# STATUS OF AQUACULTURE MANAGEMENT OF TWO GOVERNMENT FISH FARMS IN KADUNA AND KATSINA STATES, NIGERIA.

BY

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DIGITIZED

## DEDICATION

This thesis is dedicated to Jesus Christ, my Lord and personal saviour who is everything to me.

## DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented in any previous application for a higher degree. All quotations are indicated and the sources of information are specifically acknowledged by means of references.

F.O. ECHOR

.....

SIGN, APRIL, 1998

## CERTIFICATION

The thesis entitled STATUS OF AQUACULTURE MANAGEMENT OF TWO GOVERNMENT FISH FARMS IN KADUNA AND KATSINA STATES, NIGERIA by ECHOR, F.O meet the regulations governing the award of the degree of M.Sc (Fisheries) of Ahmadu Bello University Zaria, Nigeria and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

Studies on the status of aquaculture management of two government fish farms at Mando and Maska in Kaduna and Katsina States of Nigeria respectively were carried out between May, 1996 and January, 1997. Physico-chemical parameters were examined to assess the water quality characteristics of the two farms. General survey was also conducted by questionnaires to reach 23 other Fish Farms randomly selected from the 41 and 26 identified fish culture operators in kaduna and Katsina stales.

The result showed that out of the 41 identified fish ponds in Kaduna State, seventeen were commercial fish farms and twenty four homestead ponds, while eight commercial fish farms and eighteen homestead ponds were found in Katsina State. In Kaduna state, 5.9%, 17.6% and 53.1% of the fish farms were established between 1950 - 1959, 1980 - 1989 and 1930 - 1997 respectivelly. Similarly, a higher percentage of the fish farms (58.3%) in Kaduna and (60%) in Katsina were untrained in the field of fisheries.

The relationship between physico-chemical parameters at Maska and Mando fish farms (with respect to season) were correlated. The analysis indicated positive correlation between alkalinity and hardness. Seechi disc transparency and dissolved oxygen, the (ANOVA) conducted for these parameters also showed significant differences ($p<0.05$) between seasons and the two farms. While Mando fish farm appeared to have better mater quality characteristics to sustain fish

culturing, some of the parameters especially the D.O. (1.3mg/1 ) and SDT (63.6 cm) at Maska Fish Farm were not within the acceptance limit to support fish growth.

Although there were many enthusiastic fish famers in Kaduna and Katsina States, lack of technical know-how, fish seed, fish feed and finance were responsible for the poor performance and high incidence of failures of aquaculture projects in the areas. Maska and Mando fish farms are potentially viable but lack of fund, infrastructure and fish inputs were hampering the effective management of the two farms.

It is therefore recommended that the intending fish farmers engage the services of competent aquaculturists for advice before embarking on commercial fish farming. The two Federal Government Fish Farms at Mando and Maska should be reactivated and adequately funded to fulfil their primary objectives of "Fresh water fish farming and training, and Fish seeds multiplication centers".

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## ABBREVIATIONS AND SYMBOLS

| | | |
|---|---|---|
| AFC | - | Asiaphil Fisheries Corporation, Manila, Philippines |
| Alh. | - | Alhaji |
| ANOVA | - | Analysis of variance |
| A.B.U | - | Ahmadu Bello University |
| APHA | - | American Public Health Association |
| A.M | - | Ante-Meridiem (before noon) |
| $CaCO_3$ | - | Calcium Carbonate |
| CIFA | - | Committee for Inland Fisheries of Africa |
| C.V | - | Confidence of Variability |
| DFRRI | - | Directorate of Food, Roads and Rural Infrastructure |
| D.O | - | Dissolved oxygen |
| D.O%Sat | - | Dissolved oxygen percentage saturation |
| DF | - | Degree of freedom |
| EDTA | - | Ethylene diamine tetra acetic acid |
| et al | - | And others |
| FACU | - | Federal Agricultural Coordinating Unit |
| FDF | - | Federal Department of Fisheries |
| FMANR | - | Federal Ministry of Agriculture and Natural Resources |
| G.R.A. | - | Government Reservation Area |
| Ha | - | Hectare |
| $HCO_3$Alk. | - | Hydrogen Carbonate Alkalinity |
| IAR | - | Institute of Agricultural Research |
| KADP | - | Kaduna Agricultural Development Programme |
| KTARDA | - | Katsina Agricultural and Rural Development Authority |
| LGC | - | Local Government Council |
| LGA | - | Local Government Area |
| MANR | - | Ministry of Agriculture and Natural Resource |
| mg/l | - | Milligram per litre |
| mm | - | Millimetre |
| $NH_3$ | - | Ammonia |
| $NH_4^+$ | - | ammonium ion |
| NFDC | - | National Fisheries Development Committee |
| PTF | - | Petroleum Trust Fund |
| pH | - | Hydrogen ion concentration |
| RBDA | - | River Basin Development Authority |
| S.D | - | Standard Deviation |
| SDT(cm) | - | Secchi disc transparency in centimeter |

S.E - Standard error
S.P.gr - Specific gravity
Spp - Species
Sq.m - Square meter
Total alk.mg/l$CaCO_3$ - Total alkalinity in milligram per litre of calcium carbonate
Total hardness mg/l$CaCO_3$ - Total hardness in milligram per litre of calcium carbonate

UNDP - United Nations Development Programme
$V_1$-$V_8$ - Variables 1-8 (D.O: D.O% Sat: Total alk: $HCO_3$alk: Total hard: Temp: PH: and SDT).
WRECA - Water Resource and Engineering Construction Agency
WUA - Water Users Association

Symbols

N - Normality
+ - Plus
% - percentage
°C - Degree in centigrade
₦ - Naira
M - Molarity
< - Sign of less than
> - Sign of greater than
T(°C) - Temperature in degree centigrade

CHAPTER 1

## INTRODUCTION

Fish farming is an aspect of aquaculture which involves the rational rearing and husbandry of fin and non-fin fish in man-made ponds, reservoirs, cages or other enclosure systems under controlled or semi-controlled condition (Landau, 1992).

Aquaculture has a substantial history. It is believed that aquaculture had its cradle in Asia. It developed there some 4,000 years ago in harmony with a traditional rural-agrarian economy. According to Ling (1977), fish culture was first noted in Chinese records before the development of paper about 3,500 years ago. Nevertheless, fish culture became a popular practice in China around 100 B.C. with the common carp, *Cyprinus carpio*.

Ling (1977) also pointed out that the technique of keeping fish in a pond originated with fishermen who kept their surplus catch alive temporarily in baskets submerged in rivers or small bodies of water created by damming one side of a river bed. Gradually, these fishermen learned that if the holding area was well protected and if they supplied the captive fish with food, they would grow. Thus, by 500 B.C. Fan Lee, a Chinese Author coined the word aquahusbandry to depict the technology of fish culture.

Before the world war II, according to Ling (1977), most of the scientific fisheries research work involved mere survey and interpretation of existing practices. With the realization of

the potential of aquaculture to produce cheap protein food. effort began to pour into fish culture, and experiments were initiated to improve and refine existing practices. It was not until 1950(s) that serious efforts were made to produce quality "seeds" or stocking material. Traditionally, fry seed of the major carps were collected from natural habitats.

In 1955, the technique of using hormones (e.g human chorionic gonadotropin, fish pituitary gland extract) to induce spawning provided a major break through. Many fish that could not be spawned previously can now be induced to reproduce in simple hatcheries under control conditions (Ling, 1977). From Asia, aquaculture spread to other parts of the world including West Africa after the second world war.

For historical record, conventional fish farming in Nigeria falls into two distinct periods: 1950 - 1970 and 1970 - 1992. While the first period popularized fish farming, the second phase concentrated on expansion and establishment of demonstration fish farms in addition to bold attempts on reducing major constraints for rapid aquaculture development (CIFA/FAO, 1994).

Prior to the first period (1950 - 1970), experimental fish farming were carried out in a number of places. For example, the fish culture in brackish ponds at Onikan in Lagos in the early 1940s by Agricultural Development of the Colonial Office (Sagua, 1976). And notably too, the Government of the then Northern region operated Panyam Fish Farm on the Jos Plateau

with the construction beginning in 1952 and completed in 1954 (Ita, 1975).

Between 1970 and 1975, there was a remarkable increase in the number of fish farms built by both Federal and State Governments agencies and private sector participants.

In the Third National Development Plan (1975 - 1980), low priority was accorded to aquaculture. Nevertheless, a combination of factors including research activities at Ikoyi Fish Farm and UNDP/FAO project at Buguma (1970 - 1975), extension activities given by the government demonstration fish farms at Panyam (North), Ibadan and Akure (West), Umuna Okigwe, Itu and Opobo (East), led to a greater awareness on the potentials of fish farming in Nigeria. Private sector participation became significant. As a result of this, in 1976 the Federal Department of Fisheries commissioned a consultancy group, Asiaphil Fisheries Corporation (AFC) of Manila, Philippines, to study the feasibility of brackish and fresh water aquaculture potentials in Nigeria. On the basis of the recommendations of the consultancy group, aquaculture was accorded a higher priority in the Fourth National Development Plan (1980 - 1987) (CIFA/FAO, 1994)

The same source (CIFA/FAO, 1994), pointed out that between 1978 and 1980, the Federal Department of Fisheries constructed zonal seed producing and training centres at Oyo for the South-West, Umuna Okigwe for the South-East, Panyam for the North-East and Mando (Kaduna) for the North-West. Part of these

projects, notably at Oyo and Panyam, were funded by UNDP under the fresh water fish farming development and demonstration project.

The activities of eleven River Basin Development Authorities (RBDA) in the country between 1987 and 1980 accelerated aquaculture development. The RBDAs were encouraged by the Federal Government to build commercial fish farms and demonstrate the economic viability of aquaculture (AFC, 1980). Under this dispensation, commercial fish farms were built near Abeokuta for Ogun-Oshun RBDA, at Bodo and Port Hacourt for the Niger Delta RBDA, and near Owerri for the Imo RBDA. Some of the commercial fish farms were successfully managed because of the financial inputs from the state government and expatriate staff attached to them.

Uboma (1981) observed that all the 46 RBDA fish farms, covering a total surface of about 1300ha, with 31 reservoirs with total surface area of about 12600ha, if fully stocked have estimated potential fish production of 11000t/year.

All these efforts by the successive governments is in realization of the important role fish plays in the Nigerian diet. Fish provides an estimated 40% of the total animal protein consumed by the average Nigerian. In some parts of the country (e.g. Akwa Ibom, Cross River, and River States), fish may account for upto 80% of the animal protein consumed by the people (Otubusin, 1989; Ita, 1991).

According to CIFA/FAO (1994), accurate estimates of fish

production through aquaculture in Nigeria is fairly difficult due to many logistic reasons. There is no clear-cut distinction, in most cases, between capture fisheries and aquaculture, including culture-based fisheries. Available production statistics from aquaculture however, showed a higher production in 1985 over 1984, then a fall in 1986 followed by a fall again in 1990 (Appendix II).

Ita (1991) also observed that Nigeria's performance in the area of aquaculture was poor. According to him, the only important fishes cultured in Nigeria were as follows: Oreochromis niloticus (T. nilotica); Sarotherodon galilaeus (T. galilea); Clarias gariepinus; Heterotis niloticus; Liza falcipinnis; Heterobranchus spp; Tarpo atlancarpio; and Gymnarchus niloticus.

He pointed out that Nigeria's estimated 12.5 million hectares of inland waters which are capable of producing about 512,000 tonnes of fish annually were under-utilized, thus producing less than 250,000 tonnes per annum.

The other source of fish in Nigeria, apart from the aquaculture (inland water) mentioned above, is the offshore fishery resources which constitutes more than 60% of the nation's fisheries resources. The species are those of the pelagic (carrangids, mackerel, barracuda, mullets, sear fishes, bonga, and sardine, fishes) and demersal (sciaenids, elasmobranchs, big eye, catfishes, soles, thread fishes and prawns) (Ita, 1991).

The overall decline in domestic fish production both from capture and culture fisheries with continuous increase in demand for fish because of the growing population of the country implies that Nigeria has to depend heavily on foreign nations for her domestic fish consumption.

Therefore, in view of the declining capture fisheries globally and Nigeria in particular, and in addition to decimation of our livestock population in Northern part of the country by drought and diseases, culture fisheries is the only option of assuring adequate supply of animal protein to fill up the "protein gap". This role of aquaculture as security for animal protein shortage has long been recognised (Hepher and Pruginin, 1981).

Other merits of aquacultural practices include:

- Aquaculture makes productive use of poor agricultural land, i.e. the land requirements for aquaculture often permits the use of low-valued land such as mining pits or swampy land that is not well suited to other uses.
- Generally too, a pound of fish can be produced more cheaply than a pound of red meat. That is, fish are better feed converters than land-based animals, a fact that makes aquaculture particularly attractive.
- Provision of avenues for employing redundant skilled and unskilled labour.
- Aquaculture provides means of earning and conserving the scarce foreign exchange.

- Production of fingerlings to restock the already depleted natural water bodies.
- It is a means of conserving natural resources.

In spite of all the benefits of aquaculture and the abundant natural resources of the country to develop it, the practice of fish culture in Nigeria remains very rudimentary. Evidence now abound that the initial high expectations of fish farming as panacea for animal protein shortage has turned into disillusionment as most fish farms which started on a bright note have been abandoned not sooner than they were started due to many factors.

Kaduna and Katsina States have enormous water resources such as the dams, lakes and rivers which can be utilized to sustain the aquacultural development programme of the two states. According to Ita et al (1985), the total surface area in (Ha) of reservoirs and lakes in the Kaduna (which is now divided into Kaduna and Katsina States) was 14020.90. However, fish farming in the two states remains very low when compared to the abundant water resources of the states. This study is therefore intended to examine fish farming operations in both private and government fish farms in the two states.

## 1.1 Justification of the Study

This study is prompted by the high incidence of poor performances, failures and abandonment of many fish farms in

the two states. For instance, the Reservoir at Maska Fish Farm which was established in 1954 by the then Katsina Native Authority had total surface area of 20.23ha. Over the years the Reservoir has been badly silted with serious consequences on the farm. The Farm which covers an area of about 50 acres (20.23 hectares) has 24 completed ponds belonging to the Federal Department of Fisheries and 20 ponds belonging to Katsina State Government. The Federal Section was established in 1978 as a fish multiplication centre. The objective was to produce fingerlings for sale at subsidized rate to interested fish farmers in the area. However, since the establishment of this farm there has been nothing to show for it apart from the natural breeding in some of the ponds undertaken by the state. The situation in 1996 and even now is worse as nothing virtually was going on the farm.

The story with the private fish farms in the two states is not different. A private fish farm in Rigachuku, near Kaduna town has been abandoned over some five years now. This was a multi-million Naira fish farm said to have been abandoned for minor managerial problems. The Farm covers a total area of 5 ha with 23 ponds of various sizes/dimensions.

Another private fish farm in Funtua town (2 hectares) which was established in 1987 has been abandoned since 1993 and all the ponds closed up and replaced with sugar cane.

Therefore, the need for this study is to identify the reasons for the rampant failures of aquaculture projects in the

two states. In Asia and other parts of the world, aquaculture has become the alternative means of supplying the animal protein shortage to fill up the so called "protein gap". We can do likewise in Nigeria.

## 1.2 Study Objectives

(i) To update the aquaculture status of Kaduna and Katsina states.

(ii) To identify problems and prospects of fish farming in these states.

(iii) To assess the level of awareness of people in fish farming.

(iv) To evaluate water quality (physico-chemical) parameters of the two fish farms.

(v) To make appropriate recommendations that will ameliorate the problems and improve aquacultural practices based on the finding of this study.

CHAPTER 2

# 2.0 REVIEW OF LITERATURE

## 2.1 Scope and Potentials of Fish Farming in Kaduna and Katsina States

### 2.1.1 Fishery Perspective of Kaduna State

According to (MANR, 1992) effort towards the development of fisheries in Kaduna State started in 1954 with capture fisheries in Rivers, Lakes and big reservoirs and later culture fisheries with the establishment of Maska Fish Farm (now in Katsina State) by the then Katsina Native Authority in the same year. Maigana Fish Farm in Kaura L.G.A. was later established in 1969. FACU (1995) reported that few fish ponds were in existence in Kaduna State of which many (unspecified number) were either not impounded, operational, poorly constructed, managed or even abandoned. According to the same source, the ponds seen were constructed/owned by government agencies (e.g. Federal Department of Fisheries, Kaduna State MANR, Birnin Gwari LGA), individuals, communities, private companies in the rural and urban areas. FACU (1995) also observed that the aquaculture systems practised included homestead earth pond, concrete tank, integrated crop-horticulture-fish culture as well as loose association of pig husbandry and fish culture.

Lysak (1978) pointed out that the climate condition (e.g. rainfall, humidity and temperature) of Kaduna State gave positive opportunities for production of fish. He indicated that high average annual temperature of about 23.0°C and

sufficient amount of water, ensured good resources of natural food for intensive fish population in well maintained water bodies.

FACU (1995), reported that Kaduna State has surface irrigation schemes involving earth dams/reservoirs with large surface area. Such scheme the report indicated include Kuzintu (2,000 ha), Kagoro (1,000 ha), Paka (2,000 ha), Kuli (1,000 ha) being utilized by the Water User Associations (WUA) of various communities. It was further observed that their potentials for fish production could be harnessed if they were stocked with fish fingerlings. According to FACU (1995), with grant aid assistance from Tilapia International Foundation (TIF) in Holland, the 2.5 ha Wadon Community Earth Dam (Zonkwa LGA) constructed with the assistance of the Kaduna Agricultural Development Programme (KADP) in 1989/90, was stocked with fingerlings bought from Jos. Lysak (1978) had earlier pointed out that the fisheries productivity of most of the reservoirs and dams in Kaduna State have not been optimized as most of them were not artificially stocked with fish or utilized for fish farming. He observed the implications of such trend by pointing out that the indigenous fish in such reservoirs may not be adequate in comparison to sizes and rate of exploitation of such water bodies.

According to Lysak (1978), hydrological studies of Kaduna State revealed a wide range of variation between the rainy season and what happened in the dry season. He observed that

rainy season gave too much water, resulting in high turbidity, but during the dry season, on the other hand, low water level limited the feeding intensity of existing population of fish in waters, at the same time an increase of temperature well above the optimum of the feeding regime, reduces the growth rate of fish.

Lysak (1978) also observed the nature of the soil on the water retention ability pointing out that most of the soils in Kaduna State were covered with alluvial deposits composing of mostly of lateritic sands and clay materials. As the laterite and sandy materials prevailed in the majority of cases in the existing water reservoirs, a very intensive disappearance of water into the underground layers occurs very often. According to him, it was therefore difficult to maintain high enough water levels, especially during dry season, which in turn limited again fish productivity. In a related observation, Lysak (1978) noted that only 20 - 30 percent of the pond capacity in Maska was under water because of high seepage effects. As majority of water courses in Kaduna State suffered the same problem, Lysak recommended that an estimated 5.7 litres/sec/ha was necessary in order to maintain the water supply to fishery ponds and prevents losses caused by high seepage and evaporation rates.

The fish species, which could be found most often in the waters of Northern part of Nigeria, were described briefly by Reed et al (1966). By their feeding habits, they were divided

into three groups, namely carnivorous, omnivorous and herbivorous.

According to MANR (1992) and FACU (1995), 23 different species belonging to different genera were commonly found in Kaduna State, but only about seven species of fishes namely Cyprino carpio, Tilapia spp, Clarias spp, Heterobranchus spp. Lates, Gymnachus and Heterotis niloticus were presently cultured.

Fish productivity and fish yields are parameters that could be used to determine the variety of a fish farm. Thus: Lysak (1978) pointed out that the amount of fish produced from the unit of water surface area varied considerably according to the fertility, climatic zone, species of fish reared and intensity of fish culture applied. Dada (1975) observed that the average productivity recorded from privately owned ponds was approximately 750kg/ha, mostly Clarias spp and Tilapia spp. Figures of fish yields in Kaduna State were not usually available as accurate records were not kept (FACU, 1995).

According to (MANR, 1992), the concept of fish marketing in Kaduna State was generally related to specific place where group of buyers and sellers converged to make business, usually at the site of the farm and small markets in the rural areas. FACU (1995) showed that all categories of preserved fish were marketed around the State, while the various preservation methods employed to increase the shelf life of the fish products were smoking, use of deep freezers and cold room

storage.

According to FACU (1995) findings, prices were determined by mutual bargaining between the consumer and the retailer. The same source showed that 1995 sales record made by the state fisheries division of the Ministry of Agriculture and Natural Resources indicated the following prices: Tilapia ₦15 per kg, Clarias ₦20 per kg and Carp ₦25 per kg, while estimates from open market centres ranged between ₦80 per kg for Gymnachus Mormyrus, Clarias, Bagrus and Heterobranchus at peak seasons and fall to about ₦50 -₦60 per kg at glut seasons. On the other hand, less priced species such as Tilapia, Alestes, sold for ₦30 - ₦35 per kg all year round, the report indicated.

### 2.1.2 Fishery Perspective of Katsina State

Fish farming is at its embryonic stage of development in Katsina State. Field investigation by FACU (1995) and available record confirmed general awareness of and practice of aquaculture, but limited by technical know how and financial resources. According to FACU (1995), federal and state government agencies made ineffective efforts to popularize the technology in the past. The same source indicated that the presence of harnessable surface and underground water resource, good topography and soil profile, rich diversity and quantity of arable crops, and livestock cultivated within the state and the presence of popular endemic/indigenous culturable fish species in the waters can readily provide basic inputs for fish

culture system.

According to the report submitted at the 28th session of the National Fisheries Development Committee (NFDC) by the Katsina State Fisheries Division (MNAR, 1995), there were 10 big dams with an estimated water surface area of 2,951 Ha and 45 smaller dams of above 100 billion gallons which can be utilized for fish culture. There were evidences in the records of attempts to stock these dams with fish to replenish the rapid depletion of the indigenous fish species (MANR, 1995).

As it was noted for Kaduna by Lysak (1978), while the semi-arid sahel savannah climatic regime in the extreme Northern part of Katsina State resulting in low rainfall, high temperative condition made fish farming problematic, the southern part of the state has too much water during the rainy season resulting in high turbidity.

Lysak (1978) reported that the soil was generally of high laterites, sandy with a mixture of clay materials. According to this author, this has a serious consequence on the water retention ability of the soil. As the laterite and sandy materials prevailed in the majority of cases in the existing water reservoirs according to him, a very intensive disappearance of water into the underground layers, occurred very often. He therefore observed that it was difficult to maintain high enough water levels, especially during the dry season, which in turn limited fish productivity. In Maska Fish Centre, for instance, 20 - 30 percent of the pond capacity was

under water because of this high seepage effects (Lysak, 1978). FDF (1977) interim report also confirmed that the reservoir which was about 20.23 ha of surface area in 1954 when it was constructed was retaining less than 2 meter in deepest point. totalling far less than 108 million litres.

Although Katsina State has enormous fisheries potential. the available record showed that what was supplied was lower than the demand. According to FACU (1995), the total fish requirement for the state if computed by the average of 9 kg per person according to FAO, will be 40,000 metric tons compared with the estimated total production of 22.08 metric tons in the state.

Fish production records were not kept in most of the farms. However, MANR (1995) reported that of the 44 fish production ponds in Maska 4 - 5 tons of fish were produced annually both of Tilapias and Clarias species.

In the Executive Summary of Fisheries Appraisal Report submitted to Katsina State Government by FACU (1995). it was pointed out that fish preservation methods varied considerably from place to place but generally fresh fish were normally washed, degutted and spread on raised platform for dehydration before transportation to respective markets. Other preservation methods observed included fish frying, smoking and freezing.

The same source indicated that the concept of fish marketing was related to specific place where groups of buyers

and sellers converged to make business normally at the farm gates and small markets in the rural areas. Prices of fish were determined according to the bargaining power of the consumer or middlemen but generally highly nutritious species such as Clarias, Heterobtanchus, and Heterotis were found to be costlier than Tilapia, Alestes and Protopterus. It was estimated that catfishes attracted as much as ₦120 per kg while Tilapia and Alestes cost only ₦80 per kg (FACU, 1995).

## 2.2 Physico-Chemical Parameters

There were no sufficient or comprehensive data based information on the physico-chemical parameters of the aquacultural projects in the two states. However, fragmentary information gathered from related student research works pointed out the fact of inadequacies. Thus the water sample collected and analysed by Water Resources Engineering and Construction Agency (W.R.E.C.A.) in 1977 for Maska fish farm showed that some of the parameters such as the calcium level, iron, hardness were low and not within the acceptable limits for fish production (FDF, 1977).

Lysak (1978) observed the effect of temperature on the feeding and growth rate of fish in Kaduna. He stated that an increase of temperature well above the optimum of the feeding regime during the dry season, reduced the growth of fish.

Aquatic weeds are also important in the management of fish farms. FACU (1995) showed that weeds threatened the effective management of some fish farms in Kaduna and that the major

control measures employed were slashing, hoeing, hand pulling and animal grazing.

CHAPTER 3

# RESEARCH PROCEDURES

## 3.1 Introduction

This research was carried out in two phases covering a total period of 36 weeks from 13th May, 1996 to 28th January. 1997. While the first phase involved the check list of fish farms and administering of questionnaire which lasted for about 10 weeks, May to July, 1996, the second phase involved the determination of some physico-chemical parameters of two fish farms selected from the two study areas. The second phase lasted for 26 weeks, July 1996 to January 1997, thus making it possible to have three months of observation during the raining and three months during the drying periods. The sampling sites were randomly selected and labelled A and B in Mando Fish Farm (Fig. 1) while those ponds in Maska (Fig. 2) which contained enough water throughout the year were selected.

## 3.2 Description of the Project Areas:

### 3.2.1 Kaduna State

Kaduna State is located between the Longitude 6°00' and 09°00' East of the Greenwich meridian and Latitude 09°00' and 11°30' North of the Equator, and occupies an area of about 43.400 square kilometers. The state occupies almost the entire central portion of the Northern part of Nigeria and shares borders with Sokoto, Niger, Katsina, Plateau, Kano.

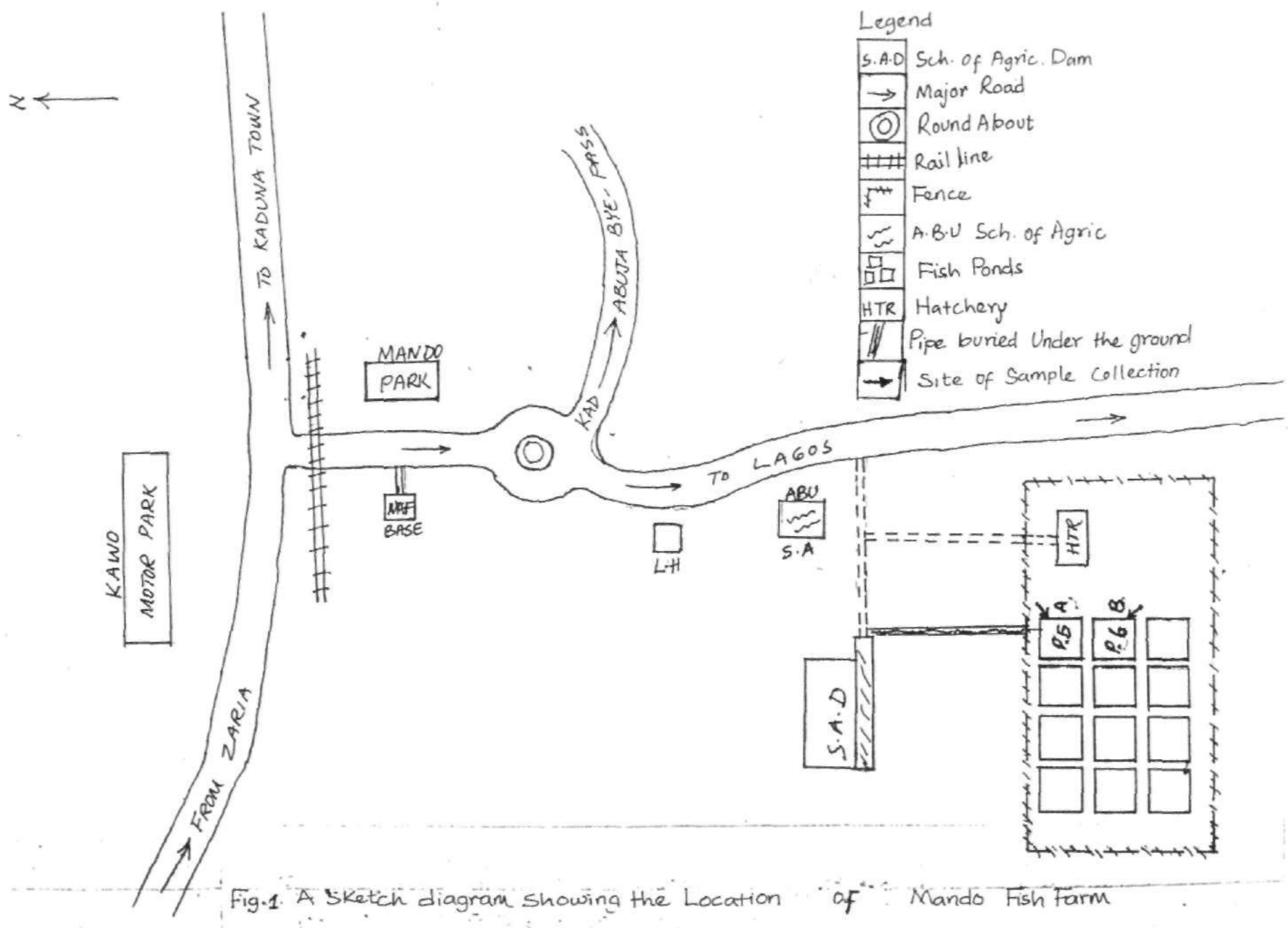


Fig.1 A Sketch diagram showing the Location of Mando Fish Farm

Bauchi states and Federal Capital Territory (Fig. 3, page 33)

Mean annual rainfall average 1300 mm (over 1000 mm in the North to about 1524 mm in the South East corner of the State). The rainy season commences in April in the state. Rainfall is primarily governed by the movement of the intertropical convergence zone. The rainfall peaks are in July and the month of August. The rainy season extends from April to first week of october. The dry season extends from October to March and is marked by bright sunshine and the dusty and cold dry North easterly harmattan winds.

Topographically, the state is dominated by a gently rolling land which rises from an elevation for some 600 meters in the North to an average of 859 meters in the South east. The state forms a watershed for the Sokoto and Kaduna River Basins in the Northern and Southern parts respectively.

The state is made up of 23 local government areas which have been grouped ecologically for Agricultural Development purposes into 4 Management/Extension zones namely Kafanchan, Birnin Gwari, Kachia and Zaria Zones.

### 3.2.2 Katsina State

Katsina State was carved out of the erstwhile Kaduna State on September 23rd in 1987. The state is located between the Longitude 6°52' and 9°2' East of the Greenwich meridian and Latitude 11°7' and 13°22' North of the Equator and occupies land area of about 23,930 square kilometers.

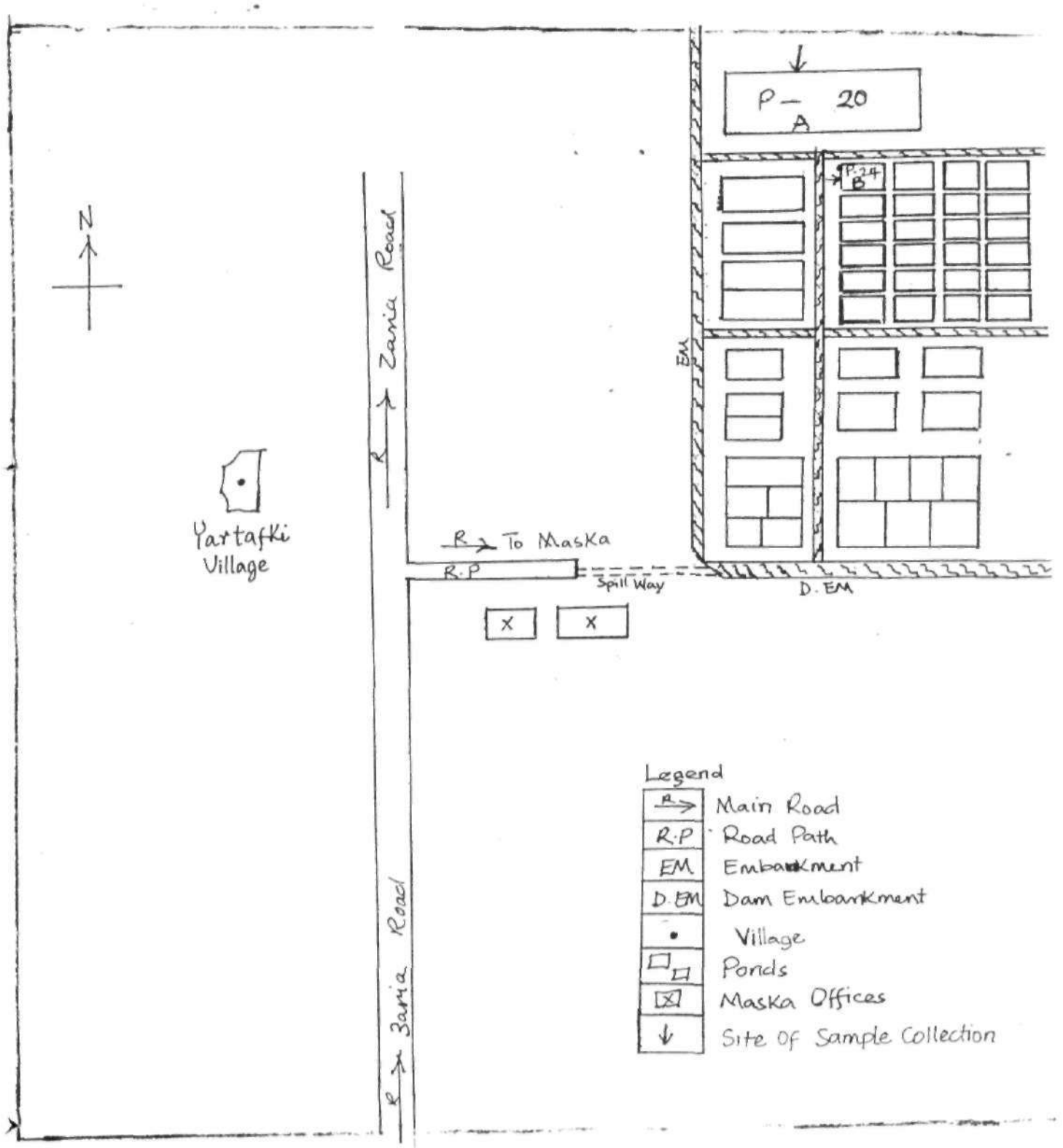


Fig. 2 A Sketch diagram showing the location of Maska Fish Farm.

The state occupies the extreme North of the country and shares borders with Sokoto, Zamfara, Kaduna, Kano states and Niger Republic (Fig. 4, page 37).

Mean annual rainfall shows marked decrease from south to the north 300 - 400 mm Sahel, 600 - 800 mm Sudan savannah and between 900 - 1100 mm in the Northern Guinea of the State (i.e. Southern part of the state).

The state form the watershed of some major rivers which are Sokoto and Karaduwa River Basins.

Weather varies according to the season of the year. Generally, the weather is cool in the morning, hot in the afternoon, cool again in the evening. Between November and January, the harmattan lowers temperature. The winds are dry in January to April.

### 3.3 Administration of the Research Questionnaire

Preliminary survey was conducted by making contact with the personnels and officers in charge of the fisheries in the State Ministries of Agriculture and Natural Resources, State Fish Farms and Agricultural Development Projects (ADPs) of the two states. The list of the existing fish farms on their record were thus obtained.

The questionnaire covers general areas of fish farms management such as water quality parameters, culture facilities, species of fish culture, general pond management, production, management staff and equipment, funding, processing, marketing and distribution. This comprises of

nine sections and 104 questions (Appendix I).

Copies of this questionnaire were distributed and administered through the use of direct and indirect contact methods .

The targets of the direct contact methods were the illiterate and semi-illiterate fish farmers who could not read and write or understand some of the technical areas contained in the questionnaire.

The farmers were contacted personally either at their farm sites or at homes and through the use of interpreters. the questions in the questionnaires were read, answered were filled and the copies of questinnaire collected back on the spot.

The second, the indirect method was employed to reach the literate fish farmers and the officers of the established government owned fish farms. The copies of the questionnaire were given to them to fill at their own spare time and returned later.

In addition to the questionnaire given out, personal visits were made and surveys were conducted on some of the fish farms to verify some of the claims and for-on the spot assessment of such farms.

### 3.4 Field Observations

The photographs of the farm facilities, pond environment were taken with the use of the camera model Yashika. The common pond weeds were collected for identification while the predators, and ectoparasites of fish encountered during the

visit and survey were noted. The nature of the sites, the design of the farms and nature of soil as well as the physical appearance of water were equally noted.

The type of fishing gears available and the harvesting methods were also noted and all other observations made were recorded.

### 3.5 Analysis of the Physico-Chemical Parameters

#### 3.5.1 Description of the sites of sample collection

(a) Mando Fish Farm:

Mando Fish Farm is one of the several fish seed multiplication centres built by the Federal Department of Fisheries in 1981 with the aim of functioning as fresh water fish farming and training centre. The farm which has a total area of 5 ha, 12 ponds and a hatchery complex is located about 1.5 kilometers West of Kaduna town. The farm receives its water supply through the use of underground pipes from the Dam which belongs to the College of Agriculture, an affiliate of Ahmadu Bello University, Zaria. While the dam is located east-ward about 300 metres away, the farm is situated west-ward at lower level thus allowing the water supply by gravity.

The ponds designated as 5 which received water directly from the dam and 6 labelled A and B respectively were selected for samples of water (Fig. 1).

(b) Maska Fish Farm:

The Maska Fish Farm which was established by the Katsina

Native Authority in 1954 is located about 8 kilometers along Zaria road, south of Funtua town. The farm has a total area of about 20.23 ha comprising of 24 ponds belonging to Federal Department of Fisheries and 20 ponds belonging to Katsina State Government. The farm has a hatchery complex consisting of 12 concrete tanks though in a dilapidated condition.

The main source of water supply to the farm is the reservoir which is fed by the Rivers Tuba and Iyaka and their tributaries. Unfortunately, these are seasonal rivers that depend on the rainfall to keep them flowing. During the rainy season, these rivers are heavily loaded with silt materials. This has consequently led to the silting of the reservoir and hence, its inability to contain enough water to withstand the high evaporation. Thus, before February of every year, the dam gets dried completely.

The two ponds selected for this research were chosen, one from the Federal section and the other from the state section for their ability to retain water for most part of the year. The pond designated 24 was selected for the research from the Federal section while pond 20 was used from the state unit. The ponds were labelled A and B respectively (Fig. 2).

### 3.6 Sampling Equipment and Methods

Physico-chemical parameters were obtained from samples collected from surface waters by hand. The bottles were held

by the neck and dipped about 10 cm below the water surface and allowed to fill to the brim. They were tightly stoppered to make sure any bubbles were trapped and also to prevent any exchange of gases. The samples were collected throughout the period of the research between 8 and 9 am fortnightly and between July and September for the rainy season. The dry season collection commenced in November 1996 and was terminated in January 1997.

Due to technical difficulty, depth sampling was not carried out.

3.6.1 Dissolved Oxygen

The samples for oxygen content determination and percentage saturation were collected in 300ml biochemical oxygen demand (BOD) bottles according to the standard methods for the examination of waste water (APHA, 1975) and as described by Lind (1979). The samples were fixed immediately in the field using alkaline iodine-azide solution with manganous sulphate as catalyst and transported to the laboratory. The precipitate formed was dissolved by sulphuric acid ($H_2SO_4$ Sp.gr = 1.84). This released molecular iodine equivalent to the amount of dissolved oxygen. 100ml of the treated sample was then titrated with 0.0125N sodium thiosulphate ($Na_2S_2O_3$) to a very pale, yellow colour followed by addition of 1ml of starch indicator. The titration continued until the first disappearance of the blue colour. From the volume of the thiosulphate used, the concentration of oxygen

was calculated and given in mg/l. The percentage oxygen saturation was calculated using the temperature measurements taken during sample collection (Montgomery, 1964).

3.6.2 Hardness

Water samples for hardness determination were collected in polyethylene bottles of about 1000 ml and transported to the laboratory. 25ml of the sample was diluted to 50ml with deionized water in titration flask, following the method of Lind (1979). To the above sample, 2ml of buffer solution was added to bring pH to 10.0. Approximately 0.1g indicator powder on the tip of the spatula was then added and titrated with EDTA over a white surface with daylight. This was stirred continuously until the last red tinge disappeared.

Calculations:

EDTA hardness as $MgCaCo_3$ per litre = $\frac{A \times B \times 1,000}{\text{ml of sample}}$ -- (3.1)

where

A = ml titration

B = Mg CaCo3 equivalent to 1.00ml EDTA titrant.

But when titrating a 25.0ml sample with 0.01M EDTA titrant, the following equation is applicable.

EDTA hardness as Mg CaCo3 per litre = A x 40 (Lind, 1979). -- (3.2)

3.6.3 Alkalinity

The Water samples for alkalinity determination were collected in 1000ml polyethylene bottles and carried to the

laboratory for analysis within 1-2 hours of collection.

The samples were tightly sealed to avoid alteration which could arise from lost of carbon dioxide from solution and this results in the conversion of bicarbonate to carbonate. 100ml of the sample was then gently poured out into a 250ml Erlenmeyer flask. The titration for alkalinity was made using 0.02N Standard Sulphuric acid solution. The colour indicator method was employed for determination of pH end-points which was taken to be 4.5 (Henderson, 1973).

4 drops of phenolphthalein indicator were added to the sample to determine if hydroxide or normal carbonate was present. There was no distinctive colour. Thus 2 drops of methyl orange indicator were further added and still. there was no colour. An alternative method was therefore employed using bromcresol green-methyl red indicator as substrate for methyl/orange and titrated until the blue changed to a clear pink. The volume of the acid used was then recorded.

Calculations:

Phenopthalein alkalinity as Mg CaCo3 per litre

$$= \frac{A \times N \times 50{,}000}{\text{ml sample}} \quad \text{-- (3.3)}$$

Total alkalinity as Mg CaCo3 per litre

$$= \frac{B \times N \times 50{,}000}{\text{ml sample}} \quad \text{-- (3.4)}$$

where

A = ml titration to PH 8.3 (phenolphthalein end points)

B = ml total titration from start to PH 4.5

methyl orange end point)

N = Normality of acid

But when titrating a 100ml sample with 0.02N $H_2SO_4$, the equations are =

*Phenolphthalein alkalinity as Mg CaCo3 per litre = A x 10* -- (3.5)

Total alkalinity as Mg CaCo3 per litre = B x 10 (Lind, 1979). -- (3.6)

3.6.4. PH

Due to non availability of pocket PH meter, water samples for PH determination were collected in about 100ml polyethylene bottles and carried to the laboratory for measurement. The PH meter Model 7010, buffered at pH 7.00 and with temperature compensation at 30°C was used. The points at which the needle stabilized were recorded as the final pH of the samples. However, in the course of the research, this model broke down and was replaced with another model Kent EIL 7055.

3.6.5 Temperature

Temperature was measured as the water was being collected. A bottle was filled and allowed to stand in pond water with a mercury in glass thermometer inserted in it for about 2 minutes. The temperature was read immediately as the bottle was taken from the water and recorded.

3.6.6 Secchi Disc Transparency

The depths of light penetration were measured by lowering a disc of 20 cm in diameter weighted on the underside with a

heavy material to make it sink. The depth at which it just disappeared was recorded. The disc was then lowered a little more and raised until it just reappeared and the depth recorded. The average of the two depth readings were taken as the secchi disc transparency (Almazan and Boyd, 1978).

CHAPTER 4

# 4.0 RESULTS

## 4.1 Fish Farms in Kaduna State

Seventeen fish farms/ponds with an estimated surface areas of 91.2 ha and twenty-four homestead ponds (approximately 1 ha.) were found in the state of which four fish farms and one homestead/research pond belong to the government. The rest were owned by the private fish farmers. 5.99%, 17.6%, and 53.1% of the fish farms were established between 1950 - 1959, 1980 - 1989 and 1990 - 1997 respectively. There were no much records of fish farming activity during the period 1960 - 1979 probably due to tensions which preceded the civil war of 1967 and which generally affected economic activities in the country.

The areas with impressive fish farming activities were Kaduna metropolis, Zaria town and Kafanchan area and its suburb like Kagoro (Fig 3). Similarly, 69.6% of the homestead ponds were found in Kaduna metropolis followed by Zaria with 17.2%, Kagoro 8.6% and Kafanchan 4.3%. The existing fish ponds and homestead ponds are presented in Tables 4.1 and 4.2 respectively.

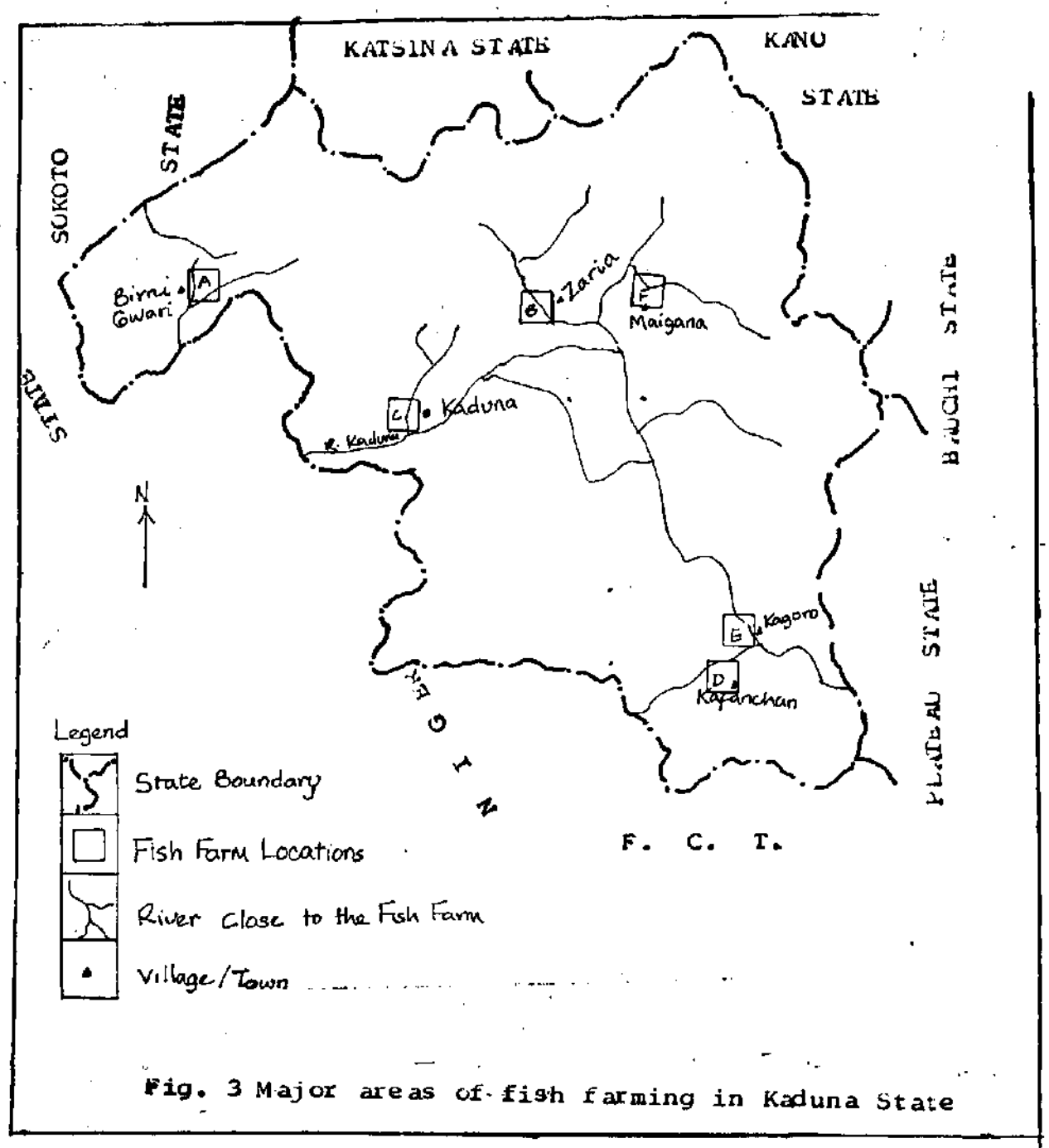


Fig. 3 Major areas of fish farming in Kaduna State

Table 4.1: Existing Fish ponds in Kaduna State.

| No. | Name | Ownership | Location | Size | Period of Establish. |
|---|---|---|---|---|---|
| 1. | Fed. Dept of Fish | Fed. Govt. | Mando | 5.0ha | 1980-1989 |
| 2. | Maigana Fish Farm | State Govt. | Maigana | 12.0ha | 1960-1979 |
| 3. | Kafanchan Seed mult Centre | " " | Takau | 5ha | 1980-1989 |
| 4. | Safaha Farms | Private | Rigachukun | 2.5ha | " " |
| 5. | Wushishi Farms | " | Dankande | 3ha | " " |
| 6. | Alh. Iliyasu Farms | " | " | 7ha | " " |
| 7. | Lemaco Farms | " | Udawa | 2.6ha | " " |
| 8. | Dadin Kowa Farm | " | Nassarawa | 2ha | 1990-1997 |
| 9 | Alh.Godogodo Farm | " | Godogodo | 15ha | " " |
| 10. | Aruwa Ranch Farm | " | KD-Ab.Rd | 10ha | 1980-1989 |
| 11. | Hasfiya Fish Farm | " | Godogodo | 5ha | " " |
| 12. | Mr.Saliyuk F.Farm | " | Kagoro | 3ha | " " |
| 13. | Malachy F. Farm | " | Goni-Gora (KD-Ab Rd) | 1.5ha | " " |
| 14. | A.B.U. Sewage ponds | A.B.U. | Samaru | 3ha | 1960-1979 |
| 15. | Niger Fish Farm | Private | Kaduna town | 2ha | 1990-1997 |
| 16. | Sabo Fish Farm | " | Kaduna town | 2ha | " " |
| 17. | Tutu Fish Farm | " | Kaduna town | 10.6ha | " " |

Table 4.2: Existing Homestead Ponds in Kaduna State

| S/No. | Name | Ownership | Location | Size | Period of Establish. |
|---|---|---|---|---|---|
| 1. | Ayuba Kwaha Farm | Private | Air P.Rd | .02ha | 1990 - 1997 |
| 2. | Mrs. Madaki | Private | Kaduna | .015ha | " " |
| 3. | Alh. Musa Ibrahim | " | " | .003ha | " " |
| 4. | Alh. Adamu Abubakar | " | Rigasa | .002ha | " " |
| 5. | National Steel Council | Private | Kaduna | .03ha | " " |
| 6. | Iyala Farm | Private | " | .008ha | 1990-1997 |
| 7. | Ogume Farm | Private | " | .001ha | " " |
| 8. | Alh. Mude Farm | " | " | .008ha | " " |
| 9. | Dr. Umar Farm | " | " | .005ha | " " |
| 10. | Bulus James | " | " | .007ha | " " |
| 11. | Mrs B. Maigari | " | " | .006ha | " " |
| 12. | NAERLS, ABU Research | A.B.U. | Samaru | .002ha | 1980-1989 |
| 13. | Dr. Balofun F.pond | Private | Samarú | .006ha | 1990-1997 |
| 14. | Dr. Shittu Homestead | " | GRA Zaria | .4 ha | " " |
| 15. | Ayaga Homestead | " | Kaduna | .008ha | " " |
| 16. | Maria Diko " | " | " | .012ha | " " |
| 17. | Mrs Lekwot " | " | " | .01ha | " " |
| 18. | Dr. Kitchner " | " | " | .02ha | " " |
| 19. | Mr. Shehu " | " | Badiko Kad. | .01ha | " " |
| 20. | Mal. Magaji " | " | Kaduna | .008ha | " " |
| 21. | Musa Ezra " | " | Dawaki Rd Kad. | .009ha | " " |
| 22. | Mr. Sidi " | " | Wadon Kad. | .021ha | " " |
| 23. | Mr. Saliyuk " | " | Kagoro | .004ha | " " |
| 24. | Muhammadu F. " | " | Kaduna | .12ha | " " |

## 4.2 Fish Farms in Katsina State

Eight fish farms (approximately 28.86 ha) and eighteen homestead ponds (approximately .33 ha) were found in the state in addition to two hatcheries located at Jibia Local Government Area and Mairuwa in Funtua Local Government Area respectively. Three of the fish farms belong to Federal Dept of Fisheries, Katsina Ministry of Agriculture and Natural Resources, and Jibia Local Government Council. Apart from the state fish farm which was established in 1954 and Federal Dept of Fishery fish farm in 1983, the rest were established between 1990 and 1997. The area with high concentration of fish farming activities were Katsina metropolis, Funtua town and suburbs, Jibia town and Dutsema Local Government Area (Fig 4). However, majority of the homestead ponds were found in Katsina metropolis and Funtua town. The list of existing fish ponds in Katsina State are found in Table 4.3.

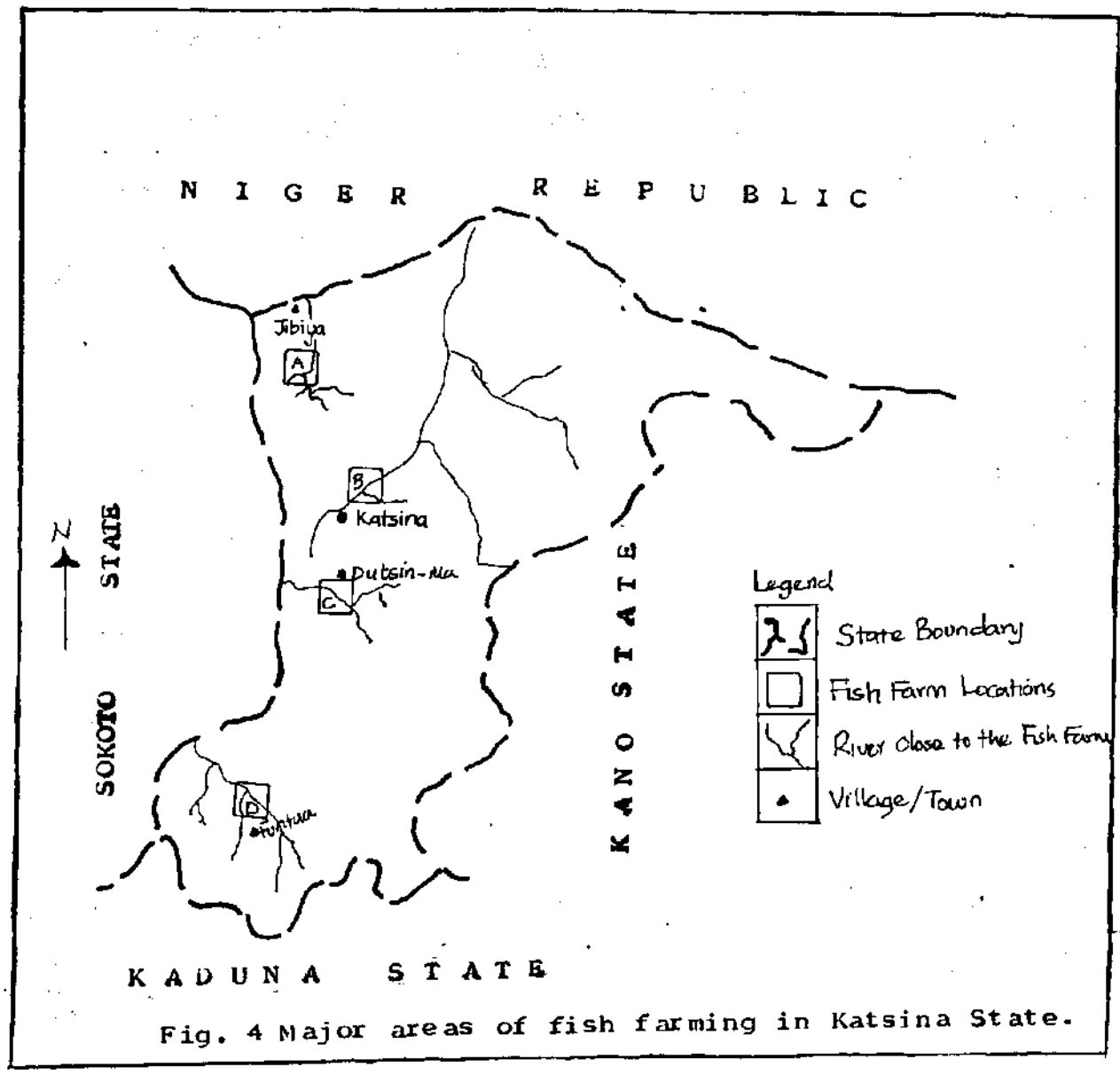


Fig. 4 Major areas of fish farming in Katsina State.

Table 4.3: Existing Fish Ponds in Katsina State

| S/No. | Name | Ownership | Location | Size | Period of Establish. |
|---|---|---|---|---|---|
| 1. | Fed. Dept.of Fish | Fed.Govt. | Funtua | 5ha | 1980-1989 |
| 2. | State Fish Farm | State Govt. | Funtua | 20.23ha | 1950-1959 |
| 3. | Jibia LGA F. Pond | LGA | Jibia | 0.08ha | 1990-1997 |
| 4. | Kado Fish Farm | Private | Funtua | 1.00ha | " " |
| 5. | Sambo Fish Farm | " | Faskari | 1.50ha | " " |
| 6. | Alh. Manema F.Ponds | " | Bakori | 0.60ha | " " |
| 7. | Alh. Bature F. Farm | " | Jibia | 0.40ha | " " |
| 8. | Alh. Maikudi Integrated Poultry/ Fish | " | Jibia | 0.05ha | " " |
| 9. | Alh.Mamman Lawal | " | Ajiwa | 0.02ha | " " |
| 10. | Babajo Farm | " | Funtua | 0.01ha | " " |
| 11. | Balan Maikala | " | " | 0.02ha | " " |
| 12. | Alh. Baba | " | " | 0.01ha | " " |
| 13. | Ja Afani | " | " | 0.03ha | " " |
| 14. | Rasheed | " | " | 0.04ha | " " |
| 15. | Alh. Iro Garba | " | " | 0.02ha | " " |
| 16. | Dahala | " | Kafar | 0.01ha | " " |
| 17. | Dan Musa F. Pond | " | Dutsema | 0.02ha | " " |
| 18. | Kartaka F. Pond | " | " | 0.03ha | " " |
| 19. | Rukue F. Pond | " | " | 0.02ha | " " |
| 20. | Alh.Ismaila M. Fish Pond | " | GRA Kat. | 0.01ha | " " |
| 21. | Zainab Fish Pond | " | Katsina | 0.01ha | " " |
| 22. | Rafindadi F.Pond | " | " | 0.02ha | " " |
| 23. | Dauda Fish Pond | " | " | 0.01ha | " " |
| 24. | Bagiwa " Pond | " | " | 0.01ha | " " |
| 25. | Kabir Sule F. Pond | " | " | 0.02ha | " " |
| 26. | DFFRI Hatchery | Fed. Govt. | Mairuwa Funtua | 0.001ha | 1980-1989 |
| 27. | DFFRI Hatchery | " | Katsina | 0.001ha | " |

## 4.3 General Information from the Fishfarms

Table 4.4 shows that the majority of the fish farmers (58.3%) in Kaduna State lacked basic academic knowledge of fisheries (i.e. they did not read fisheries courses). Although 74.7% of the farms were sited in the right soil, 49.8% of the farms depended on pumping because the farms lacked drainage systems. The majority of the farms (83%) were constructed for commercial purposes. The farm ranged in size from 0.7 - 1.5ha in subsistence farms and 1.5ha to 10.6ha in commercial farms. The number of ponds in the farms average 8.0 ± 5.94 S.D.

In Katsina State however, 60% of the farmers were inexperienced, untrained in fisheries courses. 60% also of the farms were undrainable while 40% of the farms were integrated livestock-cum-fish farming. The farms ranged in size from 0.25ha to 1ha in subsistence farms and 2.4ha to 20.23ha for commercial farms.

Table 4.4: Gen.Information from the Fishfarms in Kaduna and Katsina States.

| Paraneters | Kaduna State Fish Farms No. | % | Katsina State Fish Farms No. | % |
|---|---|---|---|---|
| Experience: | | | | |
| Fisheries courses | 5 | 41.7 | 2 | 40 |
| No Fisheries " | 7 | 58.3 | 3 | 60 |
| Farm Objective: | | | | |
| Commercial | 10 | 83.0 | 3 | 60 |
| Homestead | 1 | 8.3 | 1 | 20 |
| Research | 1 | 8.3 | 2 | 40 |
| Design: | | | | |
| Integrated | 2 | 16.6 | 2 | 40 |
| Fish only | 10 | 83.0 | 3 | 60 |
| Nature of ponds: | | | | |
| Drainable | 6 | 49.8 | 3 | 60 |
| Feasibility Studies: | | | | |
| Done | 6 | 49.8 | 3 | 60 |
| Not done | 6 | 49.8 | 2 | 40 |
| Topography: | | | | |
| Lowland area | 5 | 41.5 | 2 | 40 |
| Level ground | 1 | 8.3 | 2 | 40 |
| Contour not known | 3 | 24.9 | 1 | 20 |
| Drainage: | | | | |
| By gravity | 6 | 49.8 | 3 | 60 |
| By pump | 6 | 49.8 | 2 | 40 |
| Soil nature: | | | | |
| Clayey | 9 | 74.7 | 3 | 60 |
| Sandy/clay | 1 | 8.3 | 1 | 20 |
| Gravel/clay | 1 | 8.3 | 1 | 20 |
| Loamy | 1 | 8.3 | - | - |
| Construction Method: | | | | |
| Mechanical | 7 | 58.1 | 3 | 60 |
| Manual | 5 | 41.5 | 2 | 40 |
| Soil-water retention: | | | | |
| Low retention | - | - | 2 | 40 |
| Good retention | 12 | 100 | 3 | 60 |
| Road net work: | | | | |
| Tared | 5 | 41.5 | 3 | 60 |
| Not Tared but good | 6 | 49.8 | - | - |
| Very bad | 1 | 8.3 | 2 | 40 |
| Water quality test: | | | | |
| Done | 2 | 16.6 | 1 | 20 |
| Never done | 10 | 83.0 | 4 | 80 |
| Water abundance: | | | | |
| Enough | 8 | 66.7 | 2 | 40 |
| Not enough | 4 | 33.3 | 3 | 60 |
| Source of water: | | | | |
| Reservoir | 5 | 41.7 | 3 | 60 |

## 4.4 Culture Facilities

Most of the fish farms lack basic culture facilities. In Kaduna State 24.9% of the farms had functional hatchery facilities while the only farm in Katsina which had hatchery was not functioning. The pond culture facilities seen on the farms are as shown in Table 4.5.

## 4.5 Type of Fish Cultured

All the fish farms in Kaduna State cultured Clarias (100%) and Tilapias (100%) followed by carp (58.1%) and Heterobranchus (24.9%). Also in Katsina all the fish farms cultured Clarias (100%) and Tilapias (100%), Heterobranchus (40%) and carp (20%). 83% of fish farmers in Kaduna and 60% in Katsina obtained their fish seed (mainly Clarias and Tilapias) from Government seed multiplication centres while the rest obtained theirs from the wild and other farmers. In both cases the farmers travelled over long distances to obtain fish seed - (Table 4.6).

Table 4.5: Culture Facilities Found on the Farms

| Parameters | Kaduna State Fish Farms No. | % | Katsina State Fish Farms No. | % |
|---|---|---|---|---|
| Hatchery Facilities: | | | | |
| Outdoor hatchery | 3 | 24.9 | - | - |
| Indoor hatchery | - | - | - | - |
| No functional " | 2 | 16.2 | 2 | 20 |
| No hatchery | 7 | 58.1 | 3 | 60 |
| Pond Structure: | | | | |
| Monk | 3 | 24.9 | 2 | 40 |
| Sluice | 3 | 24.9 | 2 | 40 |
| Inlet pipe | 5 | 41.5 | 2 | 40 |
| Drainage pipe | 4 | 33.2 | 2 | 40 |
| Over flow | 1 | 8.3 | 1 | 20 |
| Drainage Pattern: | | | | |
| Common drainage | 1 | 8.3 | 2 | 20 |
| Separate | 5 | 41.5 | 1 | 20 |
| None | 6 | 49.8 | 2 | 40 |
| Flood problem: | | | | |
| No flood | 9 | 74.7 | 5 | 100 |
| Flood | 3 | 24.9 | - | - |
| Pond Types: | | | | |
| Nursery | 7 | 58.1 | 1 | 20 |
| Rearing | 8 | 66.4 | 3 | 60 |
| Production | 8 | 66.4 | 2 | 40 |
| Holding | - | | | |

Table 4.6: Type of Fish Cultured and Source of Fingerlings

| Parameters | Kaduna State Fish Farms No. | % | Katsina State Fish Farms No. | % |
|---|---|---|---|---|
| Type of Fish Cultured: | | | | |
| *Heterobranchus bidorsalis* | 3 | 24.9 | 2 | 40 |
| *Clarias gariepinus* | 12 | 100 | 5 | 100 |
| *Oreochromis niloticus* | 12 | 100 | 5 | 100 |
| *Labeo labeo* | 1 | 8.3 | - | - |
| *Lates niloticus* | 3 | 24.9 | - | - |
| *Cyprinus Carpio* | 7 | 58.1 | 1 | 20 |
| *Gymnachus niloticus* | 1 | 8.3 | - | - |
| *Heterotis niloticus* | 2 | 16.6 | - | - |
| Source of Fingerlings : | | | | |
| Govt. Seed Mult Centres | 10 | 83.0 | 3 | 60 |
| Wild and other farms | 2 | 16.6 | 2 | 40 |
| Distance to source of seed: | | | | |
| 1 - 99km | 3 | 24.9 | 1 | 20 |
| 100km and above | 9 | 74.7 | 4 | 80 |
| Fish Seed Price: | | | | |
| Generally high | 10 | 83 | 4 | 80 |
| Moderate | 2 | 16.6 | 1 | 20 |
| Fingerling Mortality in transit: | | | | |
| High mortality | 9 | 74.7 | 3 | 60 |
| No " | 3 | 24.9 | 2 | 40 |
| ulture practice: | | | | |
| Monoculture | - | - | 1 | 20 |
| Poly culture | 12 | 100 | 3 | 80 |

## 4.6 General Pond Management Practices

The common problems encountered in the management of fish farms in the two states include weed, predators ( e.g. King- fisher birds), parasites (e.g leeches) and muddy pond bottoms. The various management practices adopted by the fish farmers in the two study areas are stated in Table 4.7.

## 4.7 Production Record

In Katsina State 80% of the farmers did not keep record while in Kaduna State the ratio between those who kept record and those who did not was 1:1. Fish net constituted major problems to the operations of the farms in the two states. 66.7% and 60% of the farms in Kaduna and Katsina States respectively lacked fishing nets. Despite the lack of record, farmers indicated that the demand for their farm product was always higher than supply (Table 4.8).

Table 4.7: General Pond Management Practices

| Parameter | Kaduna State Fish Farms No. | Kaduna State Fish Farms % | Katsina State Fish Farms No. | Katsina State Fish Farms % |
|---|---|---|---|---|
| Weed problems: | | | | |
| Yes | 6 | 49.8 | 3 | 60 |
| No | 6 | 49.8 | 2 | 40 |
| Weed types: | | | | |
| Floating | - | - | 3 | 60 |
| Submerged | 1 | 8.3 | 2 | 40 |
| Emergent | 5 | 41.5 | 2 | 40 |
| Weed control measures: | | | | |
| Slashing/cutting | 9 | 74.7 | 5 | 100 |
| Burning | 1 | 8.3 | 2 | 40 |
| Predators/Parasites: | | | | |
| Reptiles | 11 | 91.3 | 4 | 80 |
| Birds | 6 | 49.8 | 4 | 80 |
| Parasites/leeches | 4 | 33.2 | 2 | 40 |
| Muddy pond bottoms: | | | | |
| Yes | 6 | 49.8 | 4 | 80 |
| No | 3 | 24.9 | 2 | 20 |
| Dried Ponds: | | | | |
| Yes | 7 | 58.1 | 3 | 6 |
| No | 4 | 33.2 | 2 | 40 |
| Reasons for dried ponds: | | | | |
| High seepages | 3 | 24.9 | 2 | 40 |
| High evaporate rate | 4 | 33.2 | 2 | 40 |
| No water in Reservoir | 4 | 33.2 | 3 | 60 |
| Pond bottom desilted: | | | | |
| Yes | 5 | 41.5 | - | - |
| No | 7 | 58.1 | 5 | 100 |
| Liming of ponds: | | | | |
| Yes | 9 | 74.7 | - | - |
| No | 3 | 24.9 | 5 | 100 |
| Pond Fertilization: | | | | |
| Yes | 10 | 83.0 | 2 | 40 |
| No | 2 | 16.6 | 3 | 60 |
| Type of Fertilizer used: | | | | |
| Organic | 9 | 74.7 | 1 | 20 |
| Inorganic | 2 | 16.6 | 1 | 20 |
| Stocking density: | | | | |
| Considered | 5 | 41.5 | 1 | 20 |
| Not considered | 7 | 58.1 | 4 | 80 |
| Feeding: | | | | |
| Intensive | 9 | 74.7 | 2 | 40 |
| Extensive | 5 | 41.5 | 3 | 60 |
| Cheaper Feed Desired: | | | | |
| Yes | 9 | 74.7 | 4 | 80 |
| No | 2 | 16.6 | 1 | 20 |

Table 4.8: Production Records of the Farms

| Parameters | Kaduna State Fish Farms | | Katsina State Fish Farms | |
|---|---|---|---|---|
| | No. | % | No. | % |
| Farm record: | | | | |
| Kept | 6 | 49.8 | 1 | 20 |
| Not kept | 6 | 49.8 | 4 | 80 |
| Fingerling problem: | | | | |
| Yes | 8 | 66.7 | 3 | 60 |
| No | 4 | 33.2 | 2 | 40 |
| Cropping method: | | | | |
| Total | 3 | 24.9 | 1 | 20 |
| Partial | 7 | 58.1 | 4 | 80 |
| No harvest | 2 | 16.6 | - | - |
| Demand for farm product: | | | | |
| Higher than supply | 12 | 100 | 5 | 100 |
| Lower than supply | - | - | - | - |

### 4.8 Staff and Equipment

49.8% of the respondents in Kaduna State had no management staff. In Kaduna and Katsina States, 66.7% and 40% respectively, represented farms without office accommodation. Security also constituted a major problem to the operation of most farmers in the two States (Table 4.9).

### 4.9 Finance and Credit Facilities

In Kaduna, and Katsina States, 58.1% and 60% respectively claimed to have established their farms with private finance. Only 24.9% of the private farmers in Kaduna and 20% in Katsina claimed that they benefited from government in form of extension advice from the government extension workers. Also, 66.7% and 40% in Kaduna and Katsina States respectively represented farmers who were running their farms at a loss. None of the farmers in the two states had insurance coverage for their farms (Table 4.10).

Table 4.9: Staff and Equipment

| Parameters | Kaduna State Fish Farms No. | % | Katsina State Fish Farms No. | % |
|---|---|---|---|---|
| Staff strength: | | | | |
| 1 - 3 | 3 | 24.9 | 3 | 60 |
| 4 - 5 | 2 | 16.6 | - | - |
| 5 and above | 1 | 8.3 | 1 | 20 |
| No staff | 6 | 49.8 | 1 | 20 |
| Office accommodation: | | | | |
| Yes | 4 | 33.2 | 3 | 60 |
| No | 8 | 66.7 | 2 | 40 |
| Equipment: | | | | |
| Water pump | 9 | 74.7 | 4 | 80 |
| Generating plant | 3 | 24.9 | 1 | 20 |
| Vehicle | 8 | 66.7 | 2 | 40 |
| Store house | 9 | 74.7 | 4 | 80 |
| Security: | | | | |
| Farm Fenced | 5 | 41.5 | 1 | 20 |
| Not fenced | 7 | 58.1 | 4 | 80 |
| Poaching incidence: | | | | |
| High | 5 | 41.5 | 4 | 80 |
| No poaching | 7 | 58.1 | 1 | 20 |
| Cattle menace: | | | | |
| Common problem | 7 | 58.1 | 3 | 60 |
| Not a problem | 5 | 41.5 | 2 | 40 |

Table 4.10: Source of Finance, Credit Facilities and Assessment of farm Performance

| Parameters | Kaduna State Fish Farms No. | % | Katsina State Fish Farms No. | % |
|---|---|---|---|---|
| Funding: | | | | |
| Problem | 10 | 83.0 | 3 | 60 |
| No problem | 2 | 16.6 | 2 | 40 |
| Source of fund: | | | | |
| Bank loan | 4 | 33.2 | 1 | 20 |
| Private | 7 | 58.1 | 3 | 60 |
| Government Agent | 3 | 24.9 | 2 | 40 |
| Interest Rate: | | | | |
| Too high | 1 | 8.3 | 1 | 20 |
| Moderate | - | - | - | - |
| Insurance coverage; | | | | |
| Yes | - | - | - | - |
| No | 12 | 10 | 5 | 100 |
| Government assistance: | | | | |
| Yes | 3 | 24.9 | 2 | 40 |
| No | 9 | 74.7 | 3 | 60 |
| Farm run at loss: | | | | |
| Yes | 8 | 66.7 | 2 | 40 |
| No | 4 | 33.2 | 3 | 60 |
| Farm Abandoned: | | | | |
| Yes | 2 | 16.6 | 2 | 40 |
| No | 10 | 83.0 | 3 | 60 |
| Categorization of farm Performance: | | | | |
| Excellent | - | - | - | 20 |
| Very good | 4 | 33.2 | - | - |
| Good | 3 | 24.9 | - | - |
| Average | 2 | 16.6 | - | - |
| Poor | 3 | 24.9 | 2 | 40 |
| Failure | - | - | 2 | 40 |

### 4.10 Processing, Marketing and Distribution of Farm Product

The concept of processing does not come to the mind of most farmers since they hardly produced enough to meet up with the market demand for their product. Farmers sold their catches on the spot right at the farm sites. The prices of fish varied from one farm to another depending on the species. However, in Kaduna State, the following prices were obtained for the various species for the period 1995/1996.

| Species | Prices/kg |
|---|---|
| Tilapias | ₦50 - 120 |
| Clarias | ₦100 - 200 |
| Lates | ₦120 - 160 |
| Carp | ₦150 - 200 |

The only two species, Tilapia and Clarias produced in Katsina by the farmers for sale ranged in price from N30 - 40 per kg for Tilapia and N40 - 50 per kg for Clarias at government fish farm - during the same period (1995/1996). The prices for private fish farmers were higher. Tilapias and Clarias were sold at between N80 - 120 and N120 - 150/kg respectively.

The respondents from Kaduna and Katsina States agreed that the general awareness of the public in the field of fish farming was low.

### 4.11 Field Observations

The photographs of the observed features recorded in some of the farms during the surveys are found in Plates (I - VIII).

Field Observations

Plate I: General Overview of Maska Fish farm near Funtua Town, Katsina State.

Plate II: Maigana Fish Farm showing the Hatchery Complex

Plate III: Unplanned and Undrainable Private Fish farm at Dankande Village, near Kaduna

Plate IV: A Multi-million Naira Fish Farm at Rigachukun near Kaduna abandoned due to Minor Technical Problems

Plate V: A Homestead Fish Pond at Samaru, Zaria drying due to lack of Water.

Plate VI: A Common Pond weed, polygon spp found in a fish pond

Plate VII: A Homestead research Pond at NAERLS, A.B.U., Zaria

Plate VIII: A Sewage Treatment Pond used for Fish Culturing at A.B.U., Zaria.

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4.12 Water quality characteristics of Maska and Mando Fish Farms

The water quality characteristics obtained during the research period at Maska and Mando fish farms are presented in Appendix III. The seasonal variations of the water characteristics are as shown in Figures 5 - 10.

The dissolved oxygen D.O. (Fig. 5, ) in Mando fish farm was more related to temperature than that at Maska fish farm (Fig.10). The differences in D.O. between the two farms were highly significant ($P < 0.05$) (Table 4.16)

The values obtained for alkalinity for Maska fish farm also showed seasonal significant differences ($P < 0.05$) while there were no significant differences in Mando fish farm (Tables 4.14 and 4.15) Total alkalinity for Mando was higher than that of Maska during the rainy season but the value obtained at Maska for dry season was more than that of Mando (Fig.6). Similarly, there were significant differences ($P < 0.05$) in the level of total hardness at Maska between the seasons (Table 4.14) but there were no significant differences ($P > 0.05$) at Mando fish farm (Table 4.15) The total hardness for Maska fish farm was consistently higher than Mando except in September, and November (Fig. 7).

There were no much differences in water temperature between the two fish farms throughout the period of the research just like that of PH which remained more or less constant (Figs. 8 and 9). There was no significant ($P > 0.05$) seasonal variation in the level of the PH for the two fish farms.

Fig. 5: Mean monthly dissolved oxygen at Maska (1) and Mando (2) fish farms between July, 1996 and January, 1997

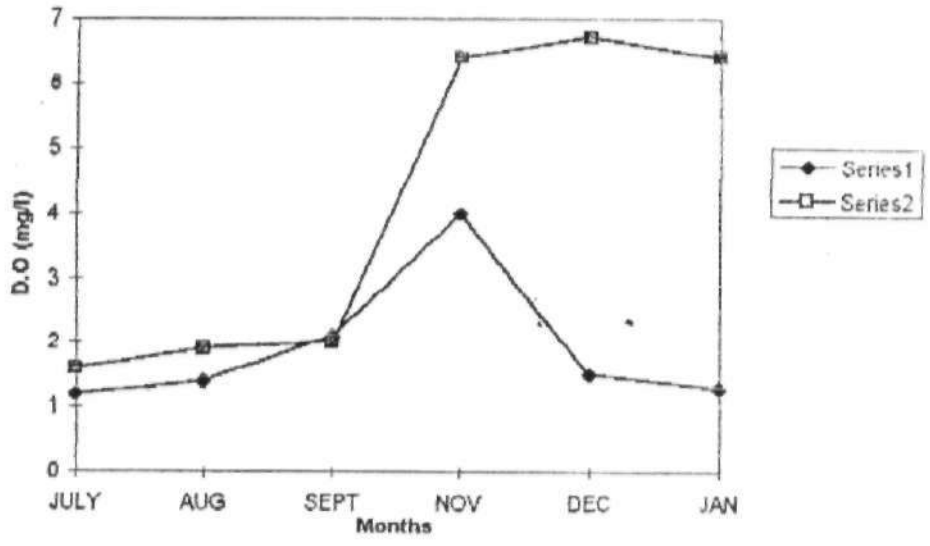
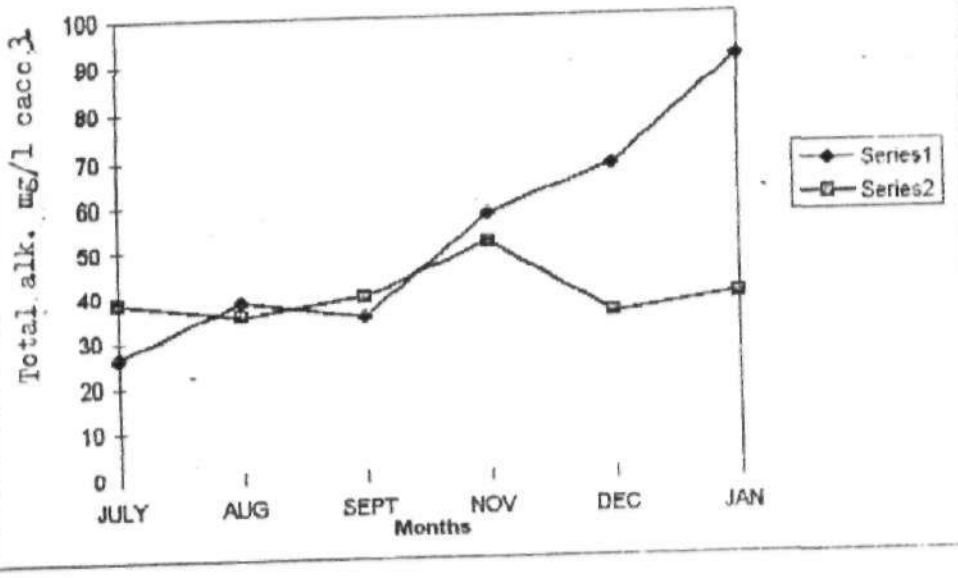



Fig. 6: Mean monthly total Alkalinity (mg/l) of CaCO3 at Maska (1) and Mando (2) fish farms between July, 1996 and January, 1997



The suspended silt content of the Mando fish farm was higher than that of Maska fish farm. It reached its peak in both farms in July when the water was just beginning to settle down. This affected directly the amount of light penetrating the ponds (Fig. 10), the depth of light penetration being least when the silt load was highest. The seasonal variation in the amount of silt in the two farms were highly significant ($P < 0.05$) (Tables 4.14 and 4.15).

Fig. 7: Mean monthly Total Hardness (mg/l) of CaCO3 at Maska (1) and Mando (2) fish farms between July, 1996 and January, 1997

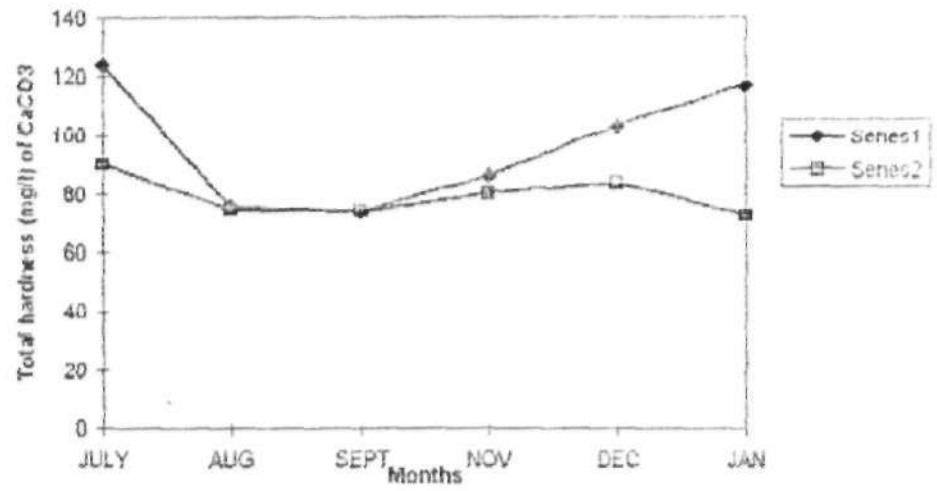



Fig. 8: Mean monthly water temperature (°C) at Maska (1) and Mando (2) fish farms between July, 1996 and January, 1997

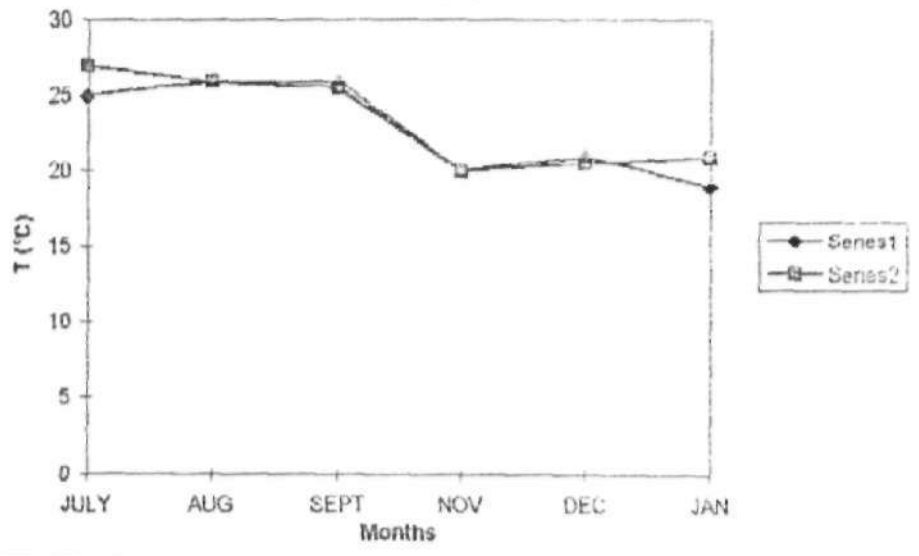


Fig. 9: Mean monthly PH at Maska (1) and Mando (2) fish farms between July, 1996 and January, 1997

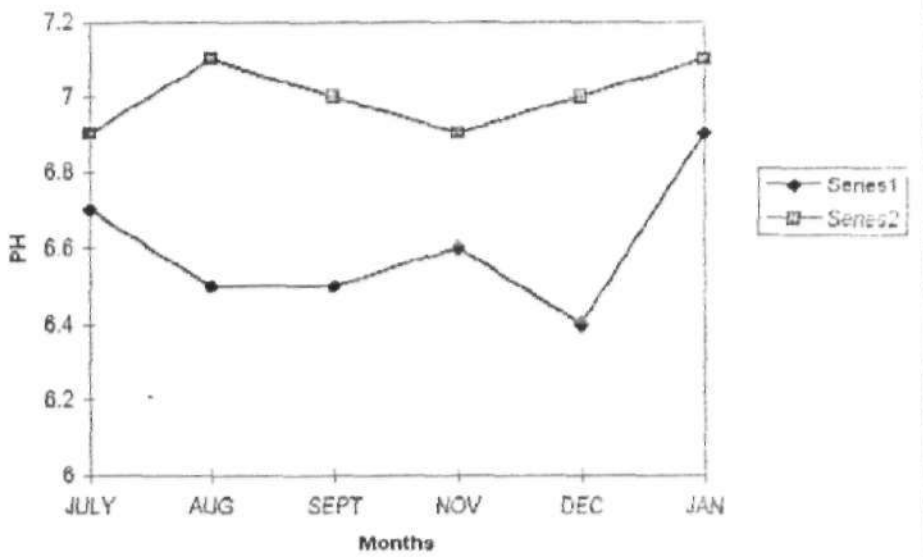
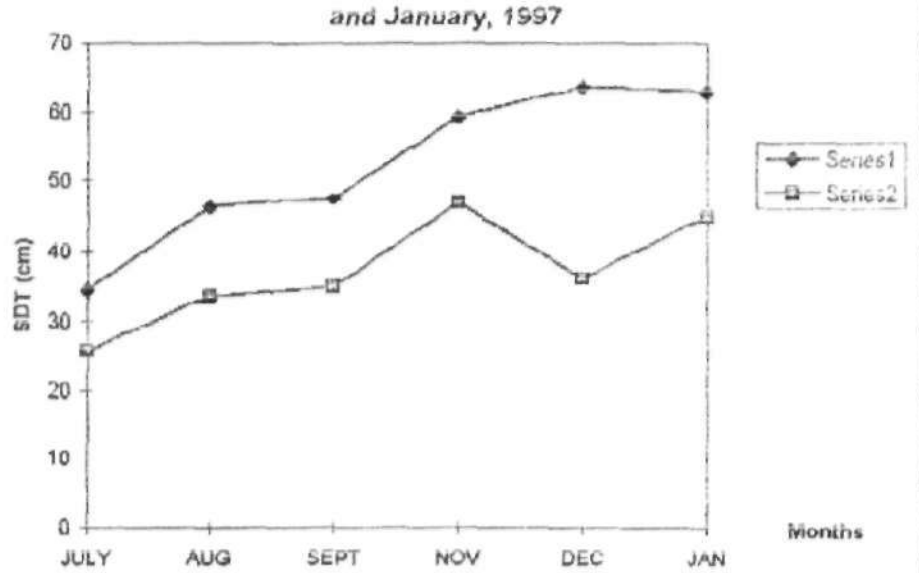



Fig. 10 Mean monthly Secchi Disc Transparency (cm) at Maska (1) and Mando (2) fish farms between July, 1996 and January, 1997



CHAPTER 5

# DISCUSSIONS

## 5.1 Distribution of Fish Farms

The number of fish farms found in Kaduna State was higher than those in Katsina State. This was due to ecological factors and level of awareness of the people in the field of aquaculture. Similarly, there were more recent homestead ponds in Kaduna State than in Katsina with high percentage among the elite class in the urban cities due to greater awareness, financial power and proximity to technical assistance.

The fish farmers in the two states were inexperienced. untrained in the field of fisheries and aquaculture indicating that a greater percentage of the farmers relied on the services of the consultants which must have compounded the problem of managing the fish farms in the areas. Results of the study conducted by FACU (1995) in kaduna corroborated this by indicating that a dangerous trend in the field of aquaculture has been the unskilled but exposed operators serving as consultants to intending farmers. Field investigation in this study also confirmed that a farmer in kaduna area was having a serious water problem on his farm not due to lack of water in the reservoir, but simply because the farm was badly sited. The farm was located at a hilly area which made water supply by gravity difficult. Other factors threatening the effective management of fish farms in the two states found in this study were lack of feasibility studies to

determine the topography of the land, drainage pattern, the nature of the soil, water quality characteristics and its availability.

The survey indicated that 49.8 and 40% of the respondents in Kaduna and Katsina States respectively did not carry out feasibility studies before siting their farms. The importance of selection of suitable site for pond construction has been described by several workers as what Marilyn (1978) and Kumar (1992) agreed that topography, source of water and its quality and soil type were the most important criteria for selecting a site for pond construction. According to the authors, ponds constructed in water logged areas, irrigation command areas or marginal lands where construction cost was relatively low due to limited earth cutting was economical.

### 5.2 General Information from the Fish Farms

It was observed that water quantity was not a major limiting factor in most farms since most of them obtained their water supply from streams and reservoirs. However, some of the fish farms suffered water shortage due to lack of insufficient water in the reservoirs and some homestead ponds which relied solely on water supply from pipe borne-water. Pond fishes which are subjected to periodic draught are prime target of predators and their eggs subjected to desiccation. It is in view of this that Wokoma and Ezenna (1982) pointed out that fish ponds should contain enough water which will not fluctuate more than 60cm during the dry months. Marilyn (1978)

also observed that water being the most single determinant factor in site selection for a fish pond, must be available all-year round either from rainfall, run-off, natural waters, springs, wells in good quantity and quality. Biological cycles of many aquatic organisms are also disturbed when sufficient water level is not maintained in the pond.

### 5.3 Culture Facilities

The lack of functional hatchery facilities in the two states has serious implications on the management of fish farms in the areas. First, it leads to inadequate supply and high cost of fingerlings. Second, high fingerling mortality in transit as farmers have to travel long distances leading to increase in operation cost.

Lack of progress in fish farming in Kaduna and Katsina States has been traced to problem of fish seed among other factors. Lysak (1978) pointed out that the stocking of some reservoirs in Kaduna State between 1971 and 1978 were done using a limited number of fish fingerlings occasionally due to insufficient supply.

The same factor militated against the initial take-off of aquaculture in the then West and in the Northern part of the country. According to Ezenwa (1975) the carp fingerlings used for stocking Panyam fish farm in the north were imported from Europe. The only readily available fish seed for most farmers were the Tilapia fingerlings but this species of fish has its own attendant problems of over reproduction resulting in large

number of small-unmarketable fish. Aquaculturists from many countries rearing Tilapia suggested recently the introduction of a monosex strain of this species or even obtaining inter-species hybrids, which are either totally monosexual or sterile (Hickling 1971, Bard et al, 1975). The use of hormone to induce spawning is another possible option for the fish farmers but viewing this option in the light of the present situation of difficulty in obtaining the hormone and hybrid species, farmers may not be able to adopt the technology to meet up their urgent fish seed need.

High quality stocking materials of Carp, Heterobranchus and Lates were difficult to come by and Clarias species do not breed in captivity. The Clarias seed obtained from the wild during the dry season and those produced by mimicking the natural environment were inadequate. The way out of the shortage in fish seeds is therefore to reactivate hatcheries where induced breeding of carp and Clarias can be undertaken.

### 5.4 Species Cultured

Most firsh farmers cultured Clarias and Tilapia as these species were easier to obtain than others. There were great differences in the species of fish cultured in Kaduna and Katsina States. While 8 species (Heterobranchus, Clarias, Tilapia, Labeo, Lates, Carp, Gymnarchus and Heterotis) were cultured in Kaduna, only 4 species (Heterobranchus, Clarias, Tilapia and Carps) were cultured in Katsina State. This disparity was due to more popularity of aquaculture (fish

farming) in Kaduna than in Katsina State. The choice of the respective fish species for culture in the two states by farmers was due to biological and economic reasons. The farmers chose to culture readily available species which command good market prices. The choice of fish seed for culture which depend upon biological and economic traits were discussed by Bell (1978).

### 5.5 Feed Availability

Aquaculture systems where the natural fish food are lacking, intensive feeding of fish using artificial feeds become necessary if the growth of the fish are to be enhanced to reach market size in short period. Feed inputs in polyculture increase both quantity and quality of fish produced. Thus the absence of readily available fish feed both in government fish farms and private farms as seen in this study poses serious problems on fish farming practices in the areas. Farmers did not only lack the feed but were also faced with the problem of the quantity and quality of feed for feeding their fish. Fishes, due to their diversity have different feed requirement. It is therefore necessary to take into consideration, the age of the fish, the feeding habits and the nutrient status of the environment before embarking on feeding the fish.

Sivalingam (1988) in brackish water polyculture trials of Chrysichthys. nigrodigitatus, Tilapia spp, Mugil spp, and Elops lacerta using a mixture of groundnut cake, gari and palm oil as

feed got a production of 2412 kg/ha; while a production of 1159 kg/ha was obtained without feed in the second trial using Tilapia spp, Mugil spp, and Elops lacerta.

It is also very relevant to take into consideration the type of artificial diets fed to the fish as they could affect the growth of the fish. According to Stickney (1979) when plant proteins were substituted for fish meal or used to augment fish meal as a protein source in fish diets, growth of some carnivorous fishes were retarded which he attributed to low levels of methionine and lysine in the vegetable meals. Soybean meal protein diets have elicited poor growth not only from channel catfish fish (Andrews and Page, 1974), but also from plaice, Pleuronectes plastessa (Cowey et al, 1971).

However, the use of soybean meal and other vegetable proteins in the feeds of herbivorous fishes were said to present fewer problems than have been encountered in the feeding of carnivorous fish. Davis and Stickney (1978) fed Tilapia aurea diets containing various levels of fish meal, soybean meal, and combinations of two proteins at various levels and demonstrated that growth was not significantly affected by protein quantity as long as the proper quantity was administered.

### 5.6 General Pond Management Practices

Weeds, predators, muddy pond bottoms, and poor stocking density in this study were indicative of poor management

practices of the farms in the areas. There were more problems of weed in Katsina than in Kaduna State because farms in Kaduna were better managed than those in Katsina State. For instance, the problems of weed inside the ponds in Maska fish farm were largely due to shallow ponds which allowed light to penetrate to the pond bottoms. This was responsible for the growth of aquatic macrophytes (Plate IV).

The problems posed to the effective management of fish farms by weeds are numerous. Weeds, apart from providing hideout for predators, increase the surface area for transpiration and loss of water and removal of nutrients from the ponds, make it difficult to crop fish, and weedy ponds, are subjected to oxygen-depletion. Ponds with weed also have the problem of wide oxygen fluctuation between night and day (Boyd and Lichtkoppler, 1979).

Predators such as King fishers and reptiles, e.g. snakes, monitor lizards were found in most farms. There were no specific measures to control these pests on the farms. These predators are dangerous not only to the operator of the farm, but also to the fish as they feed on the fish especially the young fishes in shallow ponds.

The use of organic fertilizer by most farmers was due to shortage of inorganic fertilizers. Lack of consideration or proper knowledge of stocking density by most farmers resulted in either over-stocking or understocking of ponds.

### 5.7 Production Record

There were no actual figure/data on the production record of the farms which made it very difficult to assess the performance of many fish farms. There were also serious problems of fishing nets which made pond harvest very difficult. The cropping method employed for most farms were partial (i.e. cropping only those adult which have reached table sizes). This practice has the benefit of sustaining the pond population as the juvenile fishes are allowed to remain.

### 5.8 Staff and Equipment

Most farms lacked competent personnel and equipment. The substandard performance of most farms across the two states confirmed this. Many of the farms were not fenced and without any form of security. The poaching incidence and cattle menace were therefore very high. Entry of cattles into the ponds environment have both advantage and disadvantage. Although droppings from the cows can be a source of fertilizer for the ponds, thousands of gallons of water were consumed every day by the herds of cattle thus aggravating the already shortage of water in the areas. Besides, frequent passages of cattle around the embankments led to degradation of the dykes and made them more prone to soil erosion. These effects were seen at Maska and Maigana fish farms.

### 5.9 Finance and Credit Facilities

In the two states, finance and credit facilities were found to constitute major setback to the operation of the fish farms. According to FACU (1995) inadequate funding was a major constraint to aquaculture development of Kaduna State. In a related work carried out earlier in Sokoto, Nigeria by Ipinjolu and Osuji (1989), it was pointed out that all the fish farms were established with private finance due to their inability to obtain loan from the banks. It is therefore clear from this study why the practice of fish farming in the areas was confined to the urban cities and elite class.

Fish farming is capital intensive and the capital required for commercial operation is beyond what most people, who are low income earners, can afford. The reasons advanced by financing institutions and insurance companies for their failure to advance loans and provide insurance coverage to fish farming need to be re-examined.

### 5.10 Processing, Marketing and Distribution of Farm Products

The absence of processing equipment in most farms is indicative of insufficient production since there was no left over from the buyers to process. As a result of this, fish prices in the two states were generally high. The consumption of high quality fresh fish such as Carps, *Clarias*, and *Lates* were therefore confined to the elite class who could afford the prices.

5.11 Water quality characteristics of Maska and Mando Fish Farms

As pointed out earlier, the survival of aquatic biota depends largely on good quality water. Some of the variables obtained from the two fish farms were not within the acceptable limit especially the dissolved oxygen. According to Landau (1992), plants and animals stop to grow or reproduce if the water is bad, animals living in poor water quality are also prime targets for pathogens and parasites. At Mando fish farm, carps refused to spawn but when they were removed and taken to farm in Kano area, they spawned immediately (Personal communication). This might not be unconnected with the water quality. Boyd and Litchkoppler (1979) also affirmed that a pond with "good" water quality will produce more and healthier fish than a pond with "poor" water quality.

5.11.1 Dissolved Oxygen

The levels of dissolved oxygen in the two farms were generally low during the rainy season (July - September) when compared to the dry season. The difference was highly significant ($P<0.05$). The low level of dissolved oxygen during the rainy season corresponded with poor light penetration (Fig. 10). The poor light penetration hindered the photosynthetic activities by phytoplankton, the primary source of dissolved oxygen in a fish culture system. The level of dissolved oxygen in Maska fish farm remained low almost throughout the period of investigation. This was probably due

to the poor conditions of the ponds. The organic matter resulting from the decay of dead plants must have contributed to this low level of oxygen conditions.

The importance of dissolved oxygen in fish culture demands that the fish culturist should be familiar with the dynamics of dissolved oxygen concentration in ponds. According to Stickney (1979) if a sufficient level of dissolved oxygen is not maintained, animals will be stressed, becoming vulnerable to diseases and parasites outbreaks, and might refuse to eat for a period during and after oxygen depletion. Thus growth rate and food conversion efficiency will suffer and feed will be wasted if prepared diets are provided. He, therefore argued that if D.O falls to a concentration that placed stress on animals or threatened their lives, other water quality parameters tended to become insignificant until D.O is re-established at a safe concentration. While Mabaye (1972) showed that the distribution of fish and other animals in water was strictly tied to the concentrations of oxygen. Stickney (1979) indicated that the level at which D.O. began to induce stress varied with species and undoubtedly was associated to some extent with other stress-causing factors such as un-ionized ammonia concentration, nitrite, temperature, hardness and alkalinity. Thus, the lethal concentration of D.O. for species of carp was determined to range from 0.2-1.1 mg/l while several species of Tilapia appeared to be able to survive well at D.O. concentration as low as 1mg/l and continue to grow

(Boyd and Lichtkoppler 1979; Stickney, 1979).

The amount of D.O. present in water at any given time is said to be determined by the gains and losses of oxygen into and out of water. According to Romair and Johnston (1978), the primary source of D.O. in fish culture system is photosynthetic activities of phytoplankton with minor contribution from diffusion from the atmosphere. The primary losses of dissolved oxygen from a pond include respiration by the plankton, fishes, benthic organisms and diffusion of oxygen into the air. To ensure that dissolved oxygen depletion does not occur, Boyd and Lichtkoppler (1979) suggested that more oxygen must enter or be produced in the water by plankton than is used by the organisms.

Although the daily fluctuation of dissolved oxygen in these farms were not determined, work done else where showed that the daily fluctuation of D.O. was dependent upon the activities of phytoplankton and other organic processes (Swingle, 1968). The oxygen content showed its highest concentration in the mid-day, corresponding to high photosynthetic activity of plankton, and diminished from them onwards, reaching the lowest value in the early morning (Talling, 1957 and swingle, 1968). This was due to the utilization of oxygen produced during the day, for other biological processes during the night. Boyd and Lichtkoppler (1979), concluded that daily fluctuations of dissolved oxygen in fish ponds apparently have little effect on feeding and

growth as long as the minimum D.O. concentration for the day does not drop below 1 or 2 mg/l in the morning and then rises near saturation within a few hours after sunrise.

### 5.11.2 Total Alkalinity and Total Hardness

Alkalinity is a reflection of the carbonate and bicarbonate content of the water while hardness refers to the concentration of divalent cations (primarily calcium and magnesium) present in water expressed in terms of milligram per liter of calcium carbonate. According to Boyd and Lichtekoppler (1979) and Stickney (1979), desirable levels of total hardness and total alkalinity for fish culture generally fall within the range of 20 to 300 milligram per liter. By this figure or range, the values of total alkalinity and hardness obtained for Maska and Mando fish farm were therefore within the acceptable limit. The seasonal variation in terms of alkalinity was highly significant ($P<0.05$) especially with respect to Maska fish farm. The differences in alkalinity was also highly significant ($P<0.05$) with reference to the two locations. The seasonal variation with a distinct reduction during the rainy season in the amount of both total alkalinity and hardness agreed with the work of Minshall and Andrews (1973). The values of these parameters obtained in this study for Maska were greater than those got by the earlier worker which were 4.0 mg/l of hardness and 4.3 mg/l of bicarbonates / alkalinity (FDF,1977). In Mando fish farm, the value obtained for alkalinity by earlier worker was 45 mg/l $CaCO_3$ (Anonymous,