spinachristi (Kurna), Pilirstigma reticulata (Kalgo) and Dichrostachus glomerata (Dumben) are found. Typical grasses are chloris pilosa (Kofar Takara), And ropogon and crypens species, imperata cylindrica (Tofa) often grow abundantly on soils which impeded drainage.

Generally, the vegetal cover is characterized by the open savannah woodland, low shrub land , and a low grass - scrubbed.

1.3 AIMS/OBJECTIVE OF THE STUDY

The overall objective of the study is to describe and assess the Economic and Environmental impact of (KPRI) - Kadawa irrigation project - in the

HJ - RBDA on the people of the area or the extent of probable impacts arising from activities associated with the operation of the irrigation component of the Dam in the project area visa - vis.

Within this wide aim, the specific objectives are:

(1) To determine the impact of water logging to the environment to the study area.
(2) To determine the presence of aquatic weeds in the study area
(3) To evaluate the rate of sedimentation in the reservoirs.

1.4 SCOPE AND LIMITATION OF THE STUDY

This project work is intended to study the Environmental impact of irrigation project on the Environment and to recommend some mitigation measures. The study is being Limited to those effects of, socio-economic and environment as outlined in the aims and objective of the study. However, other factors such as effects on Hydrology, Water quality, Health etc. that are also important couldn't be studied because of time factor. Therefore, those areas not to have been assessed, is kindly recommended for further studies by any student wishing to carry on in due corse.

1.5 JUSTIFICATION

It is a clear fact that, irrigated agriculture has played a positive role in the development and expansion of our agriculture system . By intensifying crop production on the land through irrigation, there is bound to be increased yield per unit area of land, thereby increasing the income per unit capita of the masses and invariably arresting rural urban migration. However, detrimental environmental impacts and health hazards have also been known to be associated with the operation of an irrigation scheme. The negative effects such as health hazards - Bilhazia, River blindness, malaria, Guinea worm etc are usually associated with improper irrigation practice; environmental hazards such as salinisation. Water logging, aquatic and agricultural weeds, pests, Sedimentation, etc, and social problem such as resettlement, charges in life-style and the change in economic status are also known to occur. Therefore, the need for the pre-and post - assessment of an environmental effects of an irrigation project becomes inevitable, likewise, the monitoring of those laudable developmental projects in order to determine its consequential effects on mankind and the environment in the spirit of sustainable development is desirous.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 ENVIRONMENTAL DEVELOPMENT AT THE GLOBAL LEVEL

The American development soon caught the attention of the rest of the world with the result that he UN Sponsored conference on the human environment in Stockton in 1972 led to the establishment of governing council for environmental programme known as United Nations Environmental Programme (UNEP). UNEP has a global jurisdiction with its headquarters in Nairobi, Kenya.

Since its inception in 1980, it has provided guidance on the environmental assessment of development proposals and supported research on environmental issues.

On the recognition of the need for an international synthesis of EIA methods and practices, the scientific committee on problems of the environment (SCOPE) organized a workshop on EIA at victoria Habour Canada, in Feb 1974 having co-sponsors as the Canadian National Committee on SCOPE, UNEP and UNESCO. Participants were drawn from many countries of the world and of various disciplines. The outcome of the workshop was the publications in 1975 of SCOPE **5: Environmental Impact Assessment, Principles and Procedures - Edited by R. E. Munn.**

In the same vein, the centre for Environmental Assessment and Management planning (CEMP) established in Aberdeen in 1972 has organized more than 15 annual international seminars on Environmental Assessment and Management

sponsored by WHO and UNDP. However, national responses to the concern about environmental impacts of development or the operation of EIA vary from country to country. In the U.K. for example, EIA procedures are not formalized in one legislation as in the USA and some other countries. Rather, the impact of the proposed development are considered under a wide range of procedures which can be categorized into planning and pollution controls. These are stimulating factors to the introduction of EIA globally.

2.2 NIGERIAN NATIONAL ENVIRONMENTAL DEVELOPMENT

In Nigeria, the new found awareness on environmental quality led to the establishment of the Federal Environmental Protection Agency (FEPA) in 1988, charged with the responsibility for the protection and development of the Nigerian environment including policy invitation in relation to environmental research and technology.

In 1989 FEPA's responsibilities were translated into the National Policy on Environment. As part of the implementation strategies, interim guidelines and standards for Environmental control in Nigeria were fashioned out in 1991 (FEPA 1991). In 1992, The EIA Decree No.86 was promulgated solely to give a legal muscle for the enforcement of the various policy provisions on the need for studies in the environmental impact of both public and private sector project as projects are being planned.

The Environmental Impact Assesment as a management tool is designed to aid officials, managers and policy makers who take decisions about major development projects in predicting the environmental consequences of such projects before their implementation and planning measures for

avoiding or mitigating adverse environmental impact.

An Environmental Impact Assesm, therefore focuses on the problems, conflicts, natural resources constraints, affluent discharge etc. that can affect the viability of project. The overall aim is to improve the suitability of the project within its proposed environment and lead to a more efficient use of resources than if remedial measures were to be introduced in an already impacted environment. Basically, the main objectives of an EIA are as follows:-

- *To predict the nature and magnitude of the proposed action and its effects.*
- *To identify and assess the physical, biological, socio-economical and cultural effects in a form that permits a logical and rational decision to be made.*
- *To document the indicators to be used in assessing the impact To help in the identification of possible alternative sites and/or process.*
- *To give confidence to the planning system by providing for public participation and/or consultation processes.*
- *To ensure that the project proponent, the government and its agencies are required by law to approve the undertaking, give due consideration to the means of avoiding or mitigating any adverse environmental effect prior to the granting of any approval.*

However, with the continuous increase in awareness on environmental related issues. The Obansanjo led PDP government found it necessary to establish a full pledge ministry of environment in the year 2000, which see's FEPA and other related Agencies being transformed into the new Ministry.

2.3 ENVIRONMENTAL IMPACT OF IRRIGATION

Water is probably the most important factor limiting agricultural production in most agro-ecological zones of Nigeria, especially the arid and semi-arid zones. Research has shown that substantial increase in agricultural production in these zones must involve the removal of rainfall uncertainties by the provision of irrigation water for supplementary irrigation during the rainy season and full irrigation during the dry season.

Large-scale irrigation in Nigeria significantly started in the early 1970's. These was a response to the 1972-73 Sudan-Sahelian drought. The Gross Domestic product (GDP) fall by 18.4% in 1971-72 (Kolawole, 1990). The fall in the GDP was accompanied by a rapid rise in price index of food stuffs.

While the drought provided the physical justification, availability of funds from the high oil prices of the time provided the financial capability to embark on the construction of large scale irrigation projects.

Environmental impact data on Nigerian Irrigation projects does not exist in any concise manner. This is mainly because environmental impact assessment prior to a project, which should give a baseline data, and subsequent monitoring to assess changes in relevant environmental variables are not done. However, there are few attempts to measure or document some aspects of the impacts of irrigation projects.

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2.3.1 WATER USES PROBLEMS

The acrerage of land under irrigation is increasing daily. Irrigation has serious implications on the environment. According to Golubev (1983), wide development of irrigation causes appreciativ changes in hydrological regime and runoff. These problems comprises of the consumptive use and also problems on the watershed. Irrigation for example, leads to replacement of phreatophytes with planted vegetation. This result into evapotranspiration problems. Furthermore, irrigation allows shallow water in area of lower reaches of rivers to disappear; and in instances where rivers are form on mountains and end on plans, newly built drainage systems contribute to more rapid drainage of groundwater and reduction of evapotranspiration from the soil surface. Irrigation can also lead to reduction in River run off due to abstraction.

While large scale irrigation projects have the potentials, if well managed of enhancing agricultural productivity, thereby providing food security and raising the economic base of poor farmers, secondary environmental effects do arise. This is because surface water in form of large dams and irrigation distributaries canals are used. The dam create artificially large bodies of water which cause significantly changes on the surrounding ecosystem. Wetting and drying regimes of soils in the dawn-stream irrigated areas are changed with possible creation of water-logged and saline conditions.

Further more, several studies have identified the actual and potential environmental impacts of irrigation development in Nigeria: to

includes loss of economic production in the downstream, loss of independence on the part of the farmer and also that of overcropping. Others includes poor resettlement schemes, and problems of strained farmer and irrigation scheme management relationship (see: Nwa 1982, Imevbore 1990, Olu 1991 among others).

To support that a study of Bakolori irrigation scheme (Olu et al 1998), observed that many ecological problems accompanied irrigation schemes. Eg. Diseases (river blindness, malaria, schistosomiasis, diarrhoea, dysentery, skin diseases etc), rising water table and water logging, salinity and alkalinity, problems of weeds, flooding and erosion, land fragmentation and social problem such as dislocation of economic and social life, loss of economic independence, frustration and despairs and cases of death.

2.3.2 EROSION AND SEDIMENTATION PROBLEM

Utilization of water resources has in one way or the other affected rates of erosion and sedimentation. Erosion and sedimentation are mainly caused by changes in land use. About 11% of the total land area an earth is under cultivation. Also bout 790% of some large basins are put under cultivation [Jimoh et al, 2000].

A study by Golubev (1983) indicates that soil erosion in the world has increased 5.6 times compared with rate of erosion in pre-agricultural times, and this ratio may exceed 10 times in the near further due to land development in tropical and subtropical zones.

Erosion and sedimentation problems have created several problems such as early silting up of reservoirs, low water transparency in reservoirs, which affect fish population. Sedimentation and erosion also increases water treatment cost

reduces navigability, increases flooding and blockage of irrigation canals. These problems have been reported along Rivers, Niger and Benue (National Environmental Study Team -NEST- 1991).

2.3.3 WATER AND BIOGEO- CHEMICALS PROBLEMS

Irrigation has been reported to be a very important factor in the determination of chemical composition and regime of inland waters, especially movement of salt, this is common especially in large-scale irrigation project (Jimoh et al 2000). A study from the Arabian basin, indicates that irrigation areas has increased from the traditional $2x10^6$ ha to appx. $4.5x10^6$ ha and this has led to simultaneous increase in salinity of the river waters from 0.35 to 0.98 9/1 (Rubinov et. al, 1976).

Further more, a study by united nations environmental programme (UNEP), has confirm that about 100 tonnes of phosphates, 60,000 of detergents gets into the Mediterranean sea as a result of human activities such as irrigation agriculture along the water shed and the use of water for refuse disposal.

Basically, consumption of different chemicals in drinking water has resulted in different diseases including hormonal diseases. For example there is increasing body of evidence to support the fact that certain synthetic chemicals when taken into the body causes imitation and blocking of Hornan in man, DDT has been found to disrupt endocrine systems, excess of calcium and magnesium leads to cardiovascular diseases (Roberts 1975). High concentration of sodium lead to soil alkalinity resulting to poor plant growth (Hem, 1982) high dictionary intake of sodium leads to a high risk of being hypertensive (WHO 1978) etc. While total solid disturbs fish foods (pojaske, 1977)

CHAPTER THREE

3.1 METHODOLOGY (DATA COLLECTION)

3.2 Reconnaissance Surveys.

The reconnaissance survey of the area was carried out by an initial visit to the study area and its surrounding environment. This was made possible through the assistance of mallam Abdulkadir Yammawa an extension officer of the project. In order to obtain a preliminary evaluation of the major aspects of the project and to establish strategies for further data collection and investigation. The dam area, the downstream irrigated area and downstream non-irrigated areas were visited. Also, carried out was the survey of all the important irrigation components (canals, reservoirs, etc.) Few snab shots were taken and some quantification also carried out.

3.3 Administration of Questionnaires

About a hundred (100) questionnaires were distributed first to the project manger, some village heads within the project study areas and some household head participating farmers within Kadawa areas and its environ. Among which sixty-five (65) responded. And fifty (50) out of the one that responded contained detailed responses which were analyzed. Among these, eighty percent (80%) reported negative effects on the general aspects of water logging, siltation, weeds, salinisation diseases just to mention but a few (see appendix on questionnaires for some certain aspects). Questions were based on the objective of the study.

3.4 Personal Interview

Personal interviews were conducted with some key principal offices at the administrative headquarters (AHQ) of the Hadejia - Jama'are River Basin Development Authority (HJ-RBDA), some participating farmers within the scheme and marketers for an in-dept extraction of information of the study area. Data's were also collected from some relevant agencies and the

H J -RBDA library.

3.5 Data Analysis

The data for this study was analysed using the following methods.

Informations/ extracted data were tabulated and discussed. This was done for various points/ stages of study.

Most of the quesnnaires were analysed using percentages, graph e.t.c.

Photographs wre also used to serve as ground truthing.

CHAPTER FOUR

4.1 RESULT DISCUSSION/ANALYSES

4.1.0 Socio Economic Impact

The operation of these irrigation scheme has attracted many people of different cultural background to settle. The dominant ethnic group are the Hausa's as the major tribe, and followed by the fulani's. The general population (60%) are actively involved in agriculture as their Primary occupation, and also has about 30% involved in animal husbandry, with the remaining 10% being involved in fishing and petty trading. There is little or no significant changes in the people's way of life. Because, they are dominantly of the same religious faith (Islam). Hence, their cultural background still remain the same that of a typical Hausa - Fulani Community.

However, because of the existence of the irrigation project . There has been some steady inflow/outflow of families. Reasons being either in search of knowledge (Koranic study), farming, personal reasons or as a result of displacement by the project siting. It is worthy to mention that not all the migrant are Muslim, some certain few percent are Christians. The inflow of the migrants has considerably boasted trade and commerce in the environment, more especially with the newly construction of a daily market for the farm produce by the Garunmallam LGA.

Furthermore, the predominant occupation within the study area (irrigated agriculture) has positively impacted the life of the people. Through

irrigated agriculture, the people were able to produce crops throughout the year. As a result their economic well-being has been enhanced (see table 4.1 a – k attached). Some were also to afford bicycles, motorcycle, building of roof zinc house and a lot of them goes for a second wife with plenty children and dependant.

Educationally, the people did not go to school. Though there are some in existence in the study area primary/ secondary schools but only few of the children attend. Being a Muslim society about 85 %, of them are Koranic litrate. Much has been achieved in the health sector. Because there exist a general hospital, dispensary/maternity, serving the needs of the people in the study area.

In the area of employment, a lot of the youth and the adult group engage in various agricultural activities, these are the gains of having the project sited there.

Also, there were little or no problem experienced in the area of resettlement and land reallocation. Since every body got almost what he has before development of the project. However some of the farmers lost some of their land during construction of either road, irrigation water ways, or reservoirs. The land tenure system remains that of inheritance, land transfer (purchase, rent or pledges etc). Thereby leading to fragmented holdings. The relationship between the nomadic cattle Fulani's and the farmers are cordial. The major crops being produced are: Tomatoes, Onion, maize, cowpeas, pepper, wheat, rice, water-melon etc. (See table 4.1).

IMPACT OF THE PROJECT ON AGRCULTURAL DEVELOPMENT

Table 4.1 (a)

S/N	CROP	YEILD/HA.	RETURN/HA. (₦)
1	Rice	3.5mt	61,425.00
2	Maize	2.3mt	42,458.00
3	Sorghum	3.0mt	41,925.00
4	Vegetables	5.0mt	41,250.00

Source: H – JRBDA (1999)

1996 Dry Season [Table 4.1b]

S/N	CROP	YIELD/HA.	RETURN/HA. (#)
1	Wheat	2.5mt	78,000.00
2	Tomatoes and Other Vegs.	6.0mt	49,500.00
3	Maize	2.5	47,125.00

1997 Wet Season [Table 4.1c]

S/N	CROP	YIELD/HA.	RETURN/HA (#)
1	Rice	3.50mt.	63,000.00
2	Maize	2.20mt	35,750.00
3	Vegetables	5.00mt	41,250.00
4	Sorghum	3.00mt	42,900.00

1997 Dry Season [Table 4.1d]

S/N	CROP	YIELD/HA.	RETURN/HA (#)
1	Wheat	2.5mt	81,250.00
2	Tomatoes & other Vegs.	6.00mt	49,800.00
3	Maize	2.5mt	47,125.00

1998 Wet Season [Table 4.1e]

S/N	CROP	YIELD/HA.	RETURN/HA (#)
1	Rice	3.50mt	63,700.00
2	Maize	2.20mt	40,040.00
3	Vegetables	5.00mt	41,250.00
4	Sorghum	3.00mt	40,950.00

Source: H-JRBDA (1999)

1998 Dry Season [Table 4.1f]

S/N	CROP	YIELD/HA.	RETURN/HA (#)
1	Wheat	2.50mt	81,250.00
2	Tomato & Other Vegetables	6.00	49,500.00
3	Maize	2.50	45,500.00

REVENUE ACCRUED TO FARMERS IN THE PROJECT AREA

In addition to tables above for returns on investment per hectare, the farmers in the project derived revenues over the years as in the following:-

1996 DRY SEASON [Table 4.1g]

S/N	CROP	AREA CULTIVATED (HA)	TOTAL YIELD (MT)	TOTAL REVENUE (#)
1	Wheat	2,771.77	6,929.43	180,165,145.50
2	Vegetables	2,553.47	42,132.26	105,330,650.00
3	Maize	5,803.32	14,508.32	21,762,450.00
4	Others	969.68	8,262.00	10,956,937.46
Totals		12,098.24	71,831.99	318,215,182.96

Source: H-IRSAA [1999].

1997 Wet Season [Table 4.1h]

S/N	CROP	AREA CULTIVATED (HA)	TOTAL YIELD (MT)	TOTAL REVENUE (#)
1	Rice	6,750.00	23,625.00	429,975,000.00
2	Maize	2,350.00	5,170.00	94,094,000.00
3	Vegetables	1,384.00	22,144.00	55,360,000.00
4	Sorghum	967.00	2,127.40	30,421,820.00
	Totals	11,451,00	53,066.40	? 609,850.00

1997 Dry season [Table 4.1i]

S/N	CROP	AREA CULTIVATED (HA)	TOTAL YIELD (MT)	TOTAL REVENUE (#)
1	Wheat	2,375.00	5,225.00	169,812,500.00
2	Vegetables	3,015.00	48,240.00	120,600,000.00
3	Maize	3,250.00	8,125.00	147,875,000.00
4	Others	755.00	1,661.00	23,752,300.00
	Totals	9,395.00	63,251.00	462,039,800.00

1998 Wet Season [Table 4.1j]

S/N	CROP	AREA CULTIVATED (HA)	TOTAL YIELD (MT)	TOTAL REVENUE (#)
1	Rice	4,787.00	16,754.50	283,151.050.00
2	Maize	2,916.00	7,290.00	87,480,000.00
3	Vegetables	2,005.00	33,082.50	82,706,250.00
4	Sorghum	960.00	2,112.00	28,828,800.00
	Totals	10,668.00	59,239.00	482,161,100.00

1998 Dry Season [Table 4.1 K]

S/N	CROP	AREA CULTIVATED (HA)	TOTAL YIELD (MT)	TOTAL REVENUE (#)
1	Wheat	1,521.00	36,504.00	132,874,560.00
2	Vegetables	2,150.00	34,400.00	86,000,000.00
3	Maize	4,435.00	11,087.50	172,965,000.00
4	Others	536.00	1,125.60	15,364,440.00
	Totals	8,642.00	83,117.10	407,204,000.00

Source: H-IRSAA [1999].

* From the above tables, the benefit-cost ratio of this project becomes very obvious, and assuming the life span of the project is 50 years, the investment made on it will pay itself many times over.

4.1.1 Aquatic/Agricultural Weeds Impact

Aquatic/Agricultural weeds growth was general visible throughout the entire scheme , thereby creating a lot of hydrological and biological problems. Water hyacinth and Salvina which are one of the world most worst aquatic weeds is very much noticeable. These floating, emerging or submerged aquatic weeds are capable of disrupting the proper function of an irrigation project by obstructing waterflow and affects the growth of crops like rice which are aquatic in nature.

These therefore calls for having a good knowledge of the aquatic flora before, during and after the implementation of an irrigation project for proper management.

Further, it was observed that, the rate at which the main canal was infested with weed is minimal. This was as a result of its concrete lining, giving rise to high velocity of flow preventing sedimentation and any possible plant settlement. But along the line, there are some part of the main canal that are not lined. They have their banks being eroded, faulting to sedimentation downstream, leading to the establishment of dense stand of aquatic weed (Typha qustralis) blocking the proper flow of water. While, the situation in the main canal is not so serious, but that of the field canals is terribly bad. The flow in the field canals is relatively very slow. This results into in increase silt deposition. The blocking of the canals causes water to spill over unwanted areas thereby causing the water table in some certain areas to be high, and this result into water logging and low crop yield.

The situation in the various night reservoirs visited shows that, a continuous siltation provides, a conducive environment for these weeds to strive . And this varies from one reservoir to the other and this is due to the location of the inlet canal. See fig.....for the various level of infestation of weeds on the entire scheme. The effects or impact of these weeds on the project, has been the reduced hydraulic efficiency of the canals.

At various levels, the reduction in storage capacity of the reservoirs is between 50% to 60% causing poor water delivery at the rear end of the project. This affect the production rate of the farmers and equally enhanc the breeding of various vector carrier diseases (Malaria, Guinea worm, Schistosomiasis, etc). This also, causes over bank spillage of water leading to erosion and sedimentation, and in some certain areas water logging increases soil alkalinity leading to total destruction of some viable agricultural lands.

4.3.0 Sediments/Waterlogging /salinisation Impacts

It was observed that, the canal lining gives a satisfactory condition against sedimentation and erosion. Though between concrete slaps joint weeds were noticed, this cause some of the concrete slabs being removed. Hence, exposing the canal wall to erosion (See fig. a – c). There were a lot of silt deposition being observed in both the distributary canals and the night storage reservoirs. These effects can easily be observed in the West Branch Canal near Garun Baba regular, the Ruwan Kanya night storage reservoir just to mention a few. This situation has lead to serious reduction in the conveyance/storage capacity of the system respectively. And also serving as a base for vegetation growth. Furthermore, there was a sign of unquantifiable waterlogged area, rendering several hundred hectres of land

unproductive (See ~~fig~~ Plate 4.4). Generally, waterlogging might be caused by high rainfall intensity and distribution. However, another major factor is that of poor irrigation practices i.e such as excessive releases of irrigation water beyond the crop water requirement. and that of seepages from the wall of canals. These were believed to have been attributed to the cropping of pady rice which requires permanent wetting for most parts of its growth and developmental stages. This encourage over growth of weeds in the conveyance system, thereby stagnating water and sometimes, arises as a result of spilage/seepages from the canals. The other negative aspect of water logging is that of health hazards. The waterlogged areas has became a very conducive environment for breeding of mosquitoes, snails etc. which are good carriers of malaria/schistosomiasis parasites respectively.

Another consequential effect of high water table is salinity of soil which is due to the lack of leaching of the soil profile. It was observed that, there were some crop failure in the West Command area of the project, and this has rendered a lot of land baren. See table 5.1.....for the summary of salt affected areas in hactres, which was a survey conducted by the Authority in collaboration AERIAL /ABU Zaria in 1999. The rate of salinisation has continue to be on the increase, which is a warning signal to the effects of high water table to the soil of the project area, which major contributing factor is that of the high level cultivation of paddy rice and some of the poor drainage system of the soil.

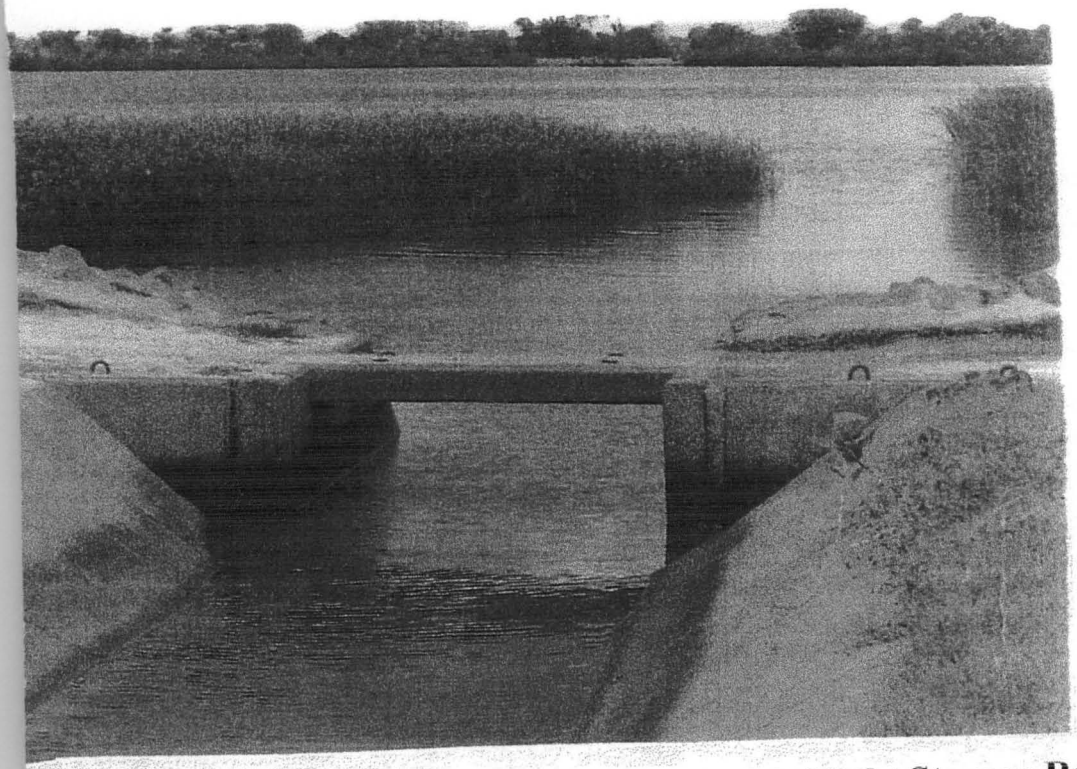
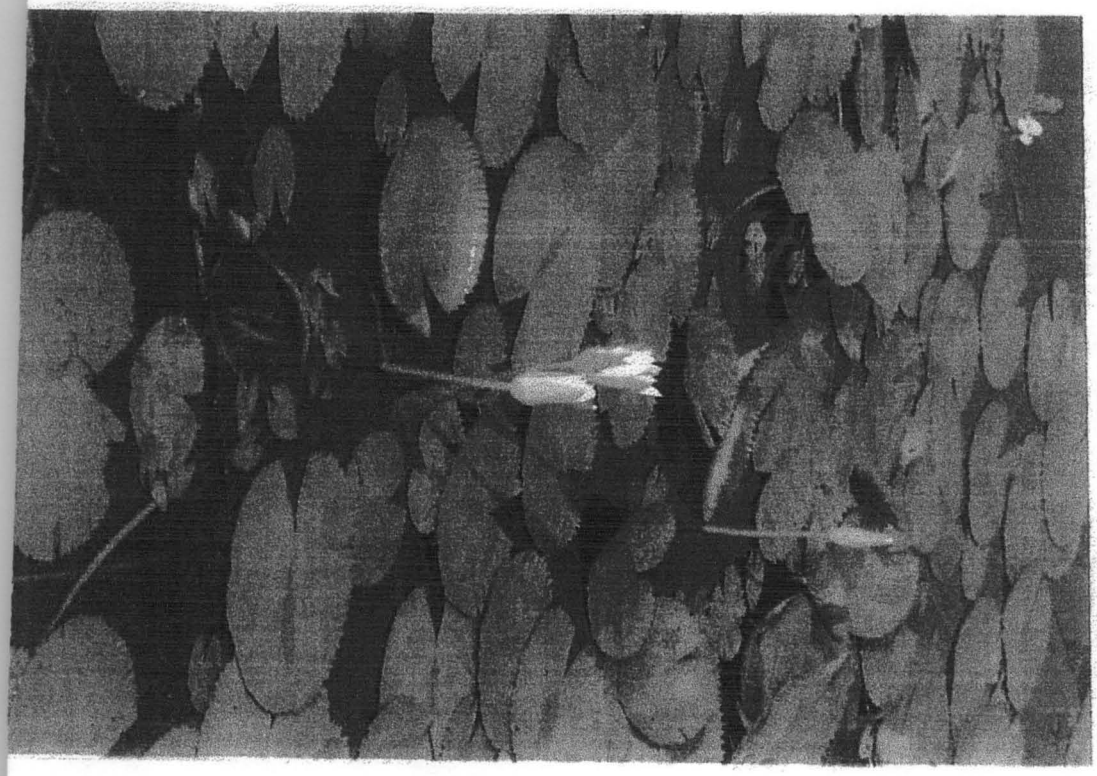


Plate 4.1a: Aquatic weeds in the Ruwan Kanya Night Storage Reservoir

Plate 4.1b: Several Hacters of Land infested with Agricultural weeds

Plate 4.2 (a & b): Shows Water ~~items~~ Letus in Storage Reservoir and water Hyacinth in canals

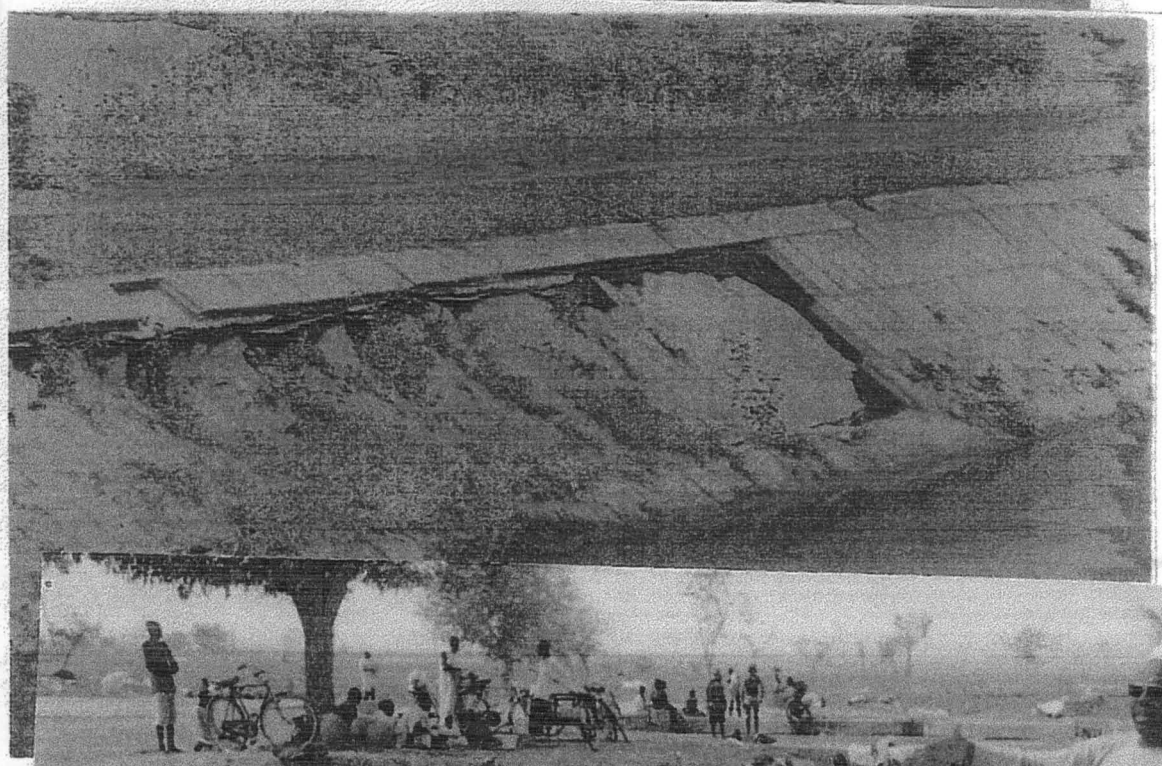


(a)

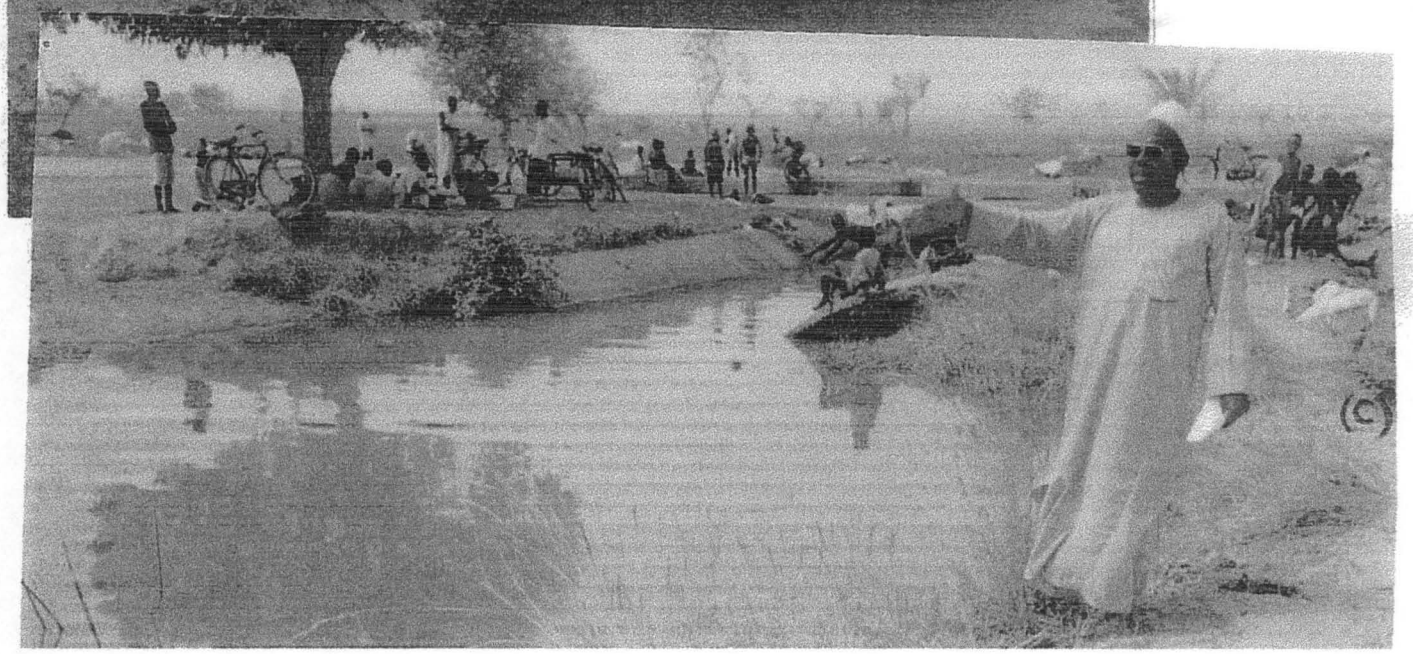
(b)

Plate 4.1 (a – c): Showing weeds effect in the Conveyance systems causing erosion and siltation at the downstream

(a)



(b)



(c)

Plate 4.4 (a): Hundred hactres being waterlogged; Note the milky part of the plate

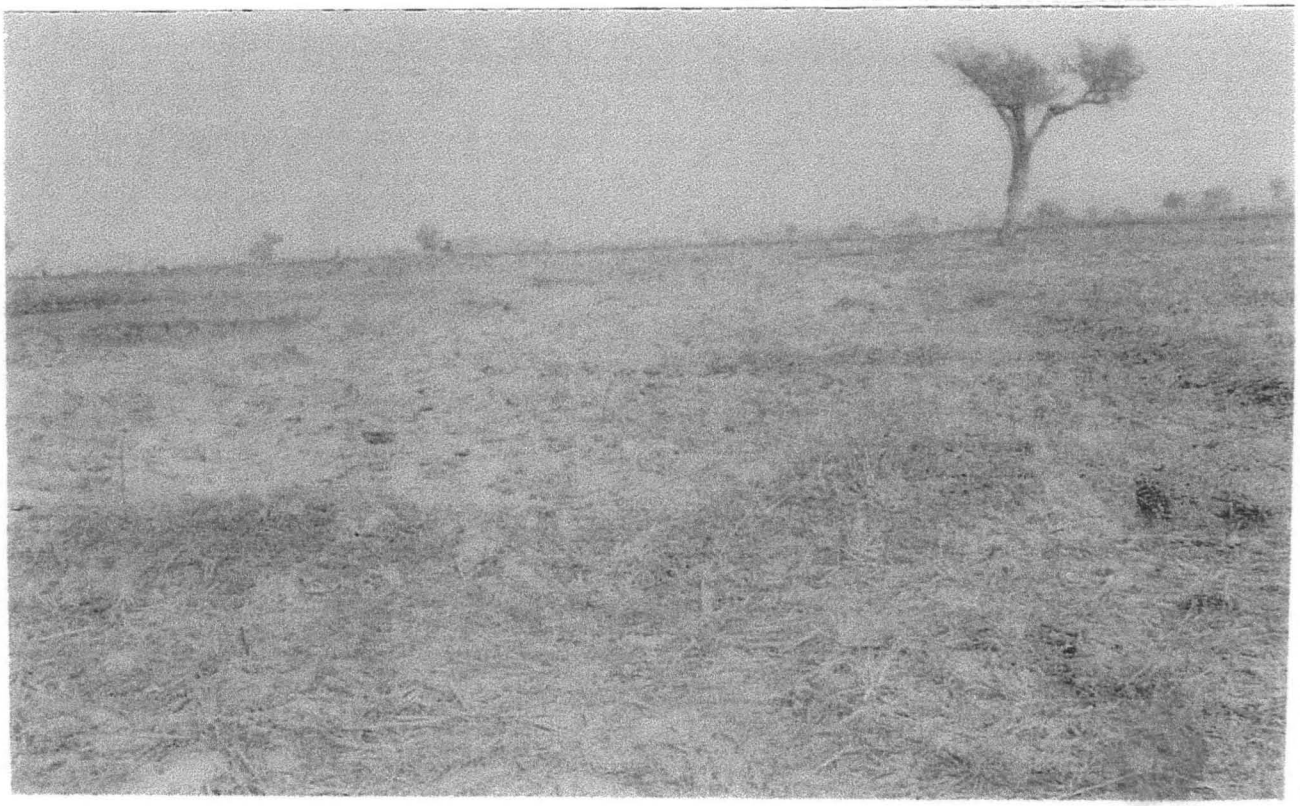


Plate 4. 5 (b): Several hactres Land rendered unproductive due to adverse effect of salinisation.

5.1: SUMMARY OF THE SALT AFFECTED AREA IN Ha

S/N	SECTORS	HECTRAGES
1	Gafan I	1.80
2	Gafan II and Makuntir	18.00
3	Kore I	63.54
4	Mudawa	13.67
5	Agolas I	20.90
6	Agolas II	20.23
7	Agolas III	5.40
8	Agolas IV	0.84
9	Agolas V	0.22
10	Majabo	3.60
11	Kosawa	19.70
12	Dalili	2.75
13	Butakwo	0.86
14	Karfi	7.18
15	Farm centre	51.08
16	Danmaura	15.00
17	Samawa	12.40
18	Makwaro	13.26
19	Azore	3.92
20	Rakauna	1.20
21	Agalawa	12.00
22	Yadakwari	5.36
23	Raje	8.86
	Grand Total	**310.77**

Source: H-JRBDA 1999

CHAPTER FIVE

5.1 General Observation

During the project study, a lot of observations have been made. However, those that were considered are based on the objectives of the study. Therefore, the following were some of the most important observation made:

- Collapse of canals lining
- High infestation of canals/Reservoirs by aquatic weeds
- High level of siltation within the storage and conveyance system.
- Poor soil drainage leading to the problems of waterlogging
- High water table, which secondary effect is soil salinisation.

Generally, the blocking of canals by silt and weeds has resulted into the low velocity flow of water in the conveyance system affecting the irrigation effinciency and irrigation time schedule. Also the poor state of maintenance of the schemes which was attributed to lack of adequate funds, as seriously affected the performance of the irrigation project . This is noticeable in the total reduction for the land area being put under cultivation for the year 2001 dry season farming. Infact out of the 22,000 ha developed area of the KRPI, not more than 5,000ha - 8,000ha has been cultivated. Simply because, farmers that are far away from the main branch canals finds water very difficult reaching their farms, as a result of poor state of irrigation facilities.

Although, health hazard were not included in the study. But being one of the important issues in an irrigation set-up. It is important to mention that, the provision of adequate sanitation facilities within the scheme will go a long way in reducing some of the health hazards, such as water borne

diseases (malaria, schistosomiasis, Dracunculiasis etc.) Because it is observed that, there was no alternative source of good water for bathing, washing and drinking. Children and adult were seen washing and bathing in the canals. (Plate 5.1a&b) Also, people defecate along the canals due to lack of toilet facilities.

The area, formerly semi-arid and drought prone, is now a region where climatic risk has been reduced, living standards, improved and food production being assured without apparent adverse effect on the environment.

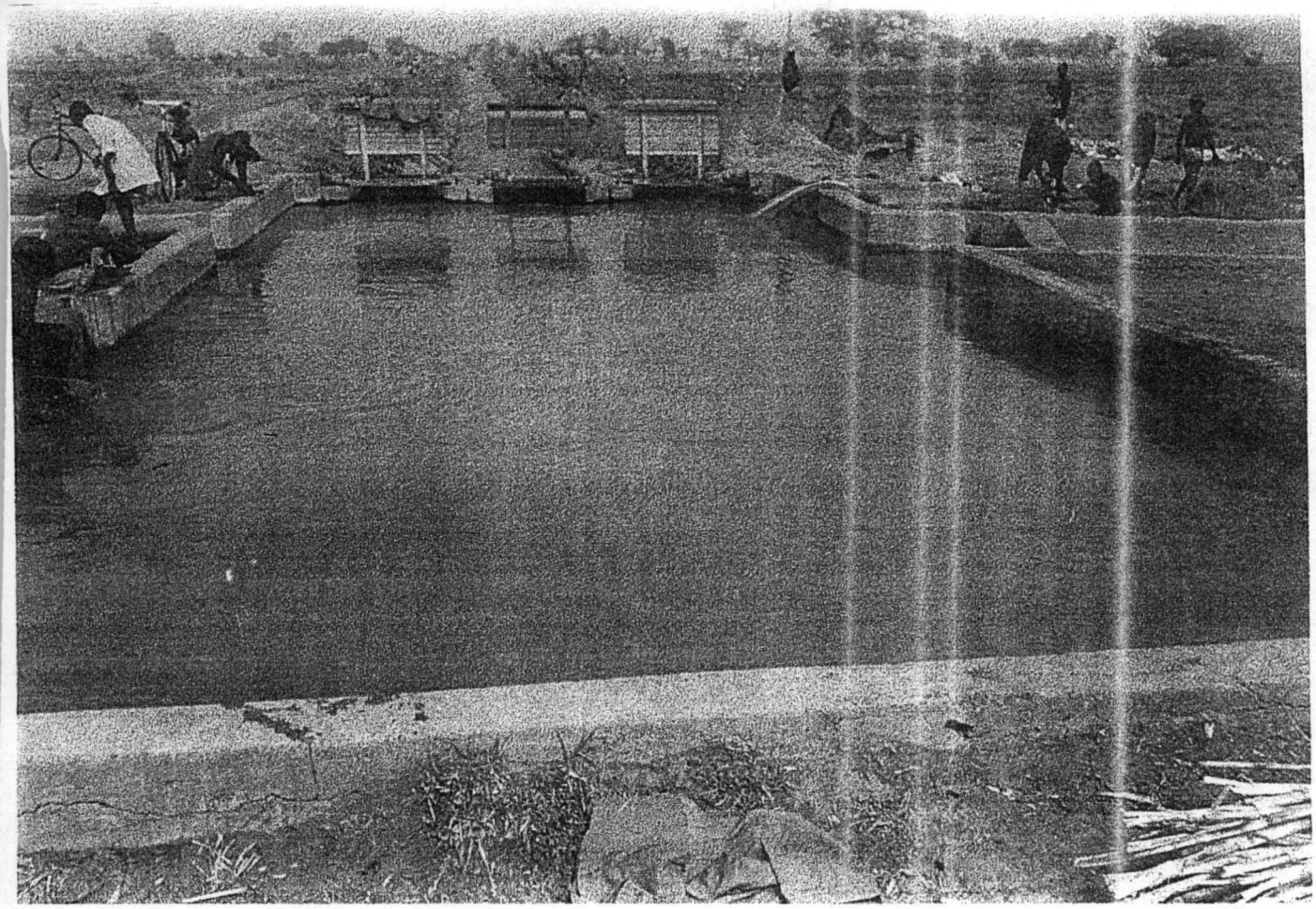


Plate 5.1 (a)

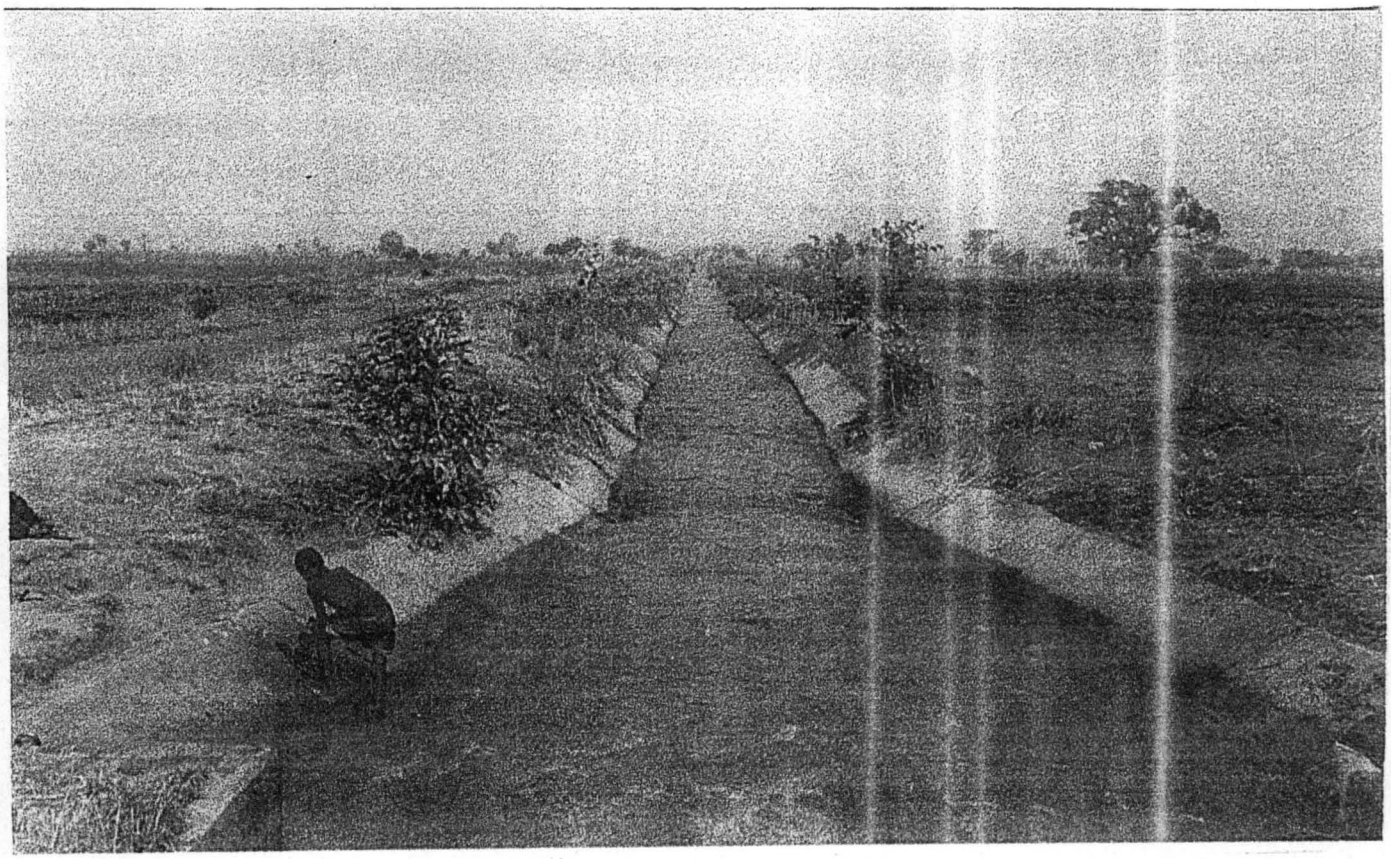


Plate 5.1 (a & b): Shows the poor stage of health and Sanitation of the project

Plate 5.2 (a – c): The view of Tiga Dam

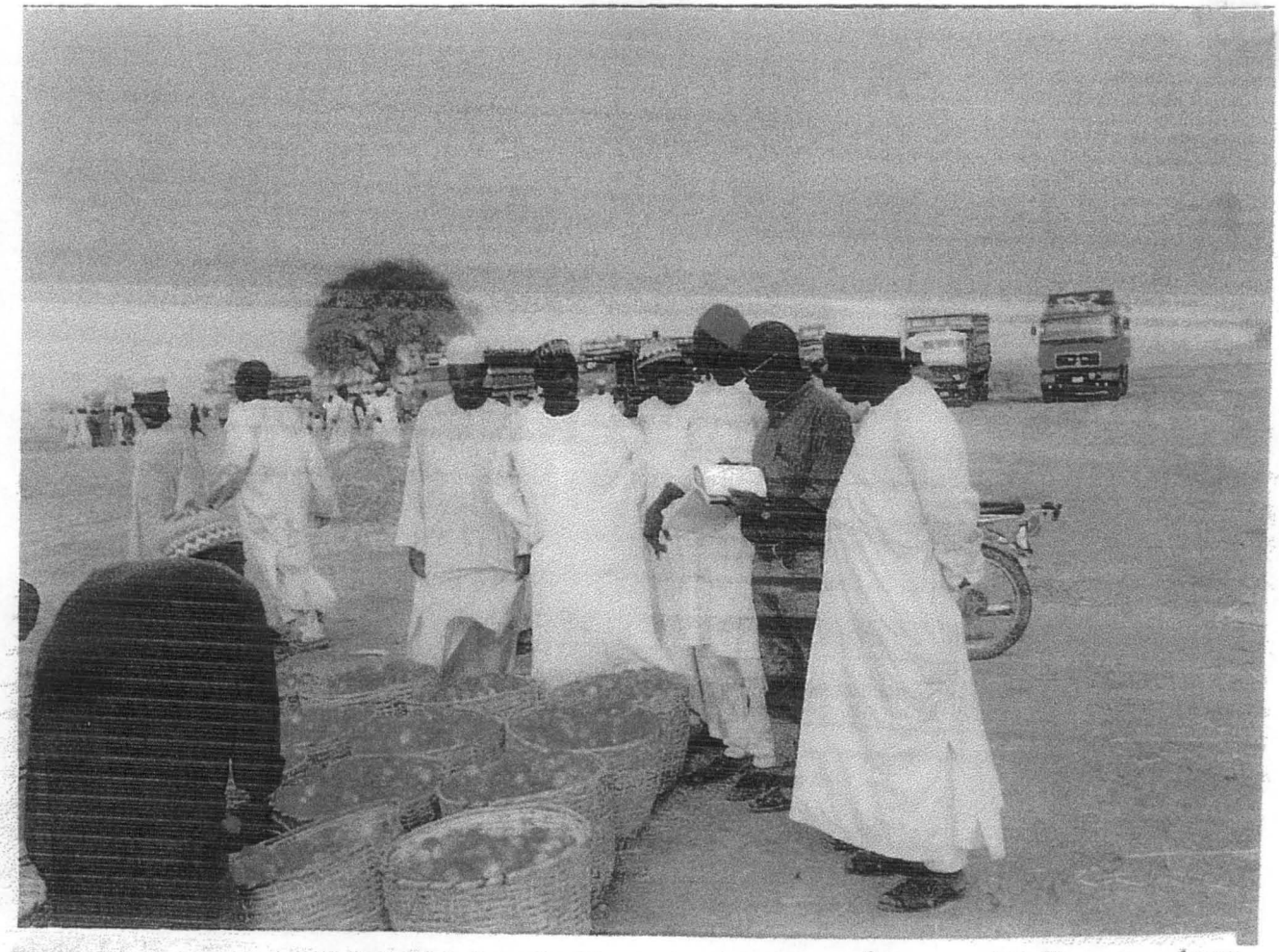


Plate 5.3: The researcher interviewing marketers at Garun – Mallam modern Market

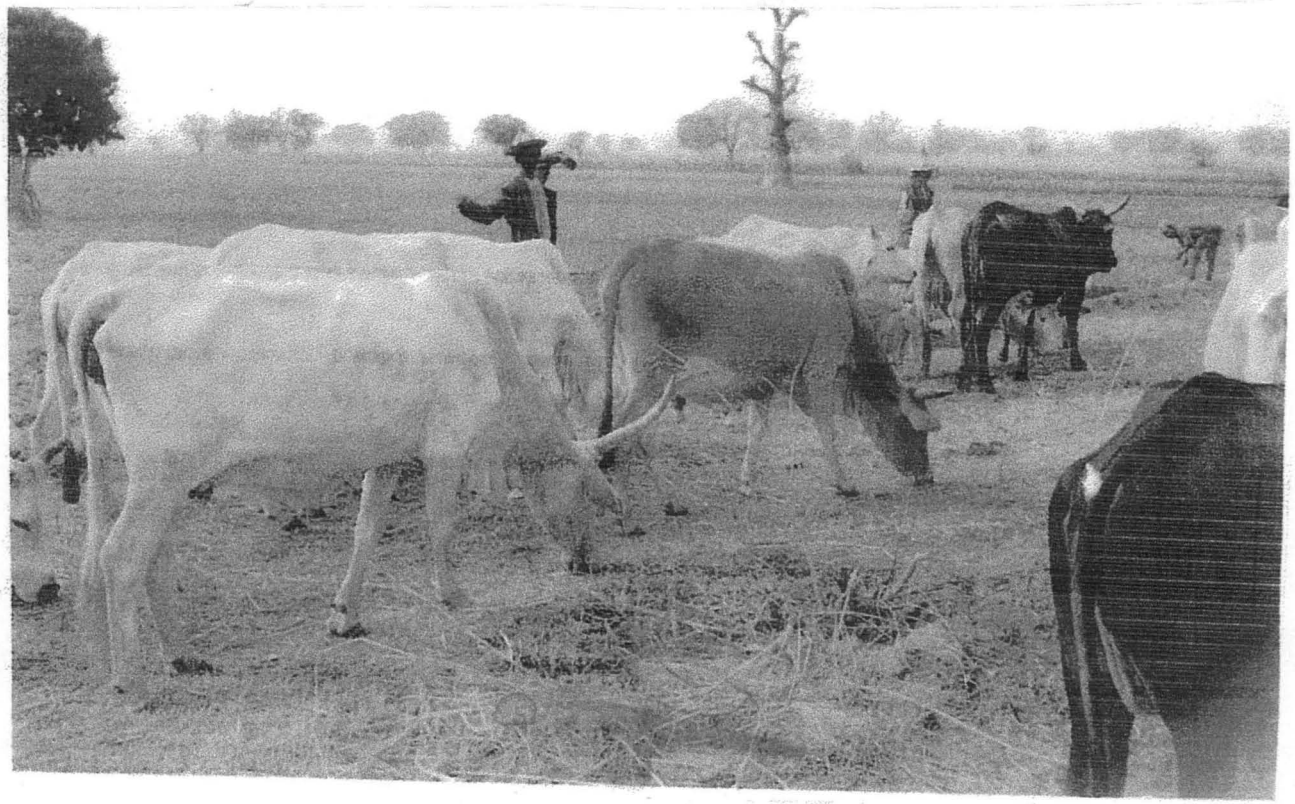
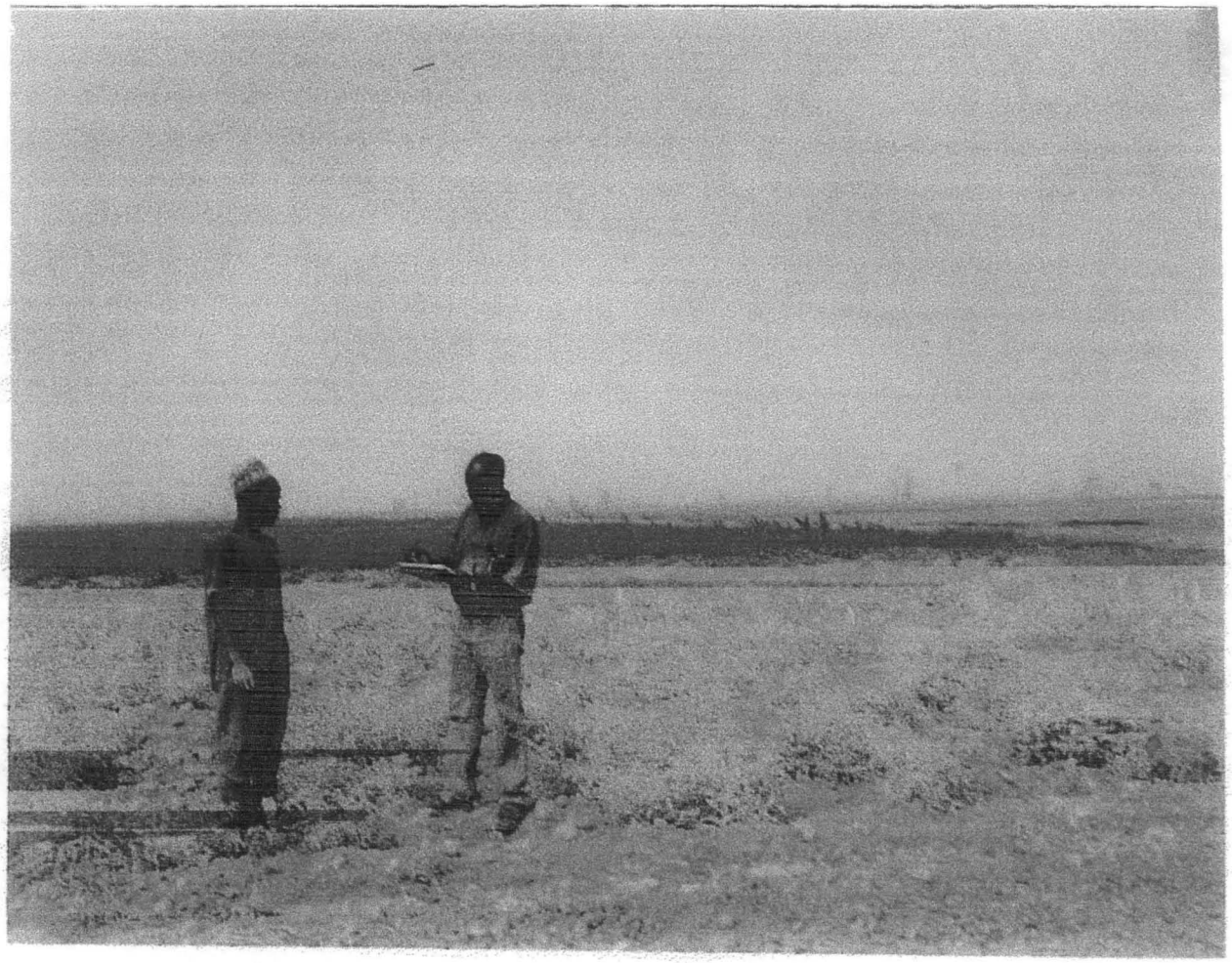


Plate 5.4: Fulani cattle herdsman within the irrigation project.



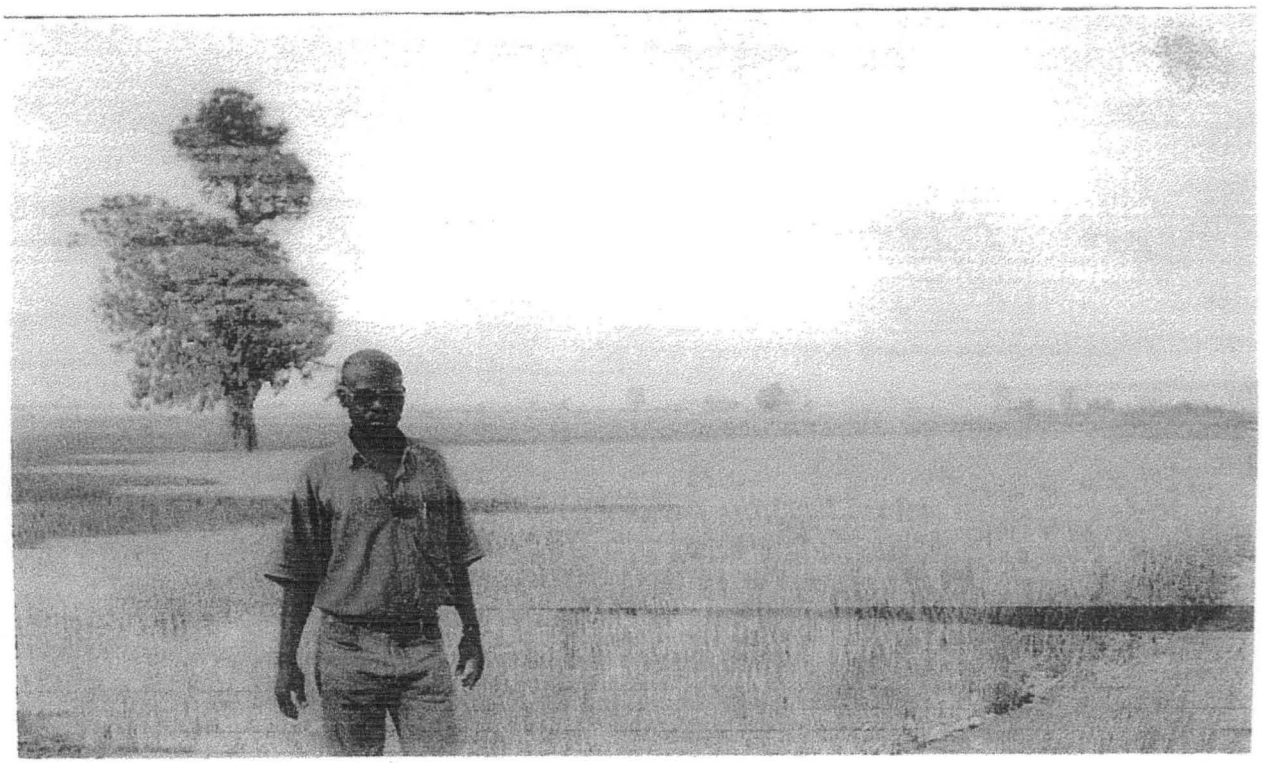


Plate 5.5:

The researcher interviewing a farmer in tomatoe farm.

CHAPTER SIX

6.1 RECOMMENDATION AND CONCLUSION

6.1.0 Recommendation

For the attainment of increased Agricultural output through irrigation for a sustainable development. The following recommendations were therefore strongly recommend.

* The provision of more adequate funds for the maintenance of he entire scheme should be made. These funds if made available will solve the problems of lining of the canals, thereby reducing the probability of the canals wall collapse leading to the establishment of vegetation within the storage/conveyance system, silting prevention and the improvement of the field drains.

* A proper and comprehensive soil fertility and ground water survey has to be conducted. This is to ascertain the extent of water logging and salinisation and adopt the following preventive and remedial measures where applicable:

i. Proper maintenance of the irrigation and entire drainage system.

ii. Appropriate cropping pattern to be adopted (discourage the cultivation of paddy rice on clayed soil and soil with imperfect drainage during the dry season). This is because, continues application of water to these soils (during dry and wet season) will cause water logging due to its poor nature of drainage system.

iii. Improved water management system.

iv. Piezometers, forming part of the ground water monitoring system should be used so that engineering solutions can be timely implemented.

* A well design and improved method of weed control has to be implemented. This can be achieved by:

i. Evaluating all the methods of weed control programme to select the best to be adopted for the environment. These methods ranges from mechanical, biological, chemical etc.

ii. Apply crop rotation system as a easier weed control method

iii. The continuos monitoring of the weeds presence, distribution, biology and ecology in the field and their immediate environment.

iv. Creating awareness in the farmers for the dangers of having settled free floating weeds in the irrigation components (canal waterways, storage resevoir and the artificial lake).

* The lack of obvious signs of serious diseases of human and animals within the project study area shouldn't call for a relax or "I don't care attitude of the government", the people and the Authority of the Hadejia – Jama'are River Basin Development Authority strong mechanism for disease, surveillance, preventive and control measures be adopted as part of the project. With provision for more funds, adequate planning and an equipped manpower with a good organizational infrastructures to carryout the job. Also there calls for a need to access to good sanitary facilities (pit latrines), good drinking water and some preventive measures of pollution of irrigation water by defecation of human waste and chemicals through the application of chemicals and herbicides by the farmer.

* The water users association currently existing has to be further strengthen. As will go along way in some of the minor maintenance of the scheme, and facilitate the desired farmer/management

relationship, more especially in the area of operation and maintenance (O & M)

* The management of the H-JRBDA and the government of Kano state should improve the level of assistance to the farmers in the area of provision of agricultural input (fertilizer, agricultural equipment, chemical/herbicides etc) and most importantly, the provision of funds as loan to the farmers. Also, other organization like the World Bank, ADP's and Banks should be encouraged to support the farmers with money, and agricultural inputs as loan.
* The general rehabilitation of the entire scheme is strongly recommended.

6.1.1 Conclusion

The Kano River Project Phase 1 has been evaluated to have a beneficial positive impact on the environment. This can simply be explained in its ability to have reduced the risk of flood, the propagation of fish and wildlife in the reservoir, increased agricultural activities with a double cropping season (dry and wet), thereby increasing the per capita income of individual farmer. A lot has been seen to have been improved in their social life. Modern schools and comprehensive health centres had been established. With the inception of the project an increased population in the environment was experienced. And most importantly, the area has seem to have benefited ecologically, because the area formerly semi-arid and drought prone, is now a Savannah green area, with climatic risk been considerable reduced, living standard improved, with production being assured throughout the year.

However, despite the numerous positive impact of the irrigation project on the environment as indicated above, the project still have some negative effects. It was observed that, there is the problem of land accumulation in the hands of few individuals thereby strengthening rural inequality. This is attributed to the increasing trend towards land consolidation, which is due to land rationalization for modern agriculture. This trend should be handled with utmost care. Especially to avoid the ugly incident of the Bakalori Dam of 1983.

Having said all these, the good achievements of KRPI on the environment of Kadawa made so far cannot be over empasized, despite some negative environmental impacts in the areas of water logging, salinization, siltation and presence of some diseases. This shows the excellent potentials of the project area with highly productive farmers. And this will continue to be attained

provided the appropriate management and conservation of the environment are also maintained. This further calls for the Federal Government to increase its budgetary allocation to the management for an effective operation and maintenance of the project.

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Questions to the Project Manager or Equivalent

1.1 Your Name
1.2 Official Position
1.3 Project Name
1.4 1.4 Nearest Town(s) Distance from project (km)
1.5 How long have you been working on this project?

1.6 Date irrigation began at this project

1.7 Interruptions:

From to caused by
From to caused by

1.8 Cultivated area: As originally planned Current
- surface: ha surface ha
- sprinkler: ha sprinkler ha

1.9 Additional area planned for cultivation in next 5 years ha

1.10 Give details of any reservoir(s) outside the project boundary supply your project

Name Reservoir	Approximate distance from project (km)	Name organisation/Dept which operates Reservoir

1.11 Give details of other irrigation schemes within 10km of the project

Name	Area Cultivate (ha)	Distance from project (km)	Source of irrigation water (name of river etc)	Date irrigation began

1.12 Do farmers live: in village/in scattered houses?
1.13 If they live in village, give the names of the main villages

Letter	Name of village	Letter	Name of village

C F

WATERLOGGING/SALINISATION

1.14 Are there areas normally cultivated where crops have died or suffered reduced yields due to .....?

1.15 If 'yes' how often has it happened since the project has been in existence?

1.16 Which proportion of the Project I affected when it occurs?

1.17 Which crops are particularly affected. If any?

1.18 Have areas originally in the Project designed now been abandoned due to ..... ?

1.19 Estimate of area lost (ha)

Excess Water	Excess Salt
Yes/no Don't know	yes/no don't know
Yes/no	yes/no

Aquatic weeds

1.11 Are aquatic weeds controlled in .....?
1.12 If 'yes', what method is used?
1.13 Do weeds interfere with operation?

1.15 What are the main weed types?

Reservation within The project boundary	Canal	Drains
Yes/no	yes/no	yes/no
Yes/no	yes/no	yes/no

1.16 What is the Project's annual budget for aquatic weed control?
1.17 What labour inputs are needed for control? (man-days)

Agricultural weeds

1.18 Methods of control normally used in the Project
No control/by hand (hoe/han/picking)/herbicides
1.19 Who is responsible for control? Project/farmers

1.20 How effective is the control? Very/partly/not

1.21 If 'partly' of 'not' say why

1.22 Which crops are mostly affected?

1.23 Annual cosdt per ha of any chemicals used (Naira)

Pests and diseases

1.24 Name of description of pest or diseas
1.25 How serious is the problem?
1.26 Control method
1.27 is it effective and if not, why?

1.28 In the past, has sediment been removed from the reservoir(s) (If any within the scheme)? Yes/no
1.29 At present is sediment interfering with operation of the reservoir(s)? yes/no
1.30 If yes, how serious is the effect?

1.31 Is sediment usually removed from?

1.32 If yes, what method used?

1.33 Does sediment usually Interfere with the operations of..?

1.34 If 'yes', how serious is the effect? (Quantity if possible)

Hydraulic	canals
Yes/no	yes/no
Yes/no	yes/no

1.35 What is the Project's annual budget for routine sediment removal from structure and canals
1.36 What labour inputs are needed for removal work? (man-days)

Effect on Hinterland (fuelwood/livestock)

1.37 Have any areas within or near the project been planted with trees? Yes/no
1.38 If 'yes' are they for fuelwood? Yes/no
1.39 If 'yes' are these adequate to meet the demand now? Yes/no
and will they be adequate in 10 years' time? Yes/no

1.41 Are there regulations prohibiting or restricting the keeping of livestock

1.42 If 'yes', are they effective? Yes/no

Operation and Maintenance of irrigation System of the project?

1.34 Where the following exist, who is responsible for authorising releases of water from:
(a) Reservoirs within project boundary
(b) Main (headworks) off-takes
(c) Distributary (secondary canal) off-takes
(d) Field off-takes

1.35 Who is responsible for the maintenance of the reservoirs and dams referred to above?

1.36 If surface irrigation is practiced, state method:
Flood/furrow/border strip/other:

1.37 and type of control of discharge:
Siphon/outlets structure/breached bank

1.38 what type of drainage system exists?
Earth ditches/lined ditches/subsurface drains

1.39 For canals structures and drains give:

	Type of canal Lining (if any)	Approximate		Who is responsible for maintenance? Canals
		Structure	Drains	
a)	Main			
b)	Secondary			
c)	Field			

1.40 for how many hours during the day is irrigation normally practiced? Hours

1.41 is the irrigation system drained dry during the hours when it is not in use yes/no

1.42 What is the typical length of the time during which no irrigation takes place (between the principal crops seasons a, and b) and when do these occur?

	Length of dry period (days)	Time of years (months)
(a)		
(b)		

1.43 is the irrigation system drained dry during these period and , if not would draining be possible?

	Current practice		Would draining be possible?	
	Canals	Reservoirs'	Canal	Reservoirs
(a)	yes/no	yes/no	(a) yes/no	yes/no
(b)	yes/no	yes/no	(b) yes/no	yes/no

Reservoirs within the Project boundary.

Crops

1.44 Names of crop: Crop 1 Crop 2 Crop 3

1.44 Planting date(s):
(a) 1st planting
(b) 2nd planting

1.45 Areas planted last Years (ha):
(a)
(b)

1.46 Typical yields (kg/ha)
(a)
(b)

1.47 Max/min yields (kg/ha)
(a)
(b)

1.48 List the main Factors affecting Yield

Health and Sanitation

1.49 What type of sanitation is available in the fields?

Give details of any programmes of disease control which benefit the people on the project.

Programme	Existing	If 'yes' Date began	Organisation is it carried Responsible out regularly
1.50 Malaria			
Mosquito	yes/no		yes/no
Spraying			
Other	yes/no		yes/no
1.51 Schistosomiasis			
Molluscides	yes/no		
Mass treatment			
With drugs			
1.52 Onchocerciasis	yes/no		yes/no
1.53 Guinea Worm	yes/no		yes/no

APPENDIX TWO

Question to village Heads or equivalent

2.1 Your name

2.2 Your official position

2.3 Name of village or area of project you represent

2.4 Was the village here before the irrigation scheme? Yes/no

2.5 Approximately how many people (men, and women and children) live in your village or area?

2.6 Which ethnical groups are represented?

2.7 How many of the families, in your village, farm fields in the Project? .
all/many/half/few/none

2.8 What are the main occupations of the villagers?

Waterlogging/Salinisation

2.9 Do any farmers lose crops or have poor yields due to……?

2.10 If 'yes' how often has it happened since the Project began?

2.11 What proportion of the land if affected (%)?

Agricultural Weeds/Pests

2.12 How are crop pests and weeds controlled

2.13 How serious is the problem? (very serious/serious/slight)?

2.14 If 'serious' or 'very serious', say why

2.15 If chemicals are used, what is their annual cost per ha?

Effects on Hinterland (Fuelwood/Livestock)

2.16 How many people use fuelwood for cooking? Many/half Few/none

2.17 If one person had to collect a day's fuelwood for a family, how long would it take? Hours

2.18 Compared with the time needed a few years ago, does fuelwood collection nowadays take longer/same/less time?

2.19 Why?

For animals kept by people in you village

	Large Animals (Cows/camels)	Smaller Animal (sheep/goats)
2.20 Estimate total numbers kept		
2.21 Is their food mainly from out side or inside the Project	Outside inside	Outside inside
2.22 If 'outside' is feeding harder/easier than a few years ago	harder/ same/ easier	harder same/ easier

2.23 Do village have gardens close to their homes which are separate from the fields of the Project yes/no

2.24 If 'yes' is irrigation practised in the garden by:
Pipes or hoses/water in channels/hand watering/none

2.25 What is the source of water for these gardens?

Domestic water supplies/water contract

Where do most people in your village obtained water for the following activities (a) open well; (b) protected well; (c) borehole; (d) individual tap; (e) shared tap; (f) river; (g) canal (h) drain; (i) pool; (j) reservoir (k) other

2.26 Drinking water?

2.27 Personal washing?

2.29 Where do children
Enjoy swimming

2.30 If boreholes, taps or wells are used, who is responsible for their maintenance?

- Primary Occupation –
(1) Farming (2) Fishing (3) Hunting (4) Forestry (5) Cattle rearing (6) Trading (7) Artisan (8) Unskilled (9) Other (specify)
.....

- Percentage of the population having this type of occupation

- Secondary Occupation for living:
(1) Farming (2) Fishing (3) Hunting
(4) Forestry (5) Cattle rearing
(6) Trading (7) Artisan (8) Unskilled
(9) Other (specify)

- Percentage of the Population having this type of occupation
Access to physical and social infrastructure

- Access road – The type of access to the ward from the main road/transportation point/all season road:
(1) Good tar (2) Bad tar (3) Good laterite (all-weather motorable road) (4) Bad laterite (5) Track (6) Footpath (7) Waterway

- Distance to the main road – (1) Less than 5.0km (2) 5.0-10.0km (3) More than 10.0km
- Sewage disposal – The main method of sewage disposal in the ward: (1) Main sewer (2) Septic tank (3) Pit latrine (4) Other (Bucket, Bush, etc.)

NEPA (2) State rural electrification (3) Private community generator (4) None.
- Hospital – The estimated distance from the ward to the nearest hospital: (1) Less than 30km (2) 31-50km (3) More than 50km
- Primary health Centre – The dstimated distance from the ward to the nearest health centre: (1) Less than 2.5km (2) 2.5-5.0km (3) Abova 5.0km
- Primary School – The estimated diatance from the ward to the nearest primary school: (1) Less than 2.5km (2) 2.5-5.0km (3) More than 10.0km
- Market – They type of market nearest to the ward: (1) Daily (2) Twice a week (3) Weekly (4) Other (specify)
- Farm service centre (FSC) – The estimated distance from the ward to the nearest farm service centre: (1) Less than 10.0km (2) More than 10.0km
- Farmers co-operatives and institutions – Existing co-operative and other farmers organisations: (1) Farmer co-op. Society (2) Credit institution (3) Licenced buying agent (market board) (4) Co-op. Shop (5) More than one of the above (6) None

Date
LGA
Village
Head of Household Name
District/Comm./Clan
Ward
Language of Interviewing

1. Tribe .....
2. Native Language .....
3. Religion .....
4. Sex .....
5. Age Group .....
6. Place of Birth .....
7. Reason for moving to the present village
   .....
8. Number of years in the village .....
9. Marital Status .....
10. Number of wives
11. Number of children .....
    (a) Male children .....
    (b) Female Children .....
    (c) Male Dependents .....
    (d) Female Dependents .....
12. Major occupation of Household head = (occupation that takes most of his time) .....
13. Secondary occupation of household head
    .....
14. Cash Income from Major Occupation-
    Enter code as follows:
    1. Up to N500 per year 2. 501-750 per year 3. 751-1,000 per year
    4. 1,000-2,500 per year 5. 2,501-5,000 per" 6. 5001-7500 per year 7. 7,501-10,000 per year 8. 10,001 + per year.
15. Cash income from secondary occupation
    Enter code as Appropaiate from the above list (Question 18)
16. House Ownership .....
17. Type of Housing .....
18. Water Supply
    1. Tap, house connection 2. Tap, public standpipe 3. Well 4. Other (Specify) .....
19. Power Supply 1. NEPA/Rural electrification (grid) 2. Generator 3. No. electricity.
20. Major Cooking Fuel. 1. Fire wood 2. Kerosene 3. Gas 4. Electrification 5. Other .....
21. Ownership of means of transport
    1. Bicycle 2. Motor cycle 3. Car 4. Lorry 5. Canoe 6. Motor boat 7. Anima 8. Other ..... 9. None
22. Radio/TV 1. Radio only 2. TV only 3. Tape recorder 4. TV/Radio and Tape Recorder 5. None
23. Livestock Husbandry Inventory – Enter number f heads:
    OXEN CATTLE CAMEL DONKEYS SHEEP

GOATS PIGS POULTRY RABBITS OTHERS

24. Agriculture Land
    51 number of field- Enter data on number of fields of the household as follows:
    Total Cultivated last season (inculding fish ponds) Not cultivated last season
25. Land Tenure
    Number of field inherited .....
    Number of field purchased .....
    Number of field rented .....
    Number of field pledged .....
    Number of field under other category .....
26. Irrigation Facilities
    1. Member of an irrigation scheme 2. Own system - shadoof 3. Own system – borehole 4. Own system pump 5. Combination 6. Hired irrigation facilities 7. None
27. Main crops cultivated – Name in order of importance the five main field and tree crops cultivated last season (Enter codes from the following list)

Grains	Roots – tubers	Vegetables	Legumes
1. Acha	8. Cassava	15. Carrots	24. Binnseeds
2. Maize	9. Cocoyams	16. Lettuce	25. Beans
3. Millet	10. Ginger	17. Melons	26. Bambara
4. Rice	11. Irish potatoes	18. Onions	27. Cowpea
5. Sorghum	12. Sweat potatoes	19. Okro	28. Groundnut
6. Wheat	13. Yam	20. Peppers	29. Pigeon pea
7. Other	14. Other	21. Pineapples	30. Soya beans
		22. Tomatoes	31 Other
		23. Others	

Tree Crops

32. Avocado	36. Kolanut		
33. Banana	37. Mango		
34. Cashewnut	38. Oil palm		
34. Citrus	39. Rubber		
35. Cocoa	40. Other		

Other Crops

41. Cotton	47. Kenaf		
42. Coffee	48. Sugar cane		
43. Castor oil	49. Tea		
45. Fish	50. Tobacco		
46. Grass/Stalks	51. Other		

28. Main Source seed/seedling/tires/fingerlings last season
    1. Own production from previous year's crop 2. Bought from ADP/FSC 3. Bought from MANR store 4. Bought from market/dealer 5. Other (specify)
29. Type of Fertilizer use last season
    1. Compound 2. Ammonium sulphate 3. CAN (Calcium ammonium nitrate) 4. Urea 5. TSP (triple super phosphate) 6. Combination 7. Other ..... 8. None
30. Source of Fertilizer: 1. Bought from ADP/FSC 2. Bought from MANR store 3. Bought from market 4. Dealer/agent 5. Combination 6. Other.
31. Use of fungicide /pesticide/herbicide last season
    1. Fungicide 2. Insecticide 3. Herbicide 4. Seed dressing 5. Storage chemicals 6. Combination 7. None
32. Use of Family Labour last season 1. Head of Household only. 2. Wife/wives 3. Children 4. Relatives/dependents 5. Head of household and wives 6. Any other combination
33. Use of Hired Labour- 1. Yes 2. No-not neede 3. No-not available 4. No-not expensive
34. Source of Institutional Credit Last Season
    1. MANR 2. ADP 3. Co-operative 4. Bank 5. Combination 6. None needed 7. None available
35. Source of Information Credit last Season.
    1. Traditional (Esusu/adashe) 2. Relatives 3. Friends 4. Money lender 5. Combination 6. None Available.
36. Extension Message Applied
    1. Land cultivation techniques 2. Use of improved varieties 3. Use of fertilizer/other chemical 4. Harvesting techniques 5. Combination (1-4) 6. Storage and processing techniques only 7. Home economics 8. All (1-7) 9. Fish farming 10. None applied
37. Participation in Extension Group meetings 1. Yes, attend regularly 2. Yes, attend irregularly 3. No, not informed 4. No, none available
38. Visits to Demonstration/Corner Plots 1. Yes, attend regularly 2. Yes, attend irregularly 3. No, not informed 4. No, none available

programmes 2. Watch TV programme 3. Read pamphlets and Brochures 4. Any Combination 5. None of the above.

40. Waste disposal: 1. Sewer 2. Septic tank 3. Pit latrine 4. Other

41. In the last 12 months, how members of your household were ill with the following diseases: 1. Zazabi – Malaria 2. Tsagina – Schistosomiasis – 3. Kurkuma – Guinea Worm 4. Zawon Wara, Gladawa – Diarrhea 5. Any other dieases (specify)

42. Did you or any other member of your household needed medical treatment in the last 12 months ..... Yes .....
If yes where (1) This village (2) Kura (3) Bunkure (4) Rano (5) Other

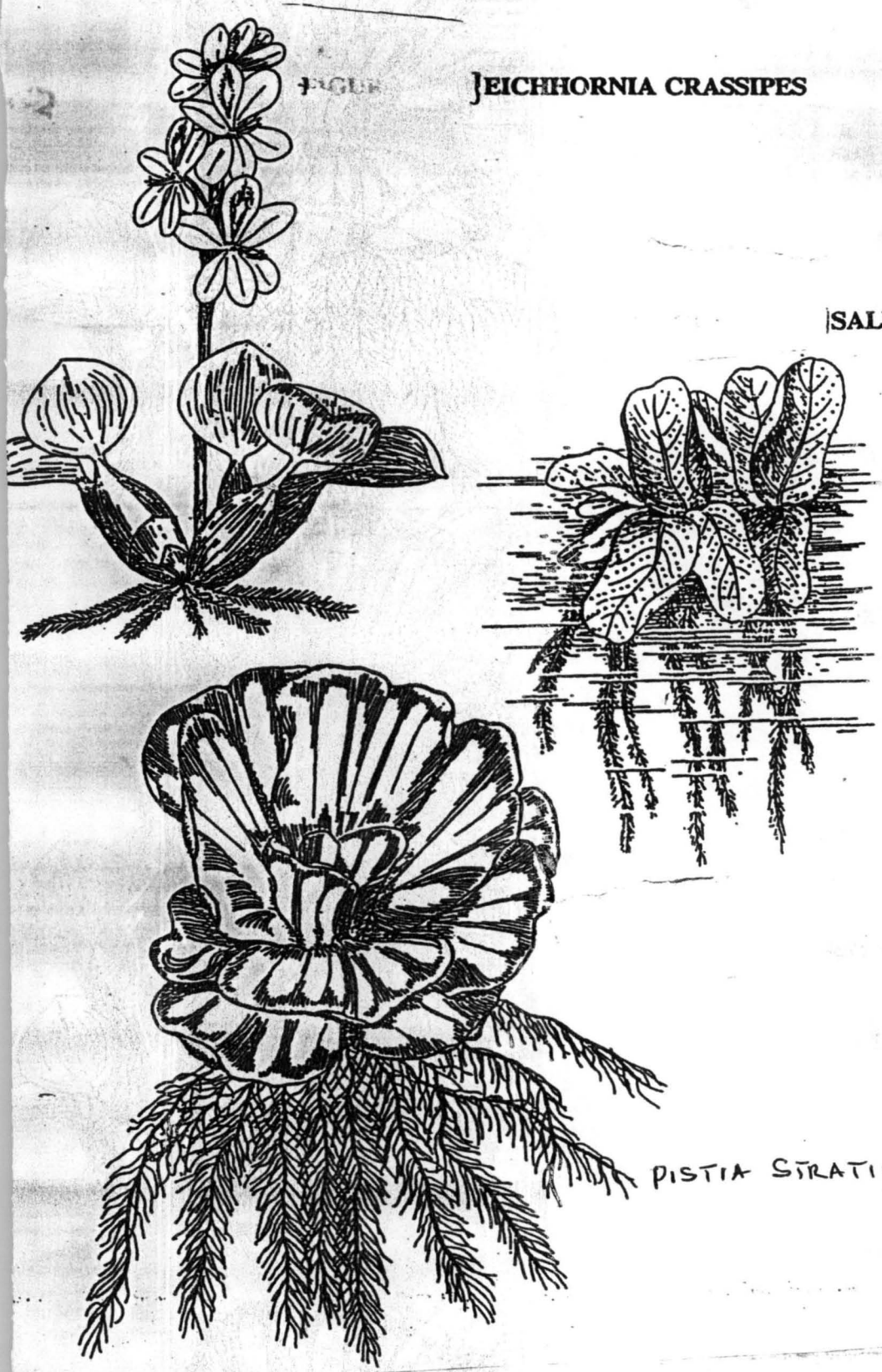
43. Do you control mosquitoes in your house ..... yes ..... If yes how (1) mosquito net (2) Spray (3) Other (Specify)
.....

44. Extension – If agriculture extension service is available, answer question a-b, if

a. Form of Contact –
1. Someone in household is contact farmer 2. Someone in household is part of extension group 3. Someone in the household is part of any other form of tension contact 4.Extension not required (Skip to question 73) 5. Extension available, but household never contacted (Skip to question 73)

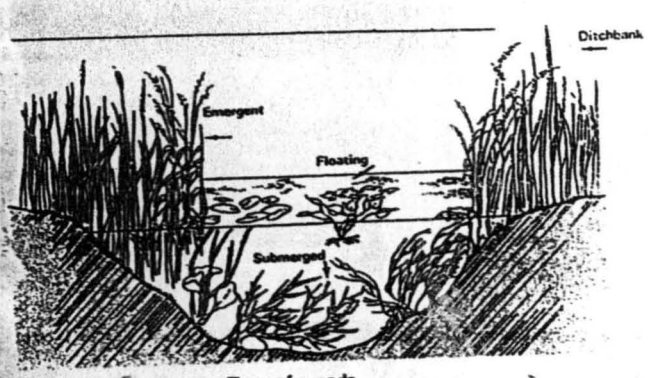
b. Frequency of visit of extension agent
1. Very Frequent, regular (once in two weeks) 2. Frequent, regular (once a month) 3. Sporadic irregular 4. Very seldom 5. Other (Specify

APPENDIX FOUR



Different species of water letus found in the project area of studies.

APPENDIX FIVE



Type of weeds