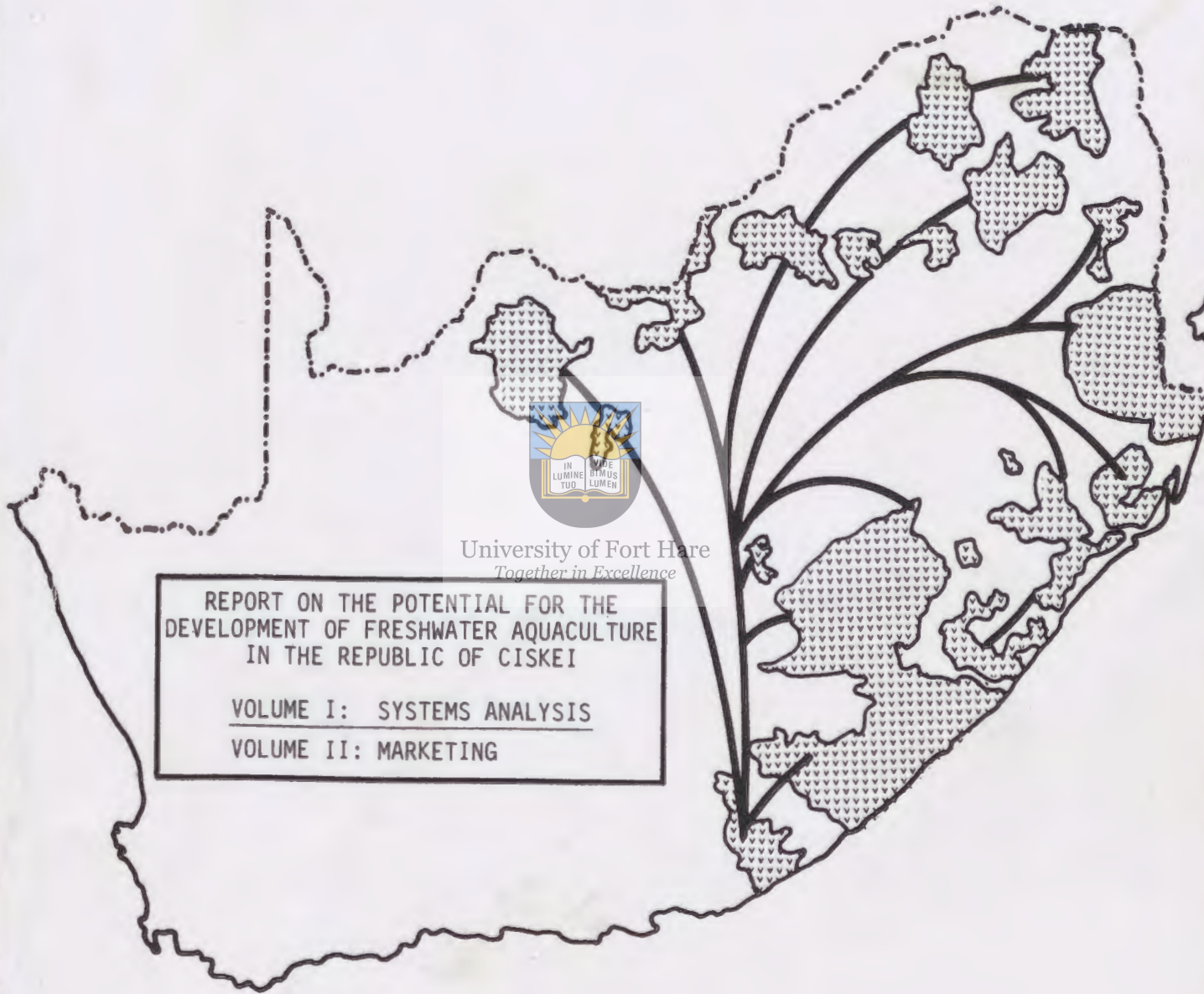


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University of Fort Hare  
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REPORT ON THE POTENTIAL FOR THE  
DEVELOPMENT OF FRESHWATER AQUACULTURE  
IN THE REPUBLIC OF CISKEI

VOLUME I: SYSTEMS ANALYSIS

VOLUME II: MARKETING

BY

A J ROSE  
D R TAPSON  
B D JORDAAN

AGRICULTURAL AND RURAL DEVELOPMENT  
RESEARCH INSTITUTE  
FORT HARE

**ACKNOWLEDGEMENTS**

This study was made possible by a grant from the Anglo American Corporation and the Chair's Chairman's Funds. This contribution to Ciskei is gratefully acknowledged.

The study could not have been completed without the continuous assistance of the officials of the Department of Agriculture and Forestry of Ciskei whose help was most generously given.

The very considerable assistance of the Institute of Ichthyology was seen at the disposal of the staff of that Institute with the experience and expertise of the staff of that Institute.

Finally the guidance and assistance of the Steering Committee played a very vital role in shaping the report. Their willingness to travel long distances and devote much time to the task is acknowledged with gratitude.

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**VOLUME II: MARKETING**



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*Together in Excellence*

**BY**

- A J ROSE**
- D R TAPSON**
- B D JORDAAN**

**AGRICULTURAL AND RURAL DEVELOPMENT RESEARCH INSTITUTE (ARDRI)  
SERVICES DIVISION**

**JULY 1987**

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The study could not have been completed without the continuous assistance of the officers of the Department of Nature Conservation of Ciskei whose help was unstintingly given.

The very considerable library of the JLB Smith Institute of Ichthyology was put at the disposal of the researchers, together with the experience and expertise of the staff of that Institute.

Finally the guidance and accumulated wisdom of the Steering Committee played a major role in shaping both the project and this report. Their willingness to travel long distances and devote much time to the task is acknowledged with gratitude.

### The Steering Committee

- Chairman: Dr B van der Waal, University of Natal  
Prof H Schoonbee, Rand Afrikaans University  
Mr P B N Jackson, JLB Smith Institute  
Mr R Markham, Department of Nature Conservation, Ciskei  
Mr M Coleman, Department of Nature Conservation, Ciskei  
Prof R van den Berg, University of Fort Hare  
Dr K Willan, University of Fort Hare  
Mr G J H de Villiers, University of Fort Hare  
Dr P J Burger, ARDRI, University of Fort Hare



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## CHAPTER 1

### INTRODUCTION

The Ciskei Fish Farming Project originated in a series of research studies conducted by the Zoology Department of Fort Hare University, starting in 1970. (Gaigher, Ntloko & Visser 1975; van den Berg, Gaigher & Lenyani 1975; Makani 1974; Nhlapo 1976; Mqolomba 1976; Mtsi 1978; Mayekiso 1978; Ngcongca 1979). In 1977 and 1978 interest in freshwater fish production, resulted in approaches from Fort Hare and JLB Smith Institute for Ichthyology to the Department of Agriculture in Ciskei, with a view to stimulating the production of fish from Ciskei's water resources. Following a formal request from the Ciskei Department of Agriculture for the submission of a project proposal on an aquaculture industry for Ciskei, it was decided to place the project under the aegis of the recently established Agricultural and Rural Development Research Institute at Fort Hare. Subsequently, a proposal prepared jointly by ARDRI, the Departments of Zoology of Fort Hare and the Rand Afrikaans University was submitted in 1980, and updated early in 1981 (ARDRI 1981).

These proposals were accepted, but it was not possible to proceed in practice until the appointment of a Senior research officer in the Institute early in 1981, nor were funds available. Consequently the first task was to prepare a project proposal as a bid for funds to a prospective donor. The background research for this occupied the early part of 1981, and by October of that year a proposal was ready for submission to the Chairman's Fund of Anglo American Corporation and de Beers. Assurance of sponsorship was obtained from the Chairman's Fund in November of 1981, and with this it was possible to proceed with a formal proposal to the Ciskei Government. The proposals were accepted by the Department of Agriculture of Ciskei in February of 1982, and with the appointment of a Project leader, the setting up of a Steering Committee in March, and the appointment of a project technician in April, the investigation was fairly launched.



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#### 1.1 STATEMENT OF PROBLEM

In the approach from the Ciskei Government, emphasis was placed on improving the diet of rural Ciskeians, providing employment and the creation of a cash flow by harnessing the potential of Ciskeian natural resources, particularly water. These three elements were subsequently incorporated into the statement of problems and objectives included in the original project report. The problems were defined as:

1. A diet, particularly in the rural population, deficient in most major nutrients but particularly in high quality protein. Direct malfunctions such as kwashiorkor, and diseases related to malnutrition particularly among children are widespread.
2. A lack of employment opportunities at all levels, that is to say from the level of unskilled laborer through the various grades of skills to the self-employed operator.

3. A critical lack of cash in circulation in the rural areas.

## 1.2 OBJECTIVES OF STUDY

Given that these were the problems most likely to respond to the development of a fisheries enterprise the objectives of the study were defined as follows:-

1. To investigate the constraints to the production, harvesting and consumption of fish at subsistence level, and to devise means to push them back.
2. To harvest existing fish resources and improve the stocks to provide the basis of a commercial fishing industry.
3. To develop methods to increase production beyond the limits set by existing water bodies and populations. This will avoid a cessation of development once these limits are reached.

It was emphasised that the proposals had a primarily practical intent, and that such research as was done would be in the interests of establishing the viability of, at that stage, unproven ventures.

The proposal envisaged that there would be four main directions of investigation.

1. Harvesting of naturally occurring populations and improving these populations in both quantity and quality over time.
2. Development of a trout production facility and a tourist business based on trout angling.
3. Promotion of subsistence consumption to improve diet in the rural population and if possible to provide marketable surpluses.
4. The investigation of production of fish in specialised systems involving ponds and intensive feeding.

Early in the life of the project it was determined that trout production was not appropriate to the subsistence requirements of Ciskei, and by agreement with the sponsor, this aspect was allocated a low priority.

## 1.3 TASKS AND PROGRAMME

In order to pursue the four avenues of research, nine separate tasks were identified and each of these were pursued over varying parts of the project's three-year life. The balance of this document is devoted to the description of the findings from these tasks, culminating in an analysis of the findings and recommendations on the future of freshwater fish production in Ciskei.

Briefly, the tasks identified were:

### 1.3.1 Resource Survey

A complete list of all water bodies in the Ciskei was to be drawn up, and quantitatively evaluated according to:

1. Volume, quality and surface area of water.
2. Geographical situation and elevation.
3. Existing fish populations.
4. Optimum fisheries potential of individual bodies of water.
5. Cost estimates of achieving optimum use.

### 1.3.2 Socio-Economic Survey of Rural Areas

This was to include;

1. Attitudes to and knowledge of fish as part of the diet.
2. Knowledge of harvesting techniques.
3. Attitudes to the inclusion of fish and organic nutrients in water bodies.
4. Institutional factors such as the appropriate individuals or groups through which to sponsor fish.

### 1.3.3 Marketing Survey

The marketing function was taken to include processing. This included preparing the fresh-caught fish, and its further processing such as drying, smoking, canning and packing.

The need for a central depot as a collection point for fish and other fresh produce, and as a purchase point for retailers was to be investigated, as well as supply to existing fish-and-chip shops and the establishment of further retail outlets.

A feature of this investigation was that it was based on only Ciskeian entrepreneurs being considered, and therefore training was a factor as well.

### 1.3.4 Establishment of Fish Harvesting Enterprises

The basic requirement was to establish fishermen who would bring in fish for sale. Their needs in terms of capital for boats and gear, and operating costs, training and supervision until self-sufficient, had to be estimated. It was expected that all these inputs would have to be provided as stimulus to get the enterprise underway.

### 1.3.5 Integrated Production System

It was proposed to set up a model family farm, which was to be designed to produce all the food requirements of the family at a



high level, plus a meaningful marketable surplus. All inputs and as far as possible, structures, were to be in keeping with what a family in the rural Ciskei could mobilise.

### 1.3.6 Warm Water Seed Stations

On the supposition that an expanding industry did become a reality, one of the basics would be the provision of suitable fish seed for distribution throughout the region. Two fish seed stations would therefore have to be established and to them could be coupled some of the requirements for training.

### 1.3.7 Training

Wholesale training would be required. It was proposed initially to provide for:

1. Fisheries extension training both at Tompi Seleka, and internally.
2. Extension and educational work among the rural population to cover both production and consumption of fish.
3. Training of fishermen and licencees in harvesting and management techniques.



### 1.3.8 Trout

With the obvious commercial potential for, and interest in, trout production, it seemed likely that the most efficient means of developing this aspect would be by encouraging an entrepreneur. As such development would have to take place within the frame-work of Ciskei policy, the encouragement and establishment would be a matter for the Ciskei Government to handle, with appropriate technical input from the consultant and others.

### 1.3.9 Net and Boat Industry

It was proposed to investigate the feasibility of setting up a net manufacturing enterprise based initially on imported net "blanks", and if appropriate, to incorporate a locally based net loom. Sales potential included most of the institutes involved in fish research, Government, and private operators.

While small boats are freely available and relatively cheap, they are not of necessity designed to be suitable as vessels for gill netting. The design of a simple boat, suitable for construction by relatively unskilled people with few tools, was to be investigated.

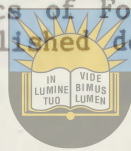
## 1.4 OUTLINE OF REPORT

This report is presented in two volumes.

The bulk of Volume 1 ie Chapters 2 to 9, comprises the reports on progress in each of the nine tasks. Chapter 10 considers some economic factors based on estimates of the individual and national costs and benefits of the planned industry.

The balance of Volume 1 is the evaluation of the data contained in Chapters 2 to 9 and its application to the identification of constraints and development of recommendations. The data to be dealt with appears as a complex, intractable mass, and to disaggregate the complexity the format of the farm systems research discipline is used. The farm systems approach is described in Chapter 11. The constraints arising from the technical element of the environment are described and evaluated in Chapter 12, and those from the human element in Chapter 13. The recommendations are described in Chapter 14, and conclusions are outlined in Chapter 15.

Volume II comprises the detailed marketing survey conducted by the Department of Business Economics of Fort Hare. Summarised findings from this report and other published documents have been included as Chapter 4 of Volume 1.



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## CHAPTER 2

### RESOURCE SURVEY

The tasks description in the Ciskei Fish Farming Project proposal was (ARDRI 1981):

"A complete list of all water bodies in Ciskei will be drawn up and quantitatively evaluated according to:

- a) volume and quality of water
- b) existing fish populations
- c) optimum use of individual bodies of water
- d) cost estimates of achieving optimum use."

Item (a) of the above was drawn from comprehensive reports published by Hill, Kaplan & Scott, 1977; Page, 1982; and Hart, 1982. Water impoundments and dams were assessed by Landsat imagery and aerial photographs for water bodies under 10 hectares in size, and water bodies of particular value were separately enumerated.

Item (b) was compiled from published data by Bruton, Jackson and Skelton (1982); Jackson (1982); and Bok (1983).

Items (c) and (d), although briefly covered in this chapter are dealt with in detail in Chapters of 10, 12, 13 and 14, where they fit more appropriately.

In this Chapter the major catchments of Ciskei and their impoundments are first listed then the resource base evaluated according to water quality, rainfall, temperature and the existing fish species. Finally an assessment of the potential is provided as the base on which the recommendations in the report can be made.

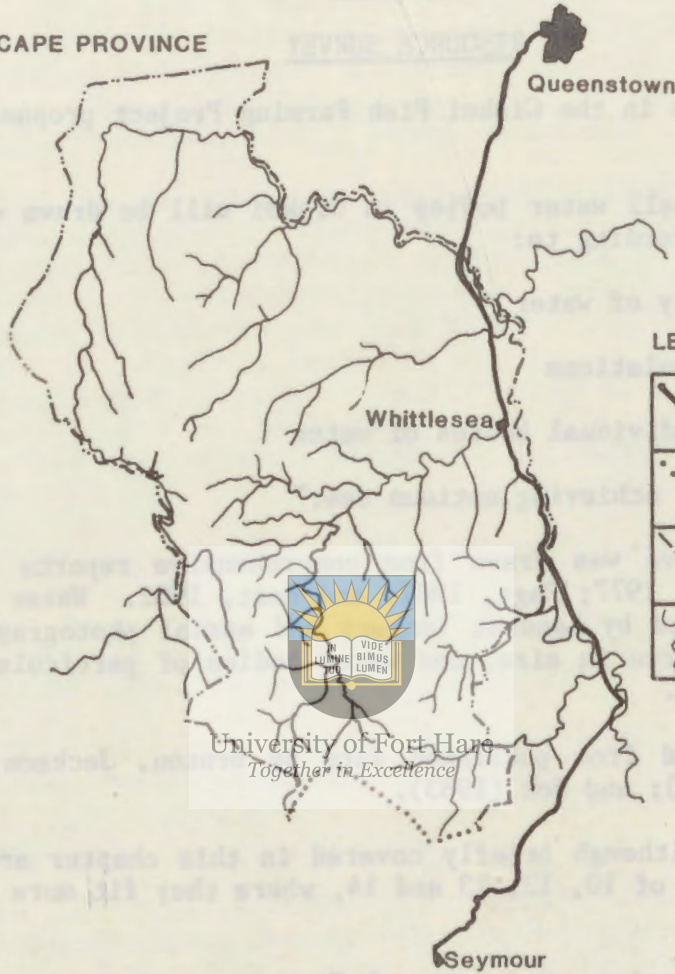
#### 2.1 RIVER CATCHMENTS AND IMPOUNDMENTS

##### 2.1.1 Kei-Klipplaat River System

This catchment occupies the northern-most part of Ciskei, draining off the northern slopes of the Katberg and Winterberg mountain ranges. It flows through the north-western boundary of Ciskei, and then turns south-east to flow into the sea north of East London, where the Kei river forms the boundary between Transkei and South Africa. (Figure 2.1)

There are three main rivers within this system, namely: the Swart Kei, the Klipplaat and the Oukraal.

CAPE PROVINCE



LEGEND





	Roads
	Main watershed
	International boundaries
	Rivers

FIG 2.1 : THE KEI-KLIPLAATS RIVER SYSTEM

The Swart Kei is the major tributary of the Great Kei River, and has a catchment area within the Ciskei of 1484 km<sup>2</sup> (Page 1982 p 50). This river and its tributaries drain the northern territories of Ciskei around Kamastone.

The Klipplaar River rises in South Africa on the north-facing slopes of the Amatola Mountains and flows into the Waterdown Dam. The area above the dam has a catchment of 603 km<sup>2</sup> (Page 1982 p 51). Below the Waterdown Dam the river forms the boundary between Ciskei and South Africa. Its tributaries, of which the Oukraal River is one, drain an area from Hackney in the north-east to the Elandsberg in the south.

The area drained by the Klipplaar River is 1344 km<sup>2</sup>, of which 462 km<sup>2</sup> is drained by the Oukraal River.

### 2.1.2 Kat-Fish River System

This catchment lies along most of the western border of Ciskei, draining a large area around the Katberg and Eastern Amatola Mountains, as well as a small area along the eastern bank of the Fish River escarpment. (Figure 2.2)

There are two main rivers within this system. The Kat River with its tributaries, rises in the Amatola Mountains north of the Balfour and Seymour areas, and flows southwards to the Kat River Dam to join the Fish River at Committees Drift. Half of this area (around Fort Beaufort) falls within South Africa, therefore of the total catchment (2034 km<sup>2</sup>) approximately 1017 km<sup>2</sup> falls within Ciskei (Page 1982 p 48).

The Great Fish River forms the western boundary of the Ciskei from the junction of the Kat River southwards to where it enters the sea on the eastern side of Waterloo Bay. A large proportion of the catchment of the Fish River, stretching as far afield as Middelburg and Steynsburg, falls within South Africa (Page 1982 p 48). This river catchment has been extended by linkage to the Orange River, one of the major rivers in Southern Africa, through the Orange-Fish tunnel.

### 2.1.3 Keiskamma River System

The Keiskamma river system is the only major catchment that falls completely within Ciskei. The river rises in the Amatola Mountains and almost bisects the country down to the coastal resort, Hamburg, where it enters the sea. (Figure 2.3)

The major tributary of the Keiskamma is the Tyumie river which rises at Hogsback in the Amatola mountains, passes through Alice and joins the Keiskamma river south of the town. The Keiskamma river has a catchment of 1260 km<sup>2</sup> and the Tyumie 490 km<sup>2</sup>.



**FIG 2.2: THE KAT-FISH RIVER SYSTEM**

### 2.1.4 Buffalo River System

This catchment area is the primary boundary of Lesotho, and is shared by South Africa and Lesotho. The Buffalo River and its tributaries drain the western portion of the Orange Free State of King William's Town, as well as the whole line William's Town area, Swellendam, Matieland and the western portion of Lesotho (Figure 2.3)



FIG 2.3 : THE KEISKAMMA RIVER SYSTEM

#### 2.1.4 Buffalo River System

This catchment lies on the eastern boundary of Ciskei, and is shared by South Africa and Ciskei. The Buffalo River and its tributaries drain the eastern portion of the Amatola range north of King William's Town, as well as the whole King William's Town area, Zwelitsha, Mdantsane and the western portion of Berlin. (Figure 2.4)

This catchment area has been dammed extensively to serve the water requirements of the large population in the surrounding towns, as well as heavy and light industries located in the area. Two dams are situated in the upper catchment area, namely Maden Dam and Rooikrans Dam, one in the middle catchment area, the Laing Dam, and one in the lower catchment area, the Bridle Drift Dam. The total catchment area is measured at 1230 km<sup>2</sup>, and is divided between the dams as follows (Stone 1982):

Rooikrans 48 km<sup>2</sup>  
Laing 913 km<sup>2</sup>  
Bridle Drift 1 176 km<sup>2</sup>

#### 2.1.5 The Chalumna River and Small Coastal Systems

Many small river catchments along the short coastal strip of Ciskei. Of these, the Chalumna River is the largest and forms the eastern coastal border of Ciskei. The others are, listing from west to east (Figure 2.5):

Old Womans River  
Mpekweni River  
Mtata River  
Mgwalana River  
Bira River  
Gquitywa River  
Kiwane River  
Ncera River

The total catchment area of the coastal rivers is approx 3500 km<sup>2</sup>. Many flow only seasonally due to their small individual catchment areas.

#### 2.1.6 Impoundments

The quote, "The Ciskei is blessed with substantial water resources" (ARDRI, 1981) does not fully reflect the situation in Ciskei. In the initial stages of the project, Landsat imagery was used to indicate the number of water bodies in Ciskei. Landsat "photographs" were ordered from the Satellite Remote Sensing Centre, dated 13 October 1981 for East London and 1 November 1981 for Queenstown and Grahamstown. These gave cloudless coverages for the whole of Ciskei. By developing the

2.1.4 Buffalo River System

This catchment lies in the eastern boundary of Ciskei, and is owned by South Africa and Ciskei. The Buffalo River and its tributaries drain the western portion of the Kango range north of King William's Town, as well as the whole King William's Town area, Swartkops, Malmesbury and the western portion of Berlin.

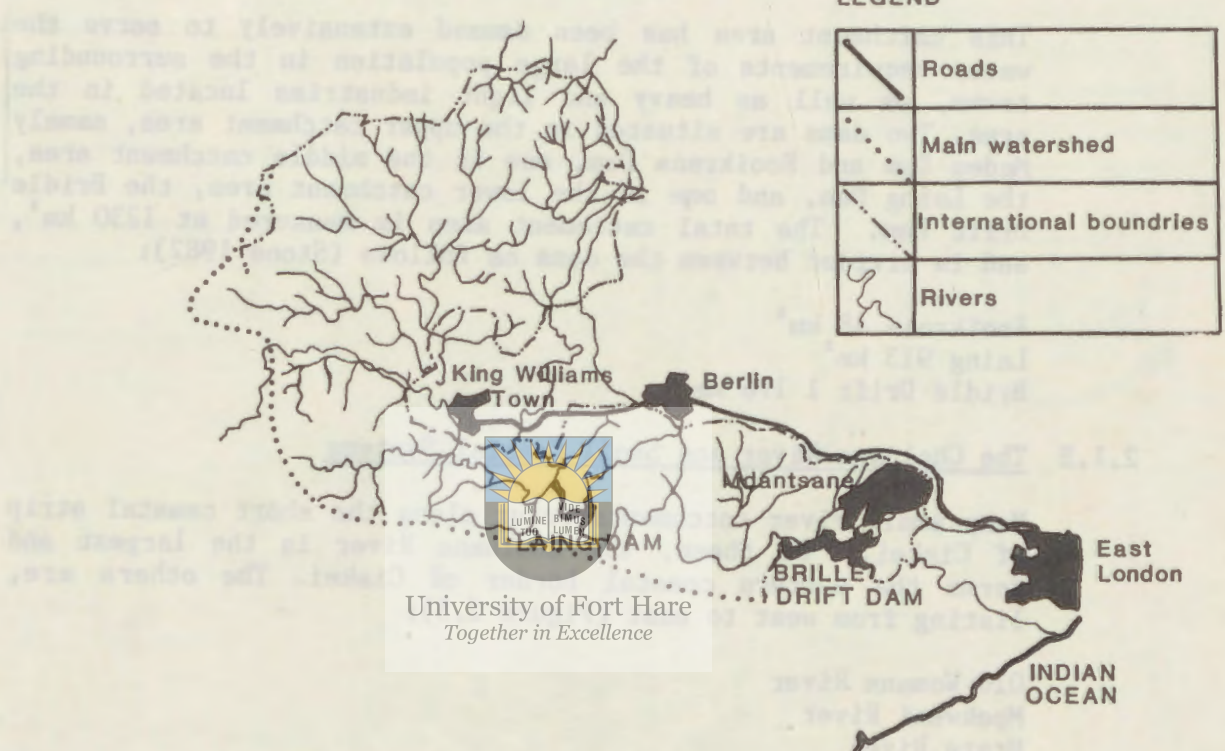


FIG 2.4 THE BUFFALO RIVER SYSTEM

The total catchment area of the Buffalo River is approximately 2500 km<sup>2</sup>. The river only occasionally flows to the sea in the winter months.

The Buffalo River is shared with neighboring water users. The water is used for irrigation, domestic use, and industrial purposes. In the initial stages of the project, land use changes were used to indicate the number of water bodies in Ciskei. Land use changes were noted from the satellite images. The project was completed in 1981. The project was a joint venture between the University of Fort Hare and the Department of Water Affairs and Forestry. The project was funded by the Department of Water Affairs and Forestry.

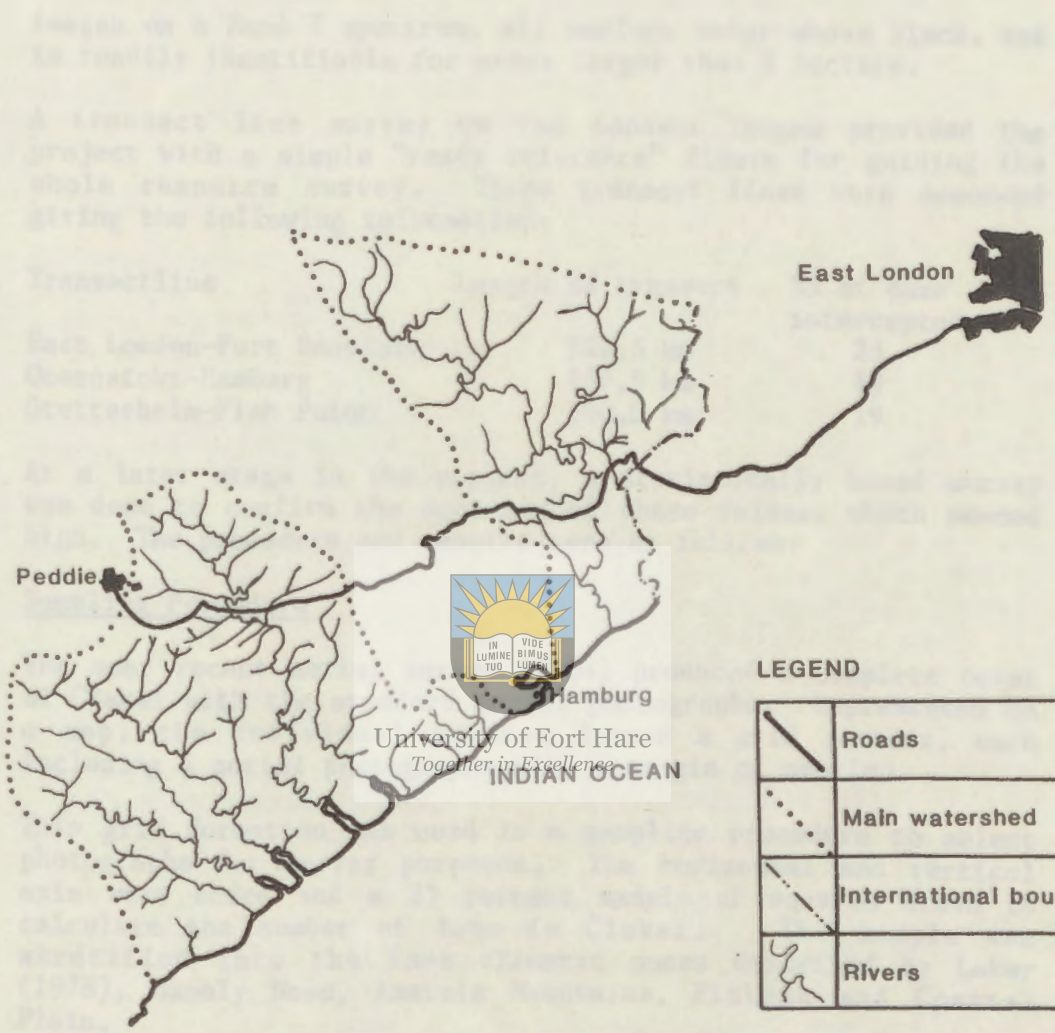


FIG 2.5 THE CHOLOMNA AND SMALL COASTAL SYSTEMS

images on a Band 7 spectrum, all surface water shows black, and is readily identifiable for areas larger than 1 hectare.

A transect line survey on the Landsat images provided the project with a simple "ready reference" figure for guiding the whole resource survey. Three transect lines were assessed giving the following information:

Transectline	Length of transect	No of dams intercepted
East London-Fort Beaufort	122,5 km	23
Queenstown-Hamburg	137,5 km	18
Stutterheim-Fish Point	100,0 km	19

At a later stage in the project, a statistically based survey was done to confirm the accuracy of these values, which seemed high. The procedure and results were as follows:

#### Sampling Procedure

The most recent aerial survey (1984) produced a complete cover of Ciskei with the standard aerial photographs. Represented on a map, the individual squares formed a grid pattern, each including 4 aerial photographs with a margin of overlap.



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This grid formation was used in a sampling procedure to select photographs for survey purposes. The horizontal and vertical axis were coded and a 25 percent sample of squares drawn to calculate the number of dams in Ciskei. The sample was stratified into the four climatic zones described by Laker (1978), namely Hewu, Amatola Mountains, Plateau and Coastal Plain.

The co-ordinates of each axis were input to a random number generator and for each climatic zone 25 percent of squares for the zone were randomly selected.

#### 2.1.6.1 Conduct of survey

Once the photographs for each zone were identified, they were individually examined through a pocket stereoscope to determine the number of ponds occurring. A transparent measuring grid was used to determine the surface area of the ponds which were classified by surface area into the following groups:

- <1,0 ha
- 1,0-10,0 ha
- 11,0-20,0 ha
- 21,0-50,0 ha
- >50,0 ha

Table 2.1 represents the recorded water bodies occurring in the 25 percent sample for each area.

**Table 2.1:** Ponds recorded on a 25 percent sample of aerial photographs of Ciskei

Hewu	Amatola Mountains	Plateau	Coastal Plain
664	204	965	282
89	5	62	13
5	1	3	-
-	-	-	-
-	3	2	-

Table 2.2 represents the extrapolated values for the various sizes of ponds, based on there data.

**Table 2.2:** Total estimated ponds in Ciskei extrapolated from the 25 percent sample

Pond Size ha	Extrapolated Values
<1,0	8460
1,0-10,0	676
11,0-20,0	36
21,0-50,0	-
>50,0	20



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**Table 2.3:** Water bodies larger than 11ha as on the aerial survey 9/2/84

<u>Aerial Photo No.</u>	<u>Dam</u>
9531	Tyefu 1
9531	Tyefu 2
9531	Tyefu 3
8827	Location No. 17
3318	Laing Dam
3298	Bridle Drift Dam
3176	Dimbaza Dam
2895	Rooikrans Dam
2691	Pleasant View Dam
2667	Sandile Dam
2523	Cala Dam
2338	Mnyameni Dam
2132	Kat Dam
1475	Waterdown Dam
1431	Perserverence Dam
1002	Whittlesea Dam
0750	Lily Vlei Dam
1239	Bedford

Although the number of ponds under one hectare in size is large, many of these are small depressions that accumulate water only during rainy periods. The soil structure in parts of Ciskei restricts water infiltration, however, so that some of them retain water for long periods.

## 2.2 WATER QUALITY

### 2.2.1 Physical Water Quality (silt load)

As large amounts of silt in the water may adversely effect fish production by abrading the gill tissues of fish and restricting the feeding of predatory fish species, silt levels are a critical aspect of water quality.

The silt load is lowest along the coast of Ciskei. Page (1982 p 51) gives a figure of  $150\text{m}^3\text{km}^2\text{annum}$ . The silt yield rises progressively up each catchment, and on the slopes of the Amatola Mountains exceeds  $950\text{m}^3\text{km}^2\text{annum}$  (Page 1982 p 51). For the Buffalo river, Weaver in Hart (1982 p 65) gives the headwaters silt yield at  $1\ 000\text{tonnes}\text{yr}\text{km}^2$ , the central catchment,  $500\text{tonnes}\text{yr}\text{km}^2$  and the coastal area  $150\text{tonnes}\text{yr}\text{km}^2$ .



### 2.2.2 Chemical Water Quality

Two comprehensive hydrological surveys have been conducted in Ciskei. One by Hill, Kaplan & Scott (1977) covers the entire Keiskamma river catchment, the other by Rhodes University, 1982 covers the Buffalo river catchment, and is summarised below:

**Table 2.4:** Summary of water quality analysis at measuring weirs on the Keiskamma River

	Upper Catchment	Middle Catchment	Lower Catchment	Average
pH	7,8	8,3	7,7	7,9
TDS (ppm)	32	78	210	93,7
Na (ppm)	3	12,5	49	17,1
Mg (ppm)	2	4	9,5	4,6
Ca (ppm)	4	8,5	16,2	8,6
SO <sub>4</sub> (ppm)	10	5,5	21,0	12,6
CaCO <sub>3</sub> (ppm)	19	38,5	61,0	29,6

The average chemical water quality of the Buffalo and Keiskamma Rivers are compared in Table 2.5 (summarised from Hart (1982 p 98) and Hill et al (1972)).

**Table 2.5:** Average comparison of chemical water quality for Buffalo and Keiskamma Rivers

	Buffalo	Keiskamma
pH	7,2	7,9
TDS	290	93,7
Na	58	17,1
Mg	14,3	4,6
Ca	19,2	8,6
SO <sub>4</sub>	11,3	12,6
CaCO <sub>3</sub>	95,1	29,6

The Kat-Fish system has particularly high chloride concentrations which can reach 500-800mg/litre and salt mass flow at Committees Drift have been recorded as high as 8,27kg/sec (Report No. P1593/03/0180 Directorate of Water Affairs as quoted in Page 1982 p 52).

## 2.3 FISH SPECIES OCCURRING IN THE REGION

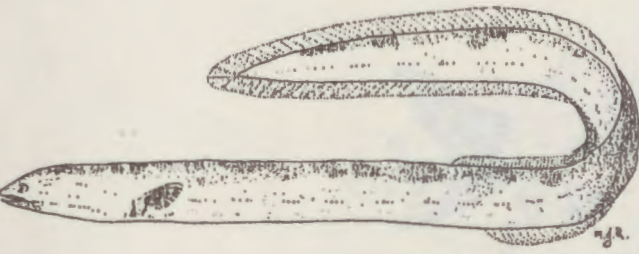
### 2.3.1 Family Anguilladae

#### 2.3.1.1 Anguilla mossambica - long fin eel

This is a popular angling and eating fish that is widely distributed in Ciskei and the surrounding areas, although due to the construction of dams and weirs on many of the river systems it is not as common as it used to be. It is tolerant of both warm and cold water as it migrates upstream from its marine breeding grounds. Adults return to the sea to breed at an approximate age of ten years, (Bruton, Jackson & Skelton 1982). Eels are carnivorous feeders, preying on dead and living animals (crabs and small fish) that occur in their natural environment.

Members of the group Anguilla are cultured widely around the world where they are marketed as luxury products. However during recent years the culture practices have become more and more intensive to overcome the cost of protein (50 - 55 percent crude protein included in diet), on which the eel relies for quick growth (Bardach, Rythe & McLarney 1972 p 389; Kabuku & Ikenoue 1983 p34).

Eels show some economic promise, but Ciskeians are not generally aware of them as a food source. A strong marketing programme would be necessary to sell the product locally. A potential exists for the export market, provided that a link with an external entrepreneur can be established.



ANGUILLA MOSSAMBICA



ANGUILLA NEBULOSA LABIATA



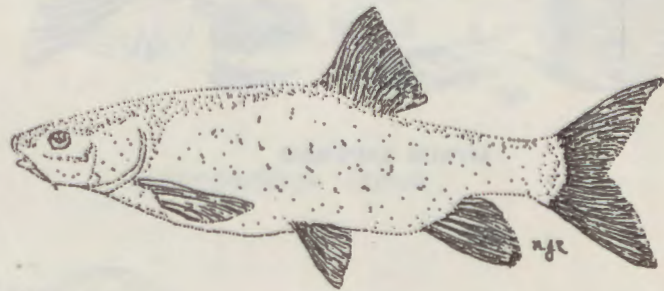
GILCHRISTELLA AESTUARIUS



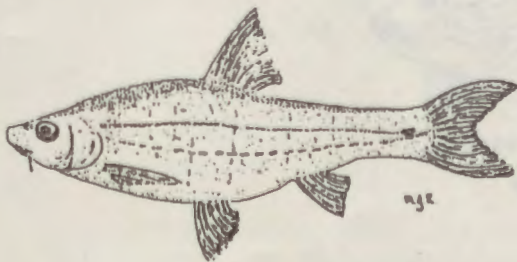
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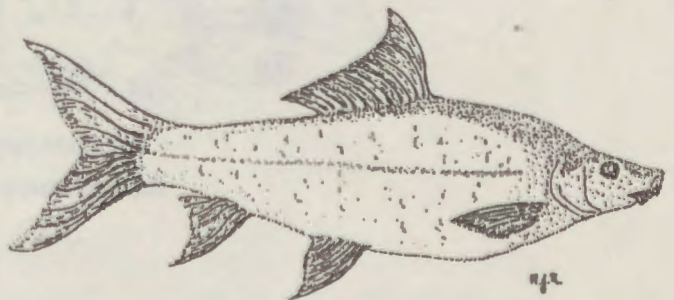
BARBUS ANOPOLUS



BARBUS HOLUBI



BARBUS TREVELYANI



LABEO CAPENSIS



**LABEO UMBRATUS**



**CYPRINUS CARPIO**



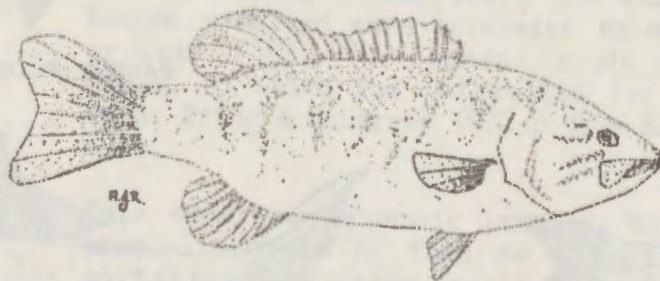
**CLARIUS GARIEPINUS**



**MYXUS CAPENSIS**



**LEPOMIS MACHROCHIRUS**



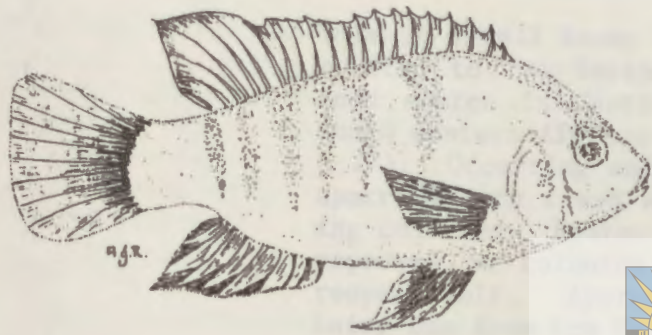
**MICROPTERUS DOLONIEU**



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**MICROPTERUS SALMOIDES**



**TILAPIA SPARRMANII**



**OREOCHROMIS MOSSAMBICUS**



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**SANDELIA BAINESI**



**GLOSSOGOBIUS GIURUS**



**PLATYGOBIUS AENEOFUSCUS**

### 2.3.1.2 Anguilla nebulosa labiata - African mottled eel

This is a larger species of eel than *Anguilla mossambica*, but it displays the same characteristics as its relative.

It is uncommon in Ciskei, its numbers having decreased due to the construction of barriers across most of the rivers in the country.

## 2.3.2 Family Clupeidae

### 2.3.2.1 Gilchristella aestuarius - Estuarine round-herring

This is a well known fish of the herring family, and is related to the Kariba Sardine or 'kapenta', a popular food source in Central Africa. It is "endemic to the south eastern African Coastal Region" (Bruton et al 1982 p 27). Occurring mainly in estuaries, it also migrates upstream into fresh water where it can establish breeding colonies. Bruton (1979) and Jackson & White, (1982) reported on colonies in Lake Sibaya and Settlers Dam respectively. Approximately 300 were introduced into Laing Dam from the Bridge Drift Dam in 1982 by ARDRI.

Little is known about the biology of this fish, more especially its breeding habits. However, it appears to produce relatively few eggs (4 000 - 8 000), and only lives for one year (Jackson & White 1982 p 7). More is known about its feeding habits. It feeds primarily on organisms low down on the food chain (diatoms and unicellular algae) but also on water fleas and aquatic insects.

This species requires further research as suggested by Jackson & White (1982 p 13). If this species is shown to fulfil even some of the characteristics shown by its cousin the 'kapenta', it could certainly be of value in some of the eutrophic water bodies of Ciskei and nutrient rich waste-water ponds.

## 2.3.3 Family Salmonidae

In the United States and in some European countries, trout culture has the longest history of any form of fish culture, due largely to its popularity as a sport and eating fish. The two most popular species for culture and angling purposes are *Salmo gairdneri* (rainbow trout) and *Salmo trutta* (brown trout).

*Salmo gairdneri* is native to the western drainages of North America whereas *Salmo trutta* is indigenous to Europe. Both species have similar characteristics in their natural environ-

ment, although the rainbow trout can withstand slightly higher water temperatures, as well as slightly less pure water. With regard to South African conditions, and more particularly Ciskei, (which is a marginal trout area) it seems that the rainbow trout is the better species for culture purposes.

Trout generally spawn in spring on gravel beds. However, the hatchery techniques of spawning are easily acquired, and all trout for present culture purposes are hatchery spawned. It is necessary to note that with this species it is possible to obtain a fairly regular supply of seed, which is of great advantage to the culturist compared to the majority of other species, where seed is available normally only once a year.

The feeding habits of the trout have been well researched. Although in the wild they prey on insects, small fish and crustacea, their diets can be manufactured in culture units in order to get the best possible production. Being predators, trout require a high percentage of animal protein. The dietary requirements for trout show the precision feeding necessary to achieve maximum levels of production, and also illustrate the high expenses involved in feeding.

It is difficult to rationalise the economic importance of trout in a developing country. Generally, in a developed economy trout do have a degree of economic viability and importance, but not necessarily with specific regard to South African and Ciskeian conditions. Trout production in South Africa has not yet achieved the yields received in other countries. This, coupled to high establishment and feed costs has resulted in Southern African trout production units tending to be marginal in economic terms. This fact was conveyed clearly during the 1984 Aquaculture Conference by the Chairman of the Natal Trout Farmers' Association and by Safriel & Bruton (1984 p 22)

#### 2.3.4 Family Cyprinidae

##### 2.3.4.1 Barbus anopolus - chubbyhead barb

This species is one of the most common small fishes in the whole Southeastern Cape region, and is widely spread in Ciskei. As with *Barbus trevelyani* and other smaller species, it has also been heavily preyed upon by some of the larger carnivores that have been introduced to Ciskei (Jackson 1982 p 122).

The chubbyhead barb breeds easily, and is able to colonise new water bodies very quickly. It feeds on algae, small insects and bottom deposits. *Barbus anopolus* has virtually no economic importance apart from the possibility of being used in the aquarium trade.

#### 2.3.4.2 Barbus holubi - Small-mouth yellowfish

This species of yellowfish, although indigenous to Southern Africa is not truly indigenous to Ciskei, as it has been introduced to the Fish River system through the Orange-Fish tunnel, and has also been successfully translocated into the Kei River (Bruton et al 1982 p 43).

Although it is a popular angling fish, it has no real importance as a culture species, due to its poor table qualities.

The yellowfish breeds on gravel beds in flowing rivers, and feeds mainly on insects, crustaceans, small fish and bottom deposits.

#### 2.3.4.3 Barbus trevelyani - Border barb

This species, in appearance, is not an ideal aquarium specimen, but it is an interesting fish in that it is endemic to the Buffalo and Keiskamma Rivers of Ciskei, and has been declared an endangered species (Skelton 1977 quoted by Jackson 1982 p 122).

The Border barb occupies the same habitat as trout, being an open water living fish, breeding in the midstream gravels (Bruton et al 1982 p 122). Poor land management practices have increased the vulnerability of the species due to the silting up of its spawning beds. Of particular note is the fact that Pirie Trout Hatchery has succeeded in breeding this fish in captivity (Jackson 1982 p 123).

#### 2.3.4.4 Labeo capensis - Orange river labeo

This species is very similar to *Labeo umbratus* (below), although it has only come into the Fish River through the Orange Fish tunnel. However, in the Orange River it is a common and well established species.

*Labeo capensis* displays similar characteristics to the moggel, although it would appear that it is more adapted to flowing rivers, preferring more rocky areas. It is a bottom feeder, grazing on algae and organic detritus (Bruton et al 1982 p 47).

The economic importance of this species is dependent on its ability to establish itself within the Fish River System. If this does take place *Labeo capensis* could become an important species in extensive gillnetting

enterprises similar to those used for the moggel in Ciskei.

#### 2.3.4.5 Labeo umbratus - moggel

This species is not a popular angling fish, due mainly to its feeding habits and the mouth shape of the fish. Because of many small bones, the labeo does not make a good eating fish unless it is prepared carefully.

The moggel is the predominant indigenous fish of the Eastern Cape region which includes Ciskei, and is found throughout the middle and lower reaches of all the major catchment areas, occurring within these areas in most streams and pools. It breeds with the onset of summer rains, moving upstream and laying its eggs on clumps of vegetation on flood plains. The eggs hatch quickly and the young larvae swim up and down in the water column to ensure that they are carried back with the receding water to the main water body (Bruton et al 1982 p 50).

The moggel feeds on detritus and algae and has a long coiled intestine for this purpose. It is possibly due to its feeding habits that the moggel can establish itself so successfully in the small dams and ponds in Ciskei which are often enriched with stock residues.

Due to its predominance and the fact that it is one of the largest indigenous species in Ciskei, this species is probably the most economically important fish for Ciskei, more especially where there are established populations in the large eutrophic water bodies such as the Laing and Bridle Drift Dams.

One of the main constraints in utilizing this species more widely is the difficulty experienced in catching it on hook and line. In many cases in rural areas a net may harvest more than can be readily consumed by the harvester. However, this problem may be overcome by using one of the methods of preserving fish, i.e. smoking or drying.

#### 2.3.4.6 Cyprinus carpio

The common carp (*Cyprinus carpio*) has the longest history of culture in the world. It was first introduced to South Africa in 1894 (Jackson 1982 p 123) and has been used since for its angling and culture potential.

The natural food of the carp includes invertebrates, detritus and numerous other forms of plant and animal

life. All these forms respond readily to fertilization and carp can also adapt quickly to accept a variety of live and prepared foods.

Carp breed readily both in the wild and in captivity. The eggs are naturally adhesive, which makes egg collection very easy. In artificial spawning, the stickiness of the eggs has to be overcome to successfully spawn batches of eggs.

The economic potential of carp farming has been developed in many countries, although under local conditions it has not been realised. This is possibly due to the high cost of production of 'prepared' foods which are commonly used. However, as carp grow readily in fertilized ponds, this is not necessarily a barrier to realising their potential.

There are numerous species and varieties of carp, some of which feed at different levels of the food web. However, all are basically similar in terms of their culture potential.



## 2.3.5 Family Claridae

### 2.3.5.1 Clarius gariepinus - sharptooth catfish

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This fish is well known for its angling and eating quality throughout most of Southern Africa. Although it is indigenous to South Africa it does not normally occur in Ciskei. However, due to the opening of the Orange-Fish Tunnel, Clarius have migrated from the Orange River System into the Fish River which borders on Ciskei and hence into its tributaries (Bruton et al 1982 p 54). There is also a small population in Alice, Ciskei and with the research work being carried out on both sides of Ciskei, it is only a matter of time before this species becomes more widely distributed. The sharptooth catfish breeds in shallow water, and the young grow very quickly. It is a carnivore and will feed on almost anything living or dead. The Clarius group have a wide range of tolerances in water quality, and survive in water with a very low oxygen content.

Clarius gariepinus has been identified by the Aquaculture Scientific Advisory Committee at Rhodes University as one of the main candidate culture species, and a large volume of research is consequently being directed towards this species. Due to its wide feeding range and tolerances it has the potential to become one of the most economic fish to culture in South Africa, including

Ciskei (Aquaculture Development at Rhodes University and J L B Smith Institute 1982 p 6).

### 2.3.6 Family Mugilidae

#### 2.3.6.1 Mugil cephalus - Flat head mullet

The mullet is a popular angling and eating fish throughout the world, and in view of its wide tolerances of water salinity and temperature, is a popular species for aquaculture.

It is a marine species that is widely distributed in the estuaries of tropical and semi-tropical waters around the world, and Ciskei is no exception. Young mullet migrate upstream and used to be common in all the river systems of Ciskei. However, due to the many dams and weirs that have been constructed on most of the rivers, mullet are now normally only found in the lower reaches.

Mullet feed low on the food web consuming diatoms and other small organisms, and therefore, like the moggel, do well in the eutrophic conditions found in some of Ciskei water bodies (Jackson 1982 p 126).

They show promise of economic importance to Ciskei, but this is University of Fort Hare dependent on the availability of fish seed. Mullet fry may either be captured in estuaries and transported to inland locations, or be artificially spawned. These techniques have formed the basis for world wide research programmes and are now fairly reliable, although the technique of raising fry has been less successful.

#### 2.3.6.2 Myxus capensis - Freshwater mullet

Much of the description of the previous species applies to this mullet which is even better adapted to fresh water conditions (Jackson 1982 p126). It has been researched locally by Bok (1983), who has shown the potential for utilizing this species in aquaculture. However, the same constraints, i.e. those of seed availability, will apply.

### 2.3.7 Family Centrarchidae

#### 2.3.7.1 Lepomis macrochirus - Bluegill sunfish

This species is found extensively in Ciskei and the Eastern Cape, where it was originally introduced as a forage fish for another introduced species, the bass.

In suitable water the Bluegill will quickly overcrowd its environment through excessive breeding, and the resulting stunted population often becomes a pest fish (Welcomme, 1981 quoted by Jackson 1982 p 123). It feeds on small fish and eggs as well as insects.

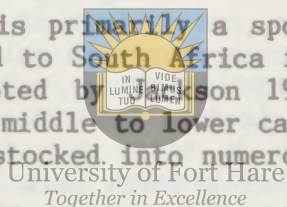
This species although having no real economic importance, is easy to catch on 'hook and line' and is very pleasant to eat and therefore has limited potential.

#### 2.3.7.2 Micropterus dalornieu - Small mouth bass

This species (introduced in 1937) although similar to the large mouth bass prefers the colder and cleaner water associated with the upper reaches of the catchment areas. It is not as common as the large mouth bass, and is unlikely to become any more common due to habitat destruction as a result of poor agricultural practices.

#### 2.3.7.3 Micropterus salmoides - Large mouth bass

This species is primarily a sport or angling fish and was introduced to South Africa for this purpose in 1928 (Hey 1944 quoted by Jackson 1982 p 124). It occurs mainly in the middle to lower catchment areas of Ciskei, and has been stocked into numerous farm dams and ponds.



The large mouth bass breeds readily, depositing its eggs in shallow nests. Its diet is principally insects, crabs, frogs and small fish, and as a consequence readily accepts artificial lures.

It is not a culture species of much potential, however, cognisance should be taken of its potential as a 'game' fish, as the bass fishing market is becoming increasingly commercialized. For this reason its tourist potential should not be overlooked.

### 2.3.8 Family Monodactylidae

#### 2.3.8.1 Monodactylus falciformis - Cape mooney

Although this is basically a marine species it does occur in adjacent fresh water bodies and makes an interesting aquarium fish (Bruton et al 1982 p 66).

### 2.3.9 Family Cichlidae

#### 2.3.9.1 Tilapia sparrmanii - Banded tilapia

This fish is a more cold tolerant species of the tilapia group. Its small size makes it unsuitable for food

culture (Jackson 1982 p 125), but its pretty colouring has attractions for the aquarium trade (Bruton et al 1982 p 72).

#### 2.3.9.2 Oreochromis mossambicus - Mossambique tilapia

This species is part of the famous 'tilapia' group which is an important culture angling and eating fish. 'From the point of view of human nutrition, tilapia was already firmly entrenched as one of the world's most important fish by the start of the twentieth century' (Bardach et al 1972 p 381). With the possible exception of carp, it is the most cultured species in the world. The Mossambique tilapia is indigenous to South Eastern Africa of which Ciskei is almost the South Western limit.

This species is tolerant of fairly low water temperatures and can successfully survive at temperatures between 10°C and 15°C, (Bruton et al 1982 p 75). It is tolerant of varying degrees of salinity right up to pure seawater, and in fact is better able to survive at lower water temperatures in saline conditions. It feeds mainly on benthic organisms, algae and diatoms, but will also feed on insects and crustaceae.

This species forms part of the mouth brooding group of tilapia and breeds easily. This often results in overcrowding and stunting of juvenile fish.

Tilapia in general and this species in particular, show great economic promise in terms of fish farming. One of its greatest assets is its ability to breed naturally. This makes it an ideal fish, for conditions where expertise for advanced spawning techniques is limited. Further to this, suitable food supplies for the species can be created simply by fertilizing the water either with manure or inorganic fertilizer.

#### 2.3.10 Family Anabantidae

##### 2.3.10.1 Sandelia bainesi - Eastern Cape Rocky

The distribution of this species has been the subject of intensive research under the Zoology Department at the University of Fort Hare, due to the fact that it is endemic to the Eastern Cape region of South Africa. However, it has little economic importance.

It occurs in the middle to upper reaches of most river systems in Ciskei, and it would seem that it is more common than has originally been estimated.

### 2.3.11 Family Gobiidae

#### 2.3.11.1 Glossogobius giuris - Tank goby

An unusual fish that is becoming less frequent in some of the river systems due to chemical pollution. It could make an interesting aquarium species. The Tank goby lays adhesive eggs and feeds on benthic organisms (Bruton et al 1982 p 77).

#### 2.3.11.2 Platygobius aeneofuscus - Fresh water goby

It would appear that this species is not as abundant as the Tank goby and is found mainly in the lower reaches of the Keiskamma River (Jackson 1982 p 126). It breeds in freshwater and feeds on benthic organisms (Bruton et al 1982 p 77). It has no real importance except as a possible aquarium species, although even here it is less popular than the Tank goby.

## 2.4 SUMMARY

Ciskei is abundantly supplied with varieties of indigenous and introduced fish. While only a few of these are of economic importance they are quite sufficient to form the basis of a varied fish production programme. For the harvesting of naturally occurring population the Moggel (*Labeo umbratus*) is pre-eminent. It occurs in all the river and reservoir systems in large numbers and is easily harvested by gill nets. In culture systems, the carp, clarius and tilapia families and eels are well suited to local conditions. For tourism, the black bass, and to a much smaller extent, trout, are viable propositions. Although the list is limited, therefore, all the requirements are available from existing species to meet any demand for development in the foreseeable future.

## CHAPTER 3

### SOCIO-ECONOMIC SURVEY

It was intended at the outset of the project to examine in detail the socio-economic aspects of freshwater fish production and consumption in Ciskei. This was due primarily to the widely held assumption that not only was the capture and consumption of fish unfamiliar to the Xhosa people, but that aspects of their culture were actually inimical to the development of fish consumption. It was held that the handling, preparation and consumption of "cold, dead fish" would be an anathema to tribes in the Xhosa group and that they would be reluctant to work in or harvest the water bodies occurring in Ciskei. Both these attitudes were assumed, on behalf of the subjects concerned, to arise out of the beliefs relating to the spirit people residing in the rivers.

Concern over these beliefs led the researchers to propose an empirical socio-economic study of attitudes to ascertain:

- "1. Attitudes to and knowledge of fish as part of the diet.
2. Knowledge of harvesting techniques.
3. Attitudes to the inclusion of fish and organic nutrients in water bodies.
4. Institutional factors such as the correct individuals or groups through which to sponsor fish."



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(ARDRI 1981 p 6)

Despite the early scepticism of the Steering Committee, many of whose members had been involved in harvesting and had experienced the demand for the fish from local people, it was determined initially, nonetheless, to proceed. Before work could be started on the socio-economic survey, however, it was overtaken by events in the form of the early results from the market survey and the sample nettings, which indicated so great a demand for fish that a specific survey of the type prepared appeared to be superfluous. Accordingly, at its meeting of October 1983 the Steering Committee decided to eliminate the socio-economic survey.

The purpose of this brief chapter is to emphasise certain of the findings of the other tasks which have bearing on the socio-economic aspects. All are reported on more fully in their respective chapters.

#### 3.1 FISH CONSUMPTION

It is quite apparent both from the results of the market survey, (Chapter 4), and the existence of numerous "fish-and-chip" shops in and around Ciskei, that the habit of eating fish is well entrenched in both urban and rural groups of Xhosa. An issue of considerable importance to this project is the eagerness among rural communities to obtain supplies of the fish species tested in the market survey, the "moggel" (*Labeo umbratus*). This appears to be the result of lack of fresh fish or meats in the rural areas which is the outcome of the poorly devel-

oped distribution networks in the rural areas. This in turn is the result of inadequate electricity distribution and road transport. Plainly a system which would facilitate the distribution of fresh fish widely in the rural areas of Ciskei would be of benefit to the rural communities. The lack of access to supplies of fresh fish or meat creates a demand, even when the fish is of low quality, as is the case with the moggel.

### 3.2 FISH HARVESTING

The harvesting of fish with gill-nets is an orderly, simple procedure, easily learnt (Chapter 5). The experience gained in all the activities of the project indicates that Ciskeians are fully able, and willing, to master the techniques of gill and seine netting. They have already become active in the coastal rivers, to the extent that "poaching" requires the specific attention of the Department of Nature Conservation.

### 3.3 INCLUSION OF FISH AND ORGANIC WATERS

It is almost certain that a community will resist the introduction of animal wastes into a pond which is primarily used as a source of domestic water (Chapter 6). The same might well apply to fish whose activities increase the turbidity of the water, such as the common carp. On the other hand, no inherent broadly-based resistance to fish or wastes introduction on cultural grounds could be identified among the groups of people consulted. Indeed, judging by the number of enquiries received from communities and womens' groups for assistance in establishing fish in existing water bodies, quite the reverse is the case.

In summary then, none of the anticipated cultural barriers materialised, but a serious barrier could be predicted in this institutional and infrastructural factors. As the project progressed the reseachers became more firmly convinced that the decision to eliminate a socio-economic survey was correct. The distribution of fish harvested in the resource survey did not elicit any negative response, and the fishing enterprise was able to dispose of all its output without difficulty, and in fact was obliged to refuse orders.

### 3.4 CONCLUSION

It may be concluded with some confidence, even in the absence of a formal survey, that socio-economic factors will not constitute a barrier to the expansion of fish production in Ciskei, within the limits of the scale envisaged.

## CHAPTER 4

### MARKETING

#### 4.1 INTRODUCTION

A major segment of the project was an investigation into the market potential of freshwater fish in Ciskei. The survey was conducted and report prepared by a member of the Department of Business Economics at Fort Hare, and because of the scope and value of the final report, it has been published as Volume II of this report. The principle findings of the marketing report and other publications are summarised in this Chapter.

#### 4.2 MARKET SURVEY

For the purpose of the survey the population of Ciskei was stratified into urban and rural dwellers and a proportionate sample of 300 families or 0,28 percent of the total was randomly drawn. Samples of the fish available were issued to the selected respondents and subsequently an interview, controlled by a questionnaire schedule was conducted with each respondent.

A total of 93 percent of all respondents indicated an intention to purchase fish, the main reasons being that "people like fish, it is cheaper than meat, it would be accessible if delivered to the township and was easy and cheap to prepare". In regard to frequency of intention to purchase, 92 percent indicated that they would buy it 2 to 3 times a month or more often. From this, using reasonable assumptions and estimation it was calculated that an annual demand of 3,21 million kilograms could be anticipated worth, R2,6 million if valued at R0,80 per kilogram. Income and expenditure surveys however indicate annual purchases of R1,054 million. The difference could be accounted for by non-availability of fish, uncompetitive pricing, lack of promotion or simple experimental error.

There appeared to be a tendency for larger families to consume fish more often but no relationship between size of household, income and consumption of fish could be established. There was no prejudice expressed against freshwater fish. Packaging, sales promotion, medium and point of sale were all investigated and in each case established.

The principle conclusion, of critical importance to the project, was that "The results of the survey have proved beyond doubt that the black population of Ciskei is greatly in favour of freshwater fish as a protein food and substitute for certain meat products".

The main recommendations were:

1. That marketing of freshwater fish should be directed especially at the lower income groups.

2. That promotion should be directed at housewives, the main decision makers in regard to the purchase of food.
3. That fish should be packed in clear plastic bags for visibility.
4. That in the rural areas marketing should be via hawkers on Monday and Friday mornings and in urban areas via supermarket outlets.
5. That fish should be sold in the whole form.

#### 4.3 MARKET PROSPECTS IN RSA

The positive tone of the findings of the survey in Ciskei is in stark contrast to that of an investigation into the aquaculture market conducted by Bross (1982). He reports that the marine fish industry is well-established in the frozen food sector throughout South Africa and is both vertically and horizontally integrated. The capture, processing, distribution and marketing of fish as a segment of a frozen food line is therefore highly efficient. The industry is dominated by three major distributors, is "fiercely competitive", operates at low mark-ups and is oversupplied with fish except in terms of variety at the upper end of the scale (Bross 1982 p 16). Further the white fish used in processing is so cheap (R0.48 per kg FOB in 1985) that it provides no market niche for aquaculture products.

"Individual consumption patterns indicate that, although each race group can be regarded as forming a separate market reflecting differing traditions, income levels, urbanisation, access to electricity and retail outlets, the fundamental cleavage is that between Blacks and non-Blacks. Predictably, little tablefish is consumed by Blacks. Neither Black households nor African stores normally are equipped to handle frozen fish which must be transported inconvenient distances for home use. The 17 500 tons of product purchased consists mainly of fish fingers and small hake. About 80% of canned fish supplies are consumed by this market segment. Generally purchasers seek high nutritional value per unit expenditure when buying fish. Where urban Blacks have displayed an affinity for fish, distributors succeed in getting product to them - the Eastern Cape township horse mackerel trade being a case in point. The Black sector offers dismal prospects as an aquacultural target market. It is worth noting that, as low as it is, the annual per capita fish consumption of SA Blacks is greater than the corresponding figure in any bordering state - a fact which may be significant in formulating aquacultural development programmes in such countries.

Non-black per capita annual consumption is high - higher than that of all OECD members other than Japan, Spain and the Nordic countries and 20% higher than the world average. Whites and Asians purchase nearly all the mixed species high grade wholefish varieties in restaurants, hotels, fishmongers and self-service stores, particularly the large chains. Whites eat more processed tablefish than any other group and are the most accessible group through conventional outlets. Much of the

fish sold to high income consumers is thawed to cater for customers requiring "fresh" fish. The consumers, selling outlets and product classes that hold most promise for large scale aquaculture are easy to identify. It seems that aquaculture cannot in the circumstances create its own markets. The aquaculturalist's problem therefore is how to channel appropriate products into existing markets.

The available data serve to show that:

- there are no soft markets for fish
- tablefish is distributed by a few efficient concerns at low cost
- fish products are distributed simultaneously through the system partly in bulk to wholesalers but usually as a minor but important part of full range of frozen food and perishable products
- fish is generally oversupplied at price levels relatively lower than other meat products
- there are few identifiable real shortages of fish but the top end of the whole fish market lacks varieties
- most consumers are demanding discriminating and conservative; South African quality standards for frozen fish are exceptionally high
- the market is geared to frozen products completely so inland
- fish is sold through a narrow range of outlets
- ownership and trade in the retail sector is concentrated amongst large self-service stores
- fish is not intensively sold in low income or sparsely populated areas despite many unmarketed varieties being available to the catching sector.
- the market is basically urban in nature."



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Bross (1982 footnote p 19) heavily discounts "the peasant sector which seems to be a universal favourite of aquaculture planners". His main argument is that the market could easily be penetrated by the established fishing sector using trash fish. This is a serious miscalculation. The transport, communications and electricity networks which are fundamental to its operations in the developed sector and are the basis of its efficiency, are completely absent in the rural or "peasant" sector. Had this not been the case it is likely that the established fishing sector would already have penetrated the market. Contrary to Bross' (1982) opinion these missing elements in the market system create precisely the conditions in which aquaculture can develop. By its very nature small-scale aquaculture is dispersed and

close to its end-market, and capable of delivering to that market fresh, unfrozen fish, at a low price. Comparing these capabilities with Table 3.2 of the Marketing Survey Report "Reasons for purchasing fish", shows three important reasons fitting the characteristics of aquaculture - fish is cheaper than meat, accessible and reasonably priced regardless of its relationship to meat. In short the strengths of established sector in the developed areas are the very weaknesses in the rural areas which create a niche for the development of small-scale dispersed aquaculture development.

#### 4.4 MARKET STRUCTURE FOR CISKEI

In proposing this structure cognisance was taken of two factors:

1. Aquaculture in Ciskei is likely to start as small-scale dispersed units and grow slowly to larger concentrated outputs.
2. The emphasis placed on freshness of the fish, and the fact that they were sold as whole fish by the respondents in the market survey. These were seen as favourable characteristics. They also showed a marked preference for smoked fish and fish processed into fish cakes (Section 2.1, 2.2, 2.3 of Fish Tasting Surveys 1982).

Based on these two sets of factors a logical sequence of development of the market sector can be devised, although it is not possible to identify the timing of each stage of development. The stages are:

1. Informal market

Two phases in this stage can be recognised. In Phase 1 fish will be sold whole and gutted either by the grower/harvester at water's edge, or by hawkers operating in the immediate surroundings. The hawkers would purchase directly from the primary producer.

Phase 2 would come about as a result of one or both of two events. Firstly the production and marketing of fish is a process which must be learnt and Phase 1 represents the simplest and therefore most easily mastered system. Once confidence is gained in this simple system the entrepreneurs might wish to improve profitably by further processing of fish. Secondly, inevitably market saturation at this level will be reached, and diversification of the product by processing will increase market size. Phase 2 therefore consists of marketing, through the same mechanisms, fish improved by hot-smoking or as prepared fish cakes.

2. Formal market-retail

For various reasons the bulk of the fish harvested by the fishing enterprise on Laing Dam (Chapter 5) was marketed through retail outlets such as fish-and-chip shops catering for the lower end of

the market. This proved a reliable and profitable outlet for relatively large volumes of fish. Once output of aquaculture and or harvesting systems exceeds the capacity of the informal market to absorb, the excess can be marketed through this channel. Prices realised based on experience are approximately half of those in the informal market (R0,40 versus R0,80 per kg) but are still attractive.

### 3. Formal market-wholesale

It must be envisaged that ultimately output will grow to a point where a fully integrated, formal collection and distribution system must be incorporated into the market mechanism. While this will occur only after Stages 1 and 2 have been achieved and this may be some time in the future, consideration must be given to the incorporation of other products into the marketing mix. For example concurrent with the development of fish production, a broiler production project is under way, capable of rapid growth. This will also in due course require collection and freezing facilities. The development of a Ciskeian abattoir provides opportunity for innovative marketing of fresh, or frozen pre-cut meat, free of the regulatory constraints of South Africa. This again will require integrated freezing and delivery systems.

With the involvement of the Ciskei Agricultural Corporation in both the abattoir and in fresh produce via the Mdantsane market, it would appear to be the obvious institution to handle the integration of the marketing system. Freezing facilities could be situated either at the abattoir or at the Mdantsane site with advantages in both.

### 4.5 CONCLUSION

At the scale of aquaculture and fish harvesting envisaged, there is no discernable impediment to expansion imposed by the market. A logical and efficient market development programme can be designed and linked to the growth rate of the production systems.

## CHAPTER 5

### FISHING ENTERPRISE

One of the tasks proposed in the project report was the establishment of a fishing enterprise. As a prerequisite to this, a survey of the fish resource was essential. This Chapter reports on the results of the survey and the experience of the fishing enterprise.

#### 5.1 SURVEY OF THE FISH RESOURCE

The water bodies surveyed included large impoundments, night storage dams and stock watering ponds. The tackle tested encompassed gill nets in varying mesh sizes, seine nets and push nets. During the conduct of the survey, the difficulties inherent in using a seine net became manifest. All of the dams tested had uneven bottoms with underwater obstructions and surface weeds. This made it impossible to effect the correct procedure and the resultant catches were very poor. It became apparent that seine nets would not be practical in a commercial undertaking conducted under these conditions.

In contrast, gillnets proved to be efficient, even when employed in rivers. Since they are set static in the water, they could be set around obstructions and in otherwise inaccessible places. Their effectiveness in size selection is shown in the data for the Laing Dam, where fish caught occupied a narrow band in terms of length and weight in relation to mesh size. The success achieved with gillnets, and their practicality suggest that this is the most viable tackle for a commercial venture.

As may be seen from the table, a narrow range of fish species was caught, limited to three main species, *Labeo umbratus*, *Cyprinus carpio* and *Micropterus salmoides*. Of these, the latter two species tend to avoid gillnets, as in certain dams their presence and numbers were visually obvious, although physical catches did not reflect their presence. Conversely *Labeo umbratus* proved to be a very easy fish to catch no matter how scarce.

Of the dams tested initially Laing Dam showed the greatest potential for exploitation, and this is confirmed by Jackson (1982 p 129). In order to substantiate the fishing potential, a more formal quantitative survey was conducted in conjunction with the Division of Nature Conservation, Ciskei Department of Agriculture and Forestry. The survey was conducted over the period July 1982 to June 1983, and fish caught were used in the market survey (Chapter 4).

##### 5.1.1 Methodology

The survey was conducted as follows:

1. Gillnets were "laid" in the water during the afternoon to late evening, and "lifted" early the following morning.

Consequently, at each netting operation the fish were caught during the night, with the nets being left in the water for periods of 13-15 hours.

2. Initially netting was carried out on a monthly basis, but this was increased later in the survey to two and three times a month.
3. A variety of mesh sizes, ranging from 90mm-180mm, was used during the survey in order to ascertain the best yielding mesh size.
4. A 10 percent random sample of fish caught was examined under the headings: date caught; species; sex; length; weight; sexual maturity; age; mesh size; mesh colour. The information yielded was stored in and then analysed by a computer.

#### 5.1.2 Summary of Data

The data were analysed to provide the following information:

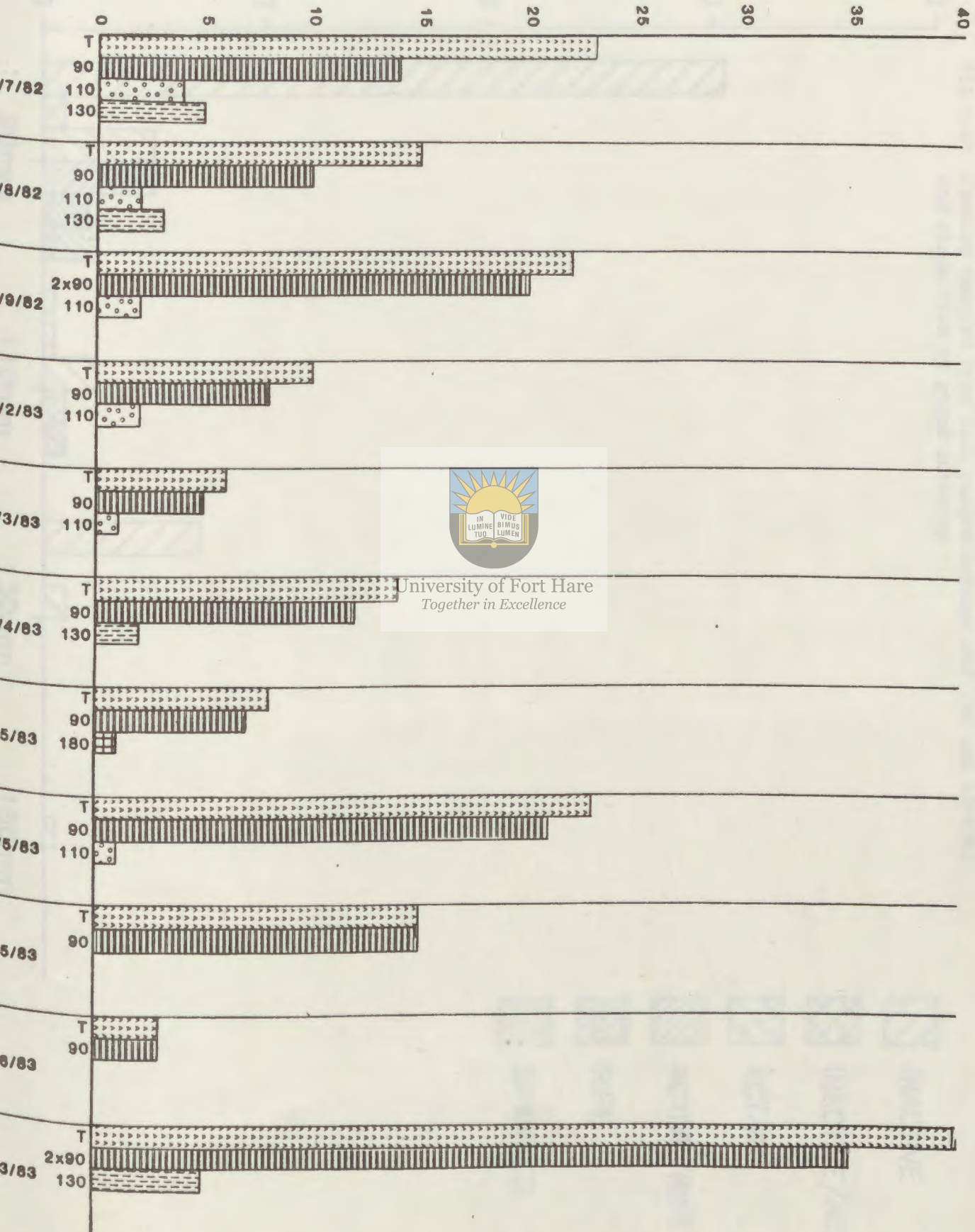
1. Number of fish per mesh size and colour, classified according to sex and gonad condition, as well as sex ratio.
2. Weight, length and species of fish according to mesh size and net length.
3. Age distribution to mesh size and net length.
4. Fish condition factor expressed as weight gain per year and weight to length ratio.

This programme would have to be continued for some years before reliable trends could be ascertained. If a commercial operation was forthcoming fish samples would be analysed to provide year class recruitment data as well.

The following information has been extracted from the computer analysis.

1. 179 fish were sampled, representing 10 percent of a total catch of 1 790 fish during this period (29 July 1982 - 15 June 1983).
2. Average mass of fish caught = 801g  
Average mass: length ratio = 2,46g:mm  
Average age = 4,5 years  
Average mass gain/year = 178,28g/yr

NUMBER OF FISH



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FIGURE 5.1: TOTAL FISH CATCHES PER NETTING EXERCISE

FIG 5.2: Females sampled from fish caught between 29/7/82 and 15/6/83 and classified by gonad activity

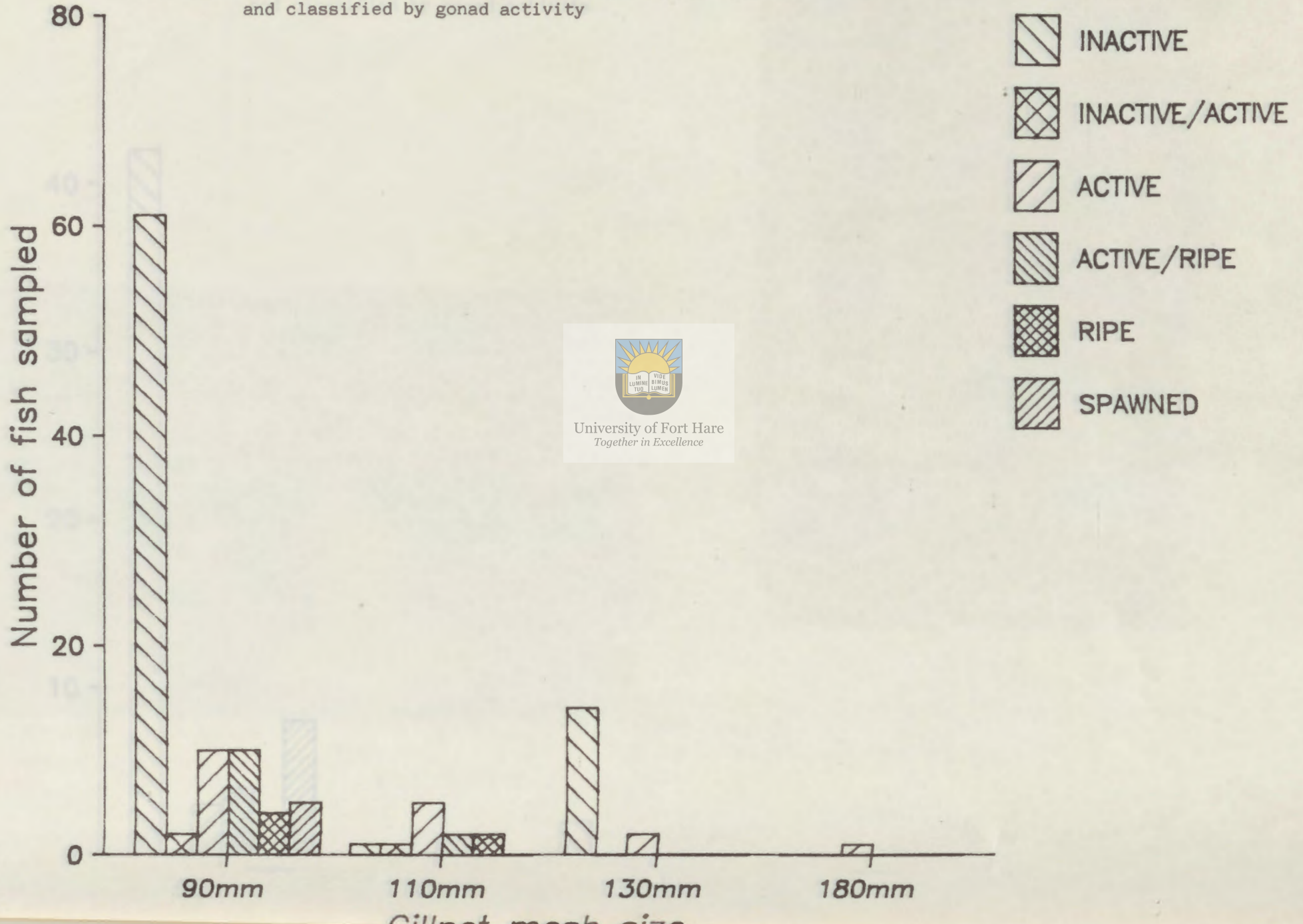
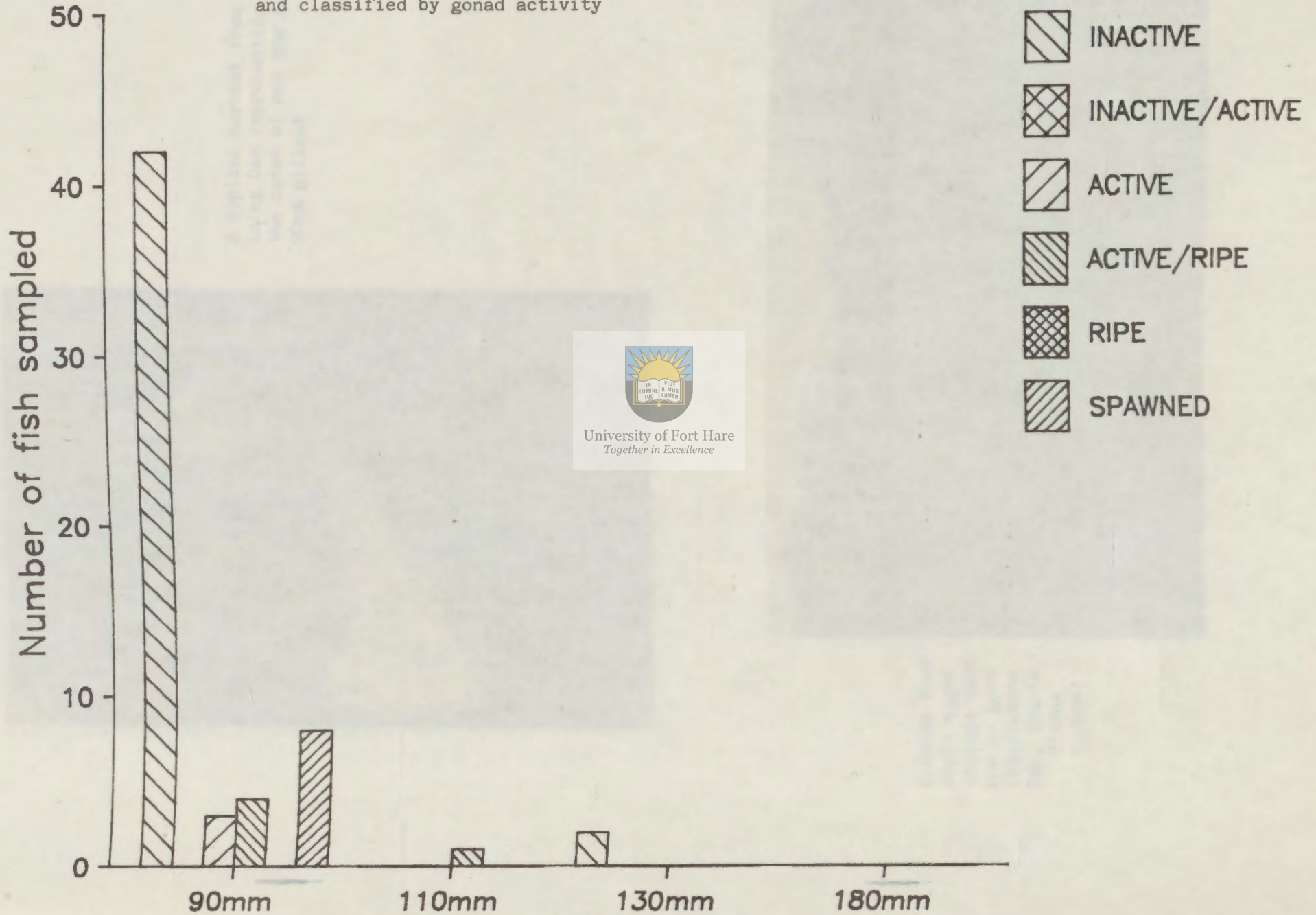


FIG 5.3: Males sampled from fish caught between 29/7/82 and 15/6/83 and classified by gonad activity





A typical harvest from Laing Dam representing the catch of one 50m x 90mm gillnet



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Catches from small night storage dams can be good (Battlesden Dam, Tyumie Citrus Estate)



3. Species composition of catches:

Labeo umbratus 97,75 percent  
Other 2,25 percent (Micropterus, Oreochromis and Cyprinus spp)

4. There were 11 netting exercises during which a total of 24 gillnets were set. The relevant data is presented in Table 5.1.

Table 5.1: Fish capture data by net size

		Total	90mm	110mm	130mm
Nets set	no.	24	16	6	2
Fish caught	no.	1790	1550	210	30
Fish/net	no.	75	97	35	15
Mass caught	kg	1484	1282	167	35
Mean mass	kg	,829	,827	,795	1,17
Range min	kg	,325	,550	,325	,850
max	kg	1,350	1,325	1,300	1,350

The data indicate that the 90mm net catches the largest proportion of fish per net set. From this it is apparent that any commercial operation would best succeed using this mesh size. The data is presented graphically in Figures 5.1 to 5.3.

Expressed in terms of catch per unit effort the figures indicate that high returns to labour can be achieved.

Number of netting exercises	- 11
Average effective time per exercise	- 2 hours
Total time taken	- 22 hours
Total mass fish harvested	- 1483,90 kg
Catch per hour	- 65,17 kg

Given a crude estimated value of R0,50 at "water's edge" this would provide the fisherman with a gross income of some R32,50 per hour of effort expended. Few employment opportunities in Ciskei offer this level of income, coupled to the low level of training required, and the minimal capital investment involved.

.2 COMMERCIAL OPERATION

The results of the survey created sufficient confidence to prompt the establishment of a commercial fisherman on Laing Dam and the division of Nature Conservation set about finding a prospective fisherman. This was done by advertising in local newspapers and magazines, and by word of mouth, which resulted in a candidate expressing an interest. This was a Mr Mtalana of Hamburg, who was interviewed on 18 April 1983.

Before the commercial operation could get under way it was necessary to receive official sanction for the operation and clearance for the fisherman in question. This was granted by the Executive Council Resolution on 29 September 1983. The delay of six months resulted in the prospective fisherman finding alternative employment and a second fisherman had to be canvassed. In December of 1983 Mr Klaas, an employee of the project, expressed an interest in becoming a private fisherman and was able to start operations in January 1984 after receiving official clearance.

Regrettably, from its inception the operation suffered setbacks and a month by month account illustrates the problems experienced.

#### January

Mr Klaas is a resident of the Tyumie valley area near Alice, and therefore did not have residential rights in the Laing Dam area. When the operation started it was necessary to apply for a land grant on which to establish his operation. It was held by the Ciskei Nature Conservation Department that the land immediately surrounding the dam was Government controlled, and therefore on 10 January 1984 an application was made to the Ministry of Internal Affairs, by the Department, for a land grant. (Figure 5.4)

#### February

During January and February, ARDF assisted the fisherman by transporting him from his home in the Tyumie Valley to Laing Dam daily to conduct his operation, whilst at the same time trying to procure accommodation for him in the nearby area, until the land grant had been approved. In the middle of February accommodation was found at a brickfield near the site, run by an Asian resident of King Williams Town.

Mr Klaas immediately fell foul of the local headman, as the land used by the brickfields belonged to the tribe and permission should first have been obtained from the Tribal Authority. Efforts to meet with the headman during this period failed, and towards the end of February the operation was curtailed in order to clarify the situation, as well as to hasten the land grant.

#### March

At the beginning of the month the initial problems with the headman seemed to have been solved and the operation was restarted and appeared to be running quite smoothly. Mr Klaas was adequately housed at the brickfields and kept the boat and nets for his operation in a nearby inlet of the dam.

Trouble started again when a group of youths took the boat without permission to swim and play in the dam. During this escapade one of the youths drowned. This resulted in the family of the drowned youth

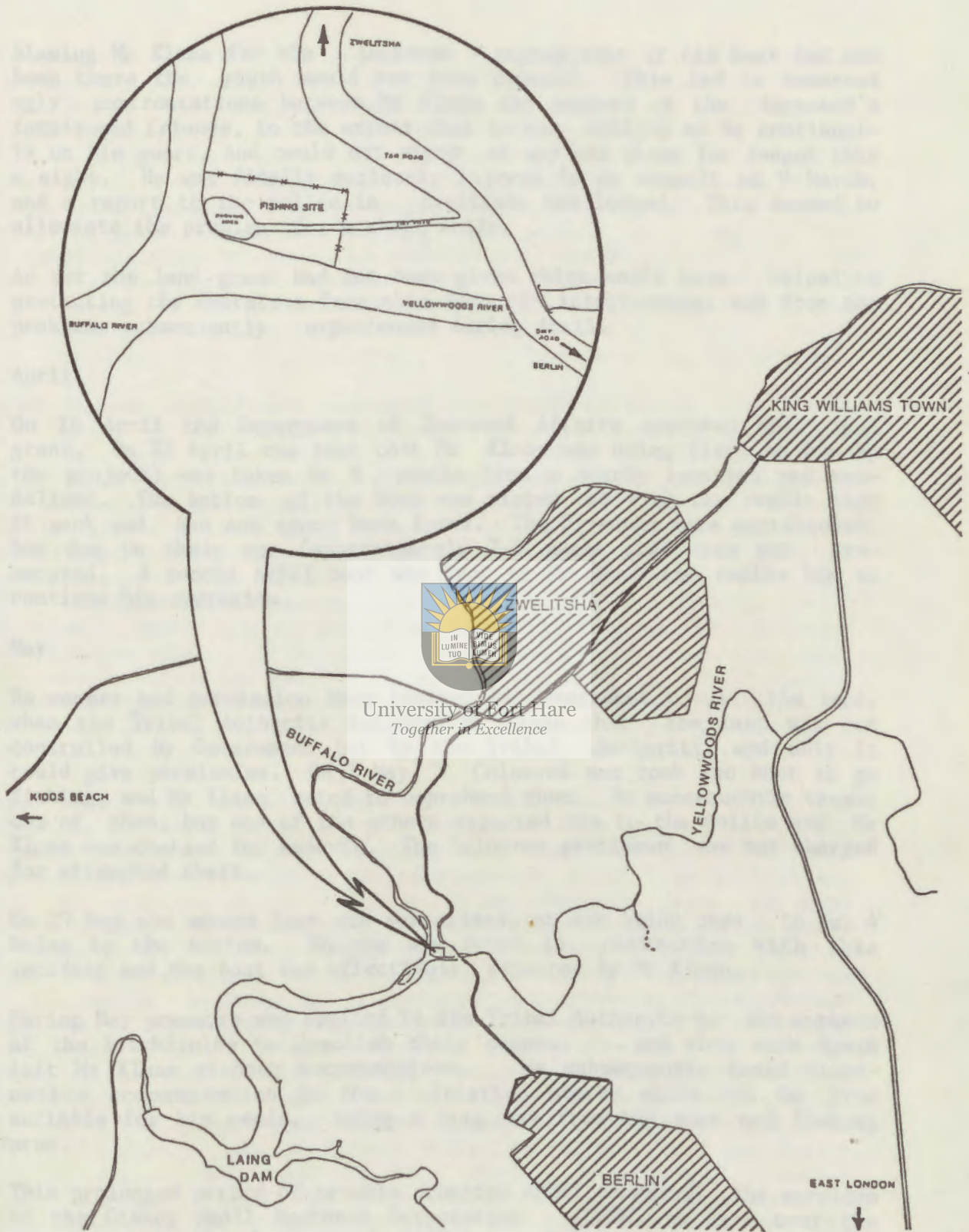


Fig 5.4 Map showing location of fishing operation and site approved by Dept. of Internal Affairs, Ciskei.

blaming Mr Klaas for the incident - saying that if his boat had not been there the youth would not have drowned. This led to numerous ugly confrontations between Mr Klaas and members of the deceased's family and friends, to the extent that he was obliged to be continually on his guard, and could not sleep at any one place for longer than a night. He was finally seriously injured in an assault on 9 March, and a report to the police in Zwelitsha was lodged. This seemed to alleviate the problem for a short while.

As yet the land grant had not been given which would have helped in protecting the operation from this form of interference, and from the problems subsequently experienced during April.

#### April

On 16 April the Department of Internal Affairs approved the land grant. On 23 April the boat that Mr Klaas was using (lent to him by the project) was taken by 3 youths from a nearby location and vandalised. The bottom of the boat was ripped out with the result that it sank and has not since been found. The 3 youths were apprehended, but due to their age (approximately 7-9 years old) were not prosecuted. A second ARDRI boat was lent to Mr Klaas to enable him to continue his operation.

#### May

No sooner had permission been granted by Government to use the land, when the Tribal Authority informed Mr Klaas that the land was not controlled by Government but by the Tribal Authority, and only it could give permission. On 7 May, 3 Coloured men took the boat to go fishing, and Mr Klaas tried to apprehend them. He subsequently caught one of them, but one of the others reported him to the police and Mr Klaas was charged for assault. The Coloured gentleman was not charged for attempted theft.

On 29 May the second boat was vandalised, an axe being used to cut 4 holes in the bottom. No one was found in connection with this incident and the boat was effectively repaired by Mr Klaas.

During May pressure was applied by the Tribal Authority to the workers at the brickfields to demolish their houses, and this once again left Mr Klaas without accommodation. He subsequently found alternative accommodation in the location nearby which was far from suitable for his needs, being a long way from his boat and fishing area.

This prolonged period of trouble prompted ARDRI to enlist the services of the Ciskei Small Business Corporation (CSBC) to take over the management of the fishermans' affairs and finances, a function for which that Corporation is properly constituted. ARDRI would confine its activities to the technical fisheries aspect alone.

## June

By the beginning of June it seemed that the efforts of Ciskei Small Business Corporation and ARDRI might bring about the necessary impetus to the operation. However, problems once again started in earnest on the 23 June when a group of 4 white men apparently from East London, while picnicking in the area utilized by the fisherman, told him he had no right to be fishing with nets and confiscated some 200 fish. On the 25 June Mr Klaas' blankets were "removed" from the house he was staying in, and he therefore had to return to Alice in the evenings to sleep until he could purchase new ones.

## July, August and September

During the period Mr Klaas was operating from Alice, he was being transported to Laing Dam on fishing days by ARDRI.

During September it was noticed that Mr Klaas' attitude and efforts towards the operation were definitely subdued when compared to the period when he first started. In the final event his interest had dwindled to such an extent that the operation was in jeopardy, and numerous discussions were held in an effort to find the cause of this diminishing enthusiasm which was uncovered eventually. It appeared to stem from his belief in the "water spirits" found in rivers, who are supposedly connected to people who may have drowned in them. It transpired that Mr Klaas had no prior knowledge of these beliefs, and his father had advised him of them that he became afraid of being connected with natural waters for fear of disturbing the spirits.

The effect of spiritual beliefs cannot be discounted, but nonetheless the possibility of rationalisation in a difficult situation should be considered. Mr Klaas had been subjected to many forms of harassment and further to this, was operating in a foreign environment, away from his area, relatives and friends. It may be possible that the reason given for his declining interest was intended to conceal hidden reasons, real or imagined. Certainly the problems and setbacks he endured must have affected his attitude and unhappily he no longer wished to continue with the operation. He withdrew at the end of September 1984, and the fishing venture was closed down.

The foregoing description of the commercial fishery has been concerned largely with factors outside the primary objective, i.e. to catch and sell fish. While the operation ran for some 9 months, only a short period can realistically be called typical of the potential. During January, February and March, when the operation was gearing up nettings were limited to actual orders and to what Mr Klaas could handle. However, catches increased from 75 kg in January to 400 kg in March. During April, May and June, nettings were carried out to harvest the maximum possible under the circumstances, and catches increased to 600 kg, 650 kg and 730 kg respectively. During July, August and September, while the fisherman was operating from Alice,

catches were restricted to the amount needed to supply standing orders, and therefore remained static at 200 kg/month. (Figure 5.5)

### 5.3 MARKETING

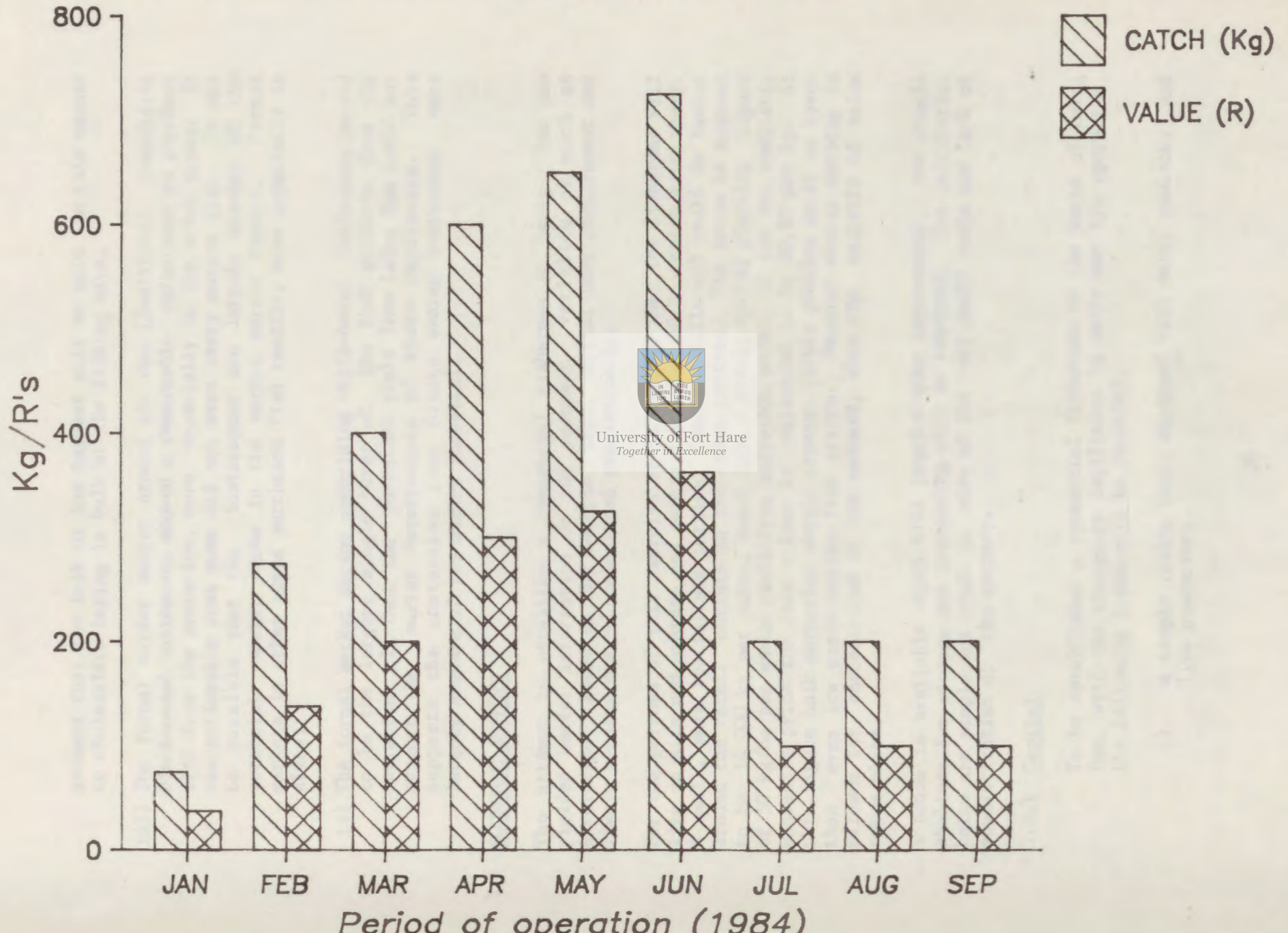
In general terms, the marketing of harvested fish can be sub-divided into four categories as follows:

- i) The informal market where "wet fish" is bought directly from the fisherman on site. Users in this category would normally purchase fish in the least prepared form, i.e. whole or gutted but with heads and scales remaining. This form commands a lower price than any other market sector.
- ii) The semi-formal market where fish are transported to high density areas (villages and locations) and sold direct to the public. Here also, users would purchase fish whole or gutted, but with heads and scales remaining, and prices would be increased to cover transport costs.
- iii) The formal market in the form of Black-owned outlets, (fish shops, cafe's, supermarkets and butcheries). These outlets would purchase fish for resale and would therefore require prepared fish, and in quantities compatible with the businesses clientele.
- iv) The formal market consisting of White-owned outlets (which supply fish to a Black market). These would have the same requirements as (iii) above.

It was assumed at the outset that categories (i) and (iii) would provide the greatest market potential for the operation. However, this did not prove to be the case, and throughout the operation the following marketing pattern was observed.

- i) Very few people actually arrived on site to purchase fish, despite the fact that there is a large resident population within a short radius of the site. This could be attributed to two reasons. Firstly, the local population tends to be impoverished, being mostly squatters, and therefore could not afford even this cheap food. Secondly, although widely advertised by word of mouth, due to the lack of physical structures the potential buyers could not associate fish availability with boats and nets. (This site has been used extensively as a fishing site by sport fishermen).
- ii) The semi-formal market consumed large quantities of fish especially in the more remote areas. The price structure for whole and gutted fish was calculated on a "per fish" basis and was roughly equivalent to R1,00 per kilogram. In order to supply fish on this basis economically, fairly large quantities must be carried per trip to cover transport costs. For the future, it is

FIG 5.5: Commercial operation of Laing Dam fishery under Mr N Klaas



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assumed that the bulk of the harvest will be sold in this manner to wholesalers buying in bulk at the fishing site.

- iii) The formal market sector around the dam (Zwelitsha) comprising Black-owned businesses showed a remarkable reluctance to purchase fish from the operation, more especially in the urban areas. It was noticeable that some did not even carry marine fish. It may be possible that the businessmen are largely unaware of the potential market shown in the market survey report. Formal markets in other areas purchased fish readily, more especially in Alice.
- iv) The formal market sector comprising white-owned businesses proved to be the largest single buyer of the fish products from the operation. In fact the potential yield from Laing Dam could not support the market requirements of these businesses. This supports the contention that Blacks owning businesses were largely unaware of the market potential.

#### 5.4 ECONOMIC ASPECTS

The attempt to establish a commercial fisherman at Laing Dam has yielded useful information on the economic variables of such an enterprise. Based on the records kept, capital cost requirement and likely returns can be calculated realistically.

For the purpose of this exercise it is assumed that the fisherman will live on site and operate and market the bulk of his catch from there. A small, more specialised portion (smoked, filleted) could be hawked around the retail outlets in the urban centres. The quota is assumed to be 14 000 kg per annum, based upon a widely quoted planning figure of 50 kg/ha per annum yield from eutrophic water. A low but realistic wholesale price for this volume is estimated to be R0,50 per kg. At this figure bulk marketing should present little problem as it is lower than even low grade marine fish prices. Regular weekly netting is allowed for, concentrated at the weekend, when the majority of sales takes place.

A house is available which will require some improvement, and simple shelters for storage and processing will be required. The calculation below are simple and crude in view of the very small scale and lack of sophistication of the venture.

##### 5.4.1 Capital

To be established a commercial fisherman on the banks of Laing Dam, with the necessary facilities to carry out his operation, the following items will be required.

- i) a simple rowing boat, equipped with oars, rowlocks and life preservers.

- ii) the necessary number of gillnets.
- iii) a house and storage facilities for equipment.
- iv) a shed for processing fish to market requirements.
- v) transport for marketing part of the catch, eg. a motor cycle plus trailer.

**Capital Costs**

Item	Costs (R)
Boat	400
Oars & life jacket	100
Nets	300
Processing shelter	280
Storage shelter	200
House improvement	500
Water supplies	200
Transport (used motor cycle)	500
Misc. equipment	60
<b>Total</b>	<b>2590</b>

Ciskei Small Business Development Corporation terms for this type of capital loan is 12 percent interest with repayment over two years. This involves an annual payment of R1 624.

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**5.4.2 Operating Costs**

The annual running costs are estimated as:-

Labour - one labourer at R80 per month	R960
Vehicle - allow R50 per month	600
Sundry - allow R30 per month	360
<b>Total direct costs</b>	<b>R1 950</b>
<b>Add annual capital costs</b>	<b>1 624</b>
	<b>R3 574</b>

With potential annual sales of 14 000 kg at R0,50 the total income is R7 000, leaving some R3 500 per annum as owner's salary plus profit. This seems a reasonable return in view of the level of investment, degree of skill and training required, and risk involved. Income could be enhanced however by improving a portion or all of the harvest. The options available and resulting "water's edge" prices are listed in Table 6.1 below.

The "water's edge" price is calculated by reducing the end price of the improved product to take account of the weight loss due to processing.

**Table 5.1:** Processing options and effective "water's edge" prices

Process	Saleable product as a %age of wet fish	Wholesale price R/kg	Water's edge price R/kg
Nil - wet fish	100	0,50	0,50
Gutted and scaled	85	0,70	0,58
Smoked	60	1,40	0,70

Source: Field data

While obviously the bulk of the catch could be sold gutted and scaled, the demand for smoked fish proved to be limited. It is undoubtedly worth exploiting however.

In view of the experience of the fisherman with administrative problems, the project model has been deliberately kept low-cost and low-risk. This is also in keeping with the type of entrepreneur likely to be involved, but once established and confident in his operation, expansion both horizontally and vertically could be considered. Some options are:

1. Establishing a pig-product unit using fish-offal as the primary source of protein.
2. Developing an intensive food system using organic wastes as a food supply
3. Developing a simple hatchery both to supply improved stock to his fishing water, and for sale to other prospective producers.
4. Improvement of the marketability of his product by smoking, drying, mincing or other processes.



## 5.5 SUMMARY

The unhappy experience of Mr Klaas in his attempt to establish himself as an artisanal fisherman illustrates vividly the stultifying effect of inadequate institutional structures on rural development, even when this has demonstrable commercial promise. Despite meticulous adherence to the official requirement, three critical factors combined to delay and finally to undermine the project to the extent that it collapsed.

1. The necessity to have so minor a decision as the approval of a single artisanal fisherman taken at the level of Cabinet-in-Council resulted in a six-month delay in getting the project under way, and the loss of the first candidate. It would seem that, given a clearly defined policy, this could have been settled at Departmental level, by issue of a permit.

2. The failure of the Department of Internal Affairs to ascertain who had jurisdiction over the land before issuing a certificate to occupy the site. Failure to observe the rights of the Tribal Authority in this respect, and its resultant umbrage deprived the entrepreneur of the support and intervention from the headman, which is essential to the survival of a stranger in a rural environment.
3. The total lack of support by the authorities in the problems experienced by the entrepreneur, even when this amounted to criminal action against him, such as the theft of his boat and harvest fish, and assault. The attitude of the police amounted to total indifference, and even hostility.

## 5.5 CONCLUSION

The neglect of this fledgeling enterprise by the Departments essentially involved can be held largely, if not completely, responsible for its failure. It should be noted that during the time the venture proceeded with little interference, it briefly showed great promise. At the time of writing, a third prospective entrepreneur is being established by the Ciskei Small Business Development Corporation, and because of the problems which were faced during the project experience, it has been decided to move through the approval cycle again, starting with Cabinet. If the experience gained means that the third candidate enjoys the support of the University of Fort Hare and the local authority, there is no doubt that he has excellent prospects for success under the guidance of the Corporation.

## CHAPTER 6

### INTEGRATED PRODUCTION SYSTEMS

Arising out of reports of integrated production systems in the Far East, it was "proposed therefore to set up a model family farm, which will be designed to produce all the food requirements of the family at a high level, plus a meaningful marketable surplus". (ARDRI 1981, p 7). All structures and inputs were to be in keeping with what is commonly available in rural Ciskei.

The first unit to be designed along these principles was the Tyefu Integrated Unit, situated on Section 3 of the Tyefu Irrigation Scheme. The reasons behind the siting of this unit were primarily because Tyefu, as one of the large irrigation schemes managed by the Ciskei Agricultural Corporation, incorporated small food plots, commercial plots and large commercial tribal blocks. All these were primarily aimed at vegetable production. A unit sited here would enjoy the benefits of the existing infrastructure, which it was hoped would manage the unit and supply the inputs for the agricultural part of the design.

It was envisaged that this unit would be run by a family group, and was consequently put to the Tyefu Selection Board, who selected 3 possible candidates. Of these a woman, Mrs. *Ellie Ngamitweni* was approved by the researchers. She already had a food plot on the scheme and was conversant with the modus operandi. She has seven children of whom 3 were available to help on the plot. As a widow she also had need of the opportunity offered.

The model finally designed is presented in the sections which follow.

#### 6.1 PHYSICAL DESCRIPTION

As an integrated production model the Tyefu unit was designed to fulfil certain functions revolving around two concepts. Firstly, the unit was to test fish production from agricultural waste and, secondly, it was to supply a living wage and produce, with the minimum of capital inputs. In order to achieve this the design of the unit catered for the following:-

- a) Two dams (total 0,3 hectare) which would supply water to irrigate a vegetable plot and would be stocked with fish.
- b) An agricultural area (0,75 hectare) which would produce the requisite number of crops to satisfy the family and livestock needs and a possible marketable surplus. Waste from the crops was to be used to feed all or some of the livestock units.
- c) A small area for the house, shed and livestock holding pens (0,08 hectare).

A.R.D.R.I.  
CISKEI FISHERIES PROJECT  
INTENSIVE UNIT: TYEFU

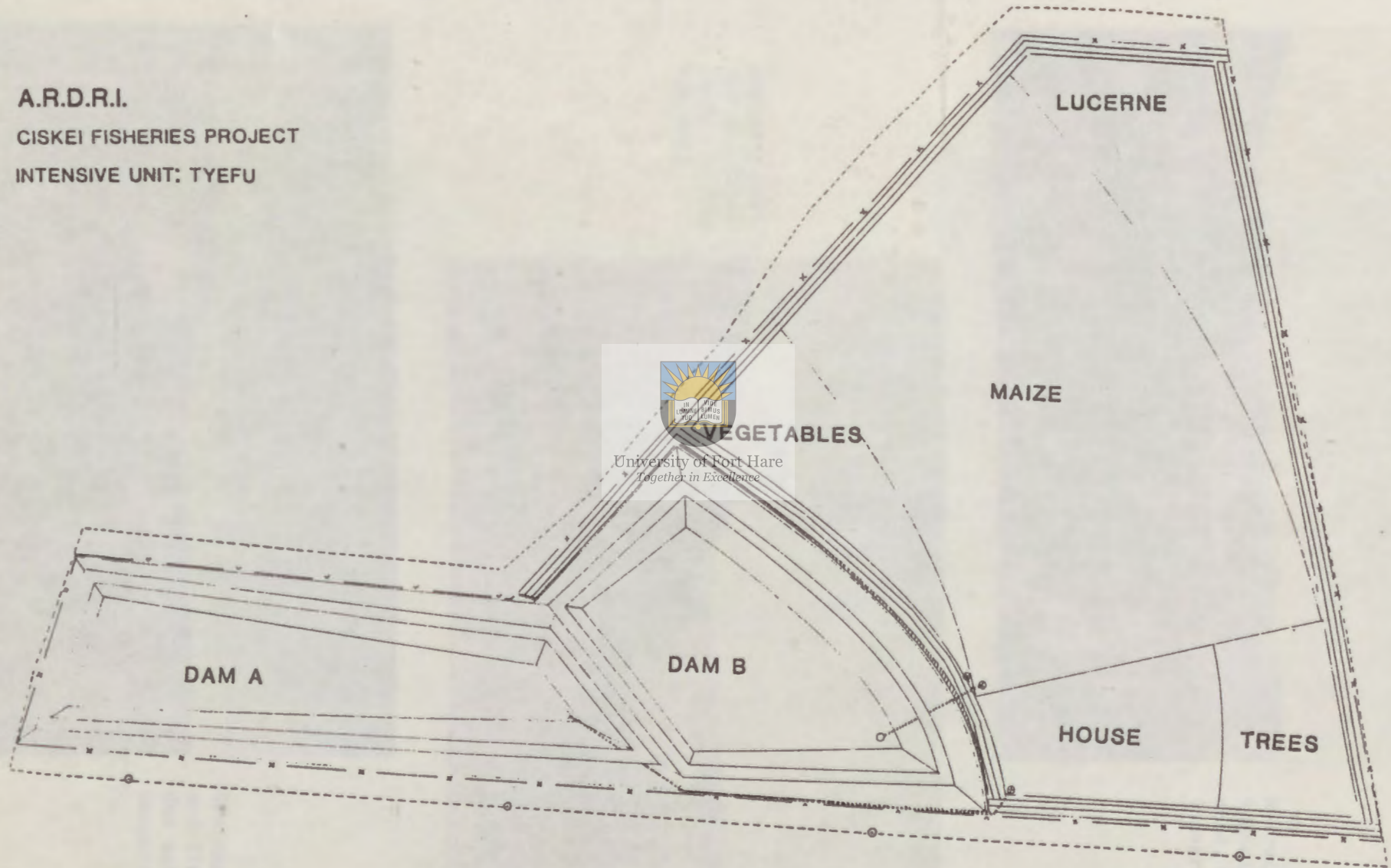


FIGURE 6.1



Removing grass and topsoil from pond site, Tyefu Integrated Unit

Scraping soil for the first layer on the dam wall



Drainage pipe laid and first layer of dam wall ready for compaction



Pond base level with no more soil to be excavated



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Compaction of second layer on dam wall



Dam walls complete,  
tenant spreading  
lucerne hay lining.  
Irrigation pipes  
ready to wet lining



First irrigation  
complete



Donkeys were used  
to assist puddling  
pond floor

It was envisaged that this unit should also test the feasibility of an almost closed system whereby the crops would feed the livestock, and the waste from the livestock would provide food for the fish. This would also have enriched the water which would be used to irrigate the crops.

For this to be achieved, the water supply area was divided into two ponds (1490 m<sup>2</sup> and 1530 m<sup>2</sup>). The agricultural area was divided further into the following: Maize 0,5 ha, lucerne 0,13 ha, vegetables 0,06 ha and trees 0,06 ha. The livestock components of the unit (ducks/chickens and pigs) would be accommodated next to the house as well as on the crest of the dam (see Figure 6.1).

## 6.2 DESIGN OF UNIT

### 6.2.1 Dam Construction

Dam (A) with a surface area of 1490 m<sup>2</sup> and a depth of 1,5 m, required earthworks involving 1090 m<sup>3</sup>. Of this amount, approximately 500m<sup>3</sup> was obtained by levelling the base of the dam from the 99,5m contour line to the inlet point. (Figure 6.2)

Dam (B) with a surface area of 1530 m<sup>2</sup> and a depth of 1,5 m, required earthworks involving 1129 m<sup>3</sup>. Once again excavations allowed for approximately 1100 m<sup>3</sup>. This left a total shortfall of earth required for the dam of 620 m<sup>3</sup> which was brought in from outside the unit.

### 6.2.2 Sealing of Ponds

Due to the permeability of the soil where the dams were constructed it was necessary to seal them. As both concept and cost of plastic lining was contrary to the motivation of the unit, an alternative involving the use of organic matter layered on the pond floor to create an impervious anaerobic layer was used. A layer of green material (cabbage leaves and reject brussel spouts) was used to cover the floor area which would come into contact with the water. Over this was placed a thin layer of dry mixed lucerne/grass hay. This was covered with a final layer of top soil which had been removed from the dam site initially. Light irrigations were applied for three weeks to keep the layers moist and then the dams were filled. After some initial seepage, the bottom of the ponds sealed off completely, despite the very pervious nature of the soil.

### 6.2.3 Pipes and Fittings

A list of the equipment required was as follows:-

100 mm PVC pipe	100 m
80 mm PVC	5 m
100 mm gated pipe	65 m
25 mm hose pipe	65 m
100-80 mm reducer	1
80-25 mm reducer	1
100 mm elbow	4

### 6.2.4 Miscellaneous Requirements

**Drainage:** drainage was required at the base of the lower dam in order to collect any seepage water. For this a trench of the dimensions 83 m long x 1 m deep x 0,5 m wide was constructed to lead water away from the plot.

**Fencing:** the unit was ring fenced with goat-proof fencing. This required 640 m of fencing made up by the following items:-

640 m "Bonnox" (1200 mm x 180 mm)	
36 posts (1000 mm x 180 mm)	
32 standards	
64 droppers	
1 4800 mm gate	
1 900 mm gate or stile	

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**Road:** a service road was constructed along the western, southern and south eastern boundary of the unit providing access to the ponds and agricultural areas. The total length was 450 m x 5 m wide.

**Land levelling:** the whole agricultural area (0,75 ha) was levelled to facilitate efficient surface irrigation.

**House:** a 3 roomed house measuring 8 m x 5 m built of poles, wire mesh and plaster according to the "zenzele" principle was planned.

## 6.3 PRODUCTION SYSTEMS

Little information was available on the combinations of crops to livestock and livestock to fish under practical conditions (Delmendo 1980 p59). Planning of the production systems was formulated on a theoretical basis using total fish to be stocked and their consumption characteristics to formulate the size of each production component. The following two guidelines were used:-

1. Initial manure applications to be loaded at 3 percent of fish biomass.

2. Manure applications not to exceed 150 kg/ha/day (wet weight).

### 6.3.1 Cropping

#### 6.3.1.1 Maize

Plant population approximately	60000/ha
Planting date	September
Desired yield approximately	8000 kg/ha

With a prospective maize yield of 4000 kg on the plot, this would supply approximately 300 kg/month for the year beginning March 1983, if it were kept for home and livestock consumption.

The sale value of the maize was approximately R800 at ruling prices.

#### 6.3.1.2 Lucerne

Seeding rate approximately	25 kg/ha
Planting date	September
Desired yield	1st year 2000 kg/ha



Lucerne would provide most of the protein source available for any form of livestock. It was necessary to move the planting forward from April 1983 to September 1982. This created a problem with weed control, but as only 0,06 ha was planted initially, this problem was overcome. The remainder was to follow during the next season (value of lucerne approximately 10c/kg)

#### 6.3.1.3 Vegetables

The motivation behind the vegetables was twofold. Firstly, to provide a source of food and income for the tenant, and secondly, to provide scraps for livestock.

The tenant had to ensure that she had vegetable scraps throughout the year for livestock feeding. Due to the size of the vegetable plot (0,06 ha) and the requirement for regularity it was inadvisable for her to try and match the other farmers on the scheme in relation to production and marketing. Therefore all vegetables were grown with as continuous a flow as possible, and marketed in the vicinity.

On 0,06 ha the following planting programme was planned:-



First crop of cabbages planted and poles erected for "Zenzele" house



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The tenant Enid Ngamntweni discussing her cabbages

		R
Cabbage	2288 plants	(400)
Carrots	48000 plants	(800)
Cauliflower	2288 plants	(460)
Beetroot	37000 plants	(740)
Potatoes	4160 plants	(400)

This was to give an excess of R50/month on an ongoing programme.

It was envisaged that this cropping programme would supply the tenant and the livestock requiring a minimum of purchased feed.

### 6.3.2 Livestock

Planning of the livestock components and the combinations thereof was extremely difficult with the lack of basic data. However, based on fish feed consumption and estimated maximum manure loadings the following format was arrived at:

Chickens/ducks: The use of these was preferred in the system due to their ability to convert feed efficiently as well as utilize a variety of food sources, and to be produced at various levels of intensity.

Manure produced per University of Fort Hare  
80-100g/chicken per day per adult. *Together in Excellence*

Pigs: The use of pigs within the system was considered mainly for their ability to effectively utilize vegetable and household scraps. Manure produced by an adult pig was estimated at 8 kg/day, and for a baconer as 3 kg/day. (Morrison 1957)

By matching these estimated manure yields per animal to the maximum manure loadings of the pond, various combinations of ducks, chickens and pigs were calculated. The final combination arrived at allowed for the fact that the unit was still being developed, and that fish stocked into the pond would initially be small and thereby have a lower food consumption rate. This combination is given in Table 6.1.

### 6.3.3 Fish

If fish were to be fed at 3 percent of the total biomass per day (Schroeder 1980 p 81) up to a possible maximum manure loading of 150 kg per hectare per day, then the total pond area of 0,3 hectare would require a maximum manure requirement of 50 kg per day. If this was fed at 3 percent of biomass, then the total biomass that could be supported was equal to 1667 kg of fish.

PROPOSED LIVESTOCK FLOW CHART 1982/83

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
PLANNED LIVESTOCK HOLDINGS								25 ducks 25 chicks PURCH	25 ducks 25 chicks O/H 25 ducks 25 chicks PURCH	25 ducks 25 chicks SOLD O/H 25 ducks 25 chicks PURCH	25 ducks 25 chicks SOLD O/H 50 ducks 50 chicks PURCH	25 ducks 25 chicks SOLD O/H 50 ducks 50 chicks PURCH
	50 ducks	50 ducks	50 ducks	50 ducks	50 ducks	50 ducks	50 ducks				1 sow	1 sow
	50 chicks	50 chicks	50 chicks	50 chicks	50 chicks	50 chicks	50 chicks					
	SOLD	SOLD	SOLD	SOLD	SOLD	SOLD	SOLD					
	50 ducks	50 ducks	50 ducks	50 ducks	50 ducks	50 ducks	50 ducks					
	50 chicks	50 chicks	50 chicks	50 chicks	50 chicks	50 chicks	50 chicks					
	O/H	O/H	O/H	O/H	O/H	O/H	O/H					
	50 ducks	50 ducks	50 ducks	50 ducks	50 ducks	50 ducks	50 ducks					
	50 chicks	50 chicks	50 chicks	50 chicks	50 chicks	50 chicks	50 chicks					
	PURCH	PURCH	PURCH	PURCH	PURCH	PURCH	PURCH					
1 sow	1 sow	1 sow	2 sows	2 sows	2 sows	2 sows						
6 piglets	6 piglets	6 young p	6 y p	6 y p	6 y p	6 y p	6 y p SOLD					
					6 piglets	6 y p	6 y p					
ESTIMATED FISH BIOMASS (KG)	1040	1040	1094	1334	1640	1640	1694	93	247	487	549	734
ESTIMATED DAILY MANURE REQUIRE- MENT (KG)	34	34	36	44	54	54	56	3	8	16	18	24



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This weight of fish would be achieved by a yield of 4168 fish, and would require an initial stocking of 5000 fingerlings. This figure allowed for a 20 percent mortality, assuming that fish of approximately 400 grams were harvested

#### 6.3.4 Tenant

The tenant on the unit was required to carry out normal daily tasks on the plot. These included the following:-

1. To feed all forms of livestock on the plot, i.e. ducks, chickens, pigs and fish, and to record the amounts fed to the fish.

Feeding times for most livestock would be twice daily.

2. Irrigation: normal irrigation patterns would be followed, as on the rest of the scheme, i.e. irrigation would be supplementary to any rainfall.
3. Planting/harvesting/weeding: All these tasks were to be carried out by the tenant and her family.

4. The following facts were to be recorded regularly:

- |    |                          |                             |
|----|--------------------------|-----------------------------|
| a) | Amount of manure applied | EACH DAY                    |
| b) | Water temperature        | EVERY MORNING               |
| c) | Fish losses              | ON OCCURANCE                |
| d) | Fish weight and length   | MONTHLY (TENANT & ARDRI)    |
| e) | Water quality            | TWO WEEKLY (TENANT & ARDRI) |
| f) | Record of sales          | ON OCCURANCE                |
| g) | Fish harvested           | ON OCCURANCE                |

All these tasks were carried out to ensure that the feasibility data was collected, as little is known about the day to day management of such units.

#### 6.4 PROGRESS

Ciskei Government donated R6000,00 for use in developing this unit, and it was envisaged that this finance was to be used for items outside Tyefu Irrigation Scheme scope of activities, i.e. Tyefu would supply all tractors, heavy equipment and labour and the donation would be used to finance the construction of a house, shed, livestock pens and fencing. As it was, the pond construction was completed by mid 1983 at which stage house construction was due to commence in order to be ready for the 83/84 summer growing period. The project was subsequently advised that the Tyefu authorities had handed back all unspent money (an amount of R4000), at the end of the 1982 financial year. As the 1983 budget had already been prepared, Tyefu undertook to finance or provide new and second hand materials for any subsequent development. This coupled to a change in staff resulted in

virtually no progress during the 1983 year. However, in November approximately 1500 mullet and tilapia were stocked. The tenant fed these fish with manure collected outside the scheme in an effort to achieve some results.

During 1984 development continued very slowly and the house was only nearing completion by the end of 1984. The agricultural component of the unit, once prepared, produced good crops of vegetables, maize and lucerne and would have been able to adequately feed the proposed livestock component. The pond was netted at the end of 1984 and only mullet were caught. These averaged 170 g each. However, only 40 were caught, demonstrating the ineffectiveness of seine netting for complete harvests. For all the fish to be harvested would have necessitated the draining of the pond. This could not be done due to the wastage of water, which could not be allowed in the drought conditions existing at the time.

## 6.5 EVALUATION AND CONCLUSION

One of the puzzling aspects of this sector of the investigation was the paucity of planning data obtainable from the literature, even that originating from countries where integrated production is an established practice. That is to say, there was no planning model available which placed fish production at the point of departure, and proceeded to work out from there, the number and types of livestock required to support the fish production. The reason for this is fundamental to the appreciation of the role of the intensive culturing of fish, and did not become totally clear until detailed planning of a project in Transkei had been completed (Appendix 2).

The crux is that because fish production is economically uncompetitive with traditional forms of agriculture, particularly in regard to the consumption of prime food resources, it must of necessity be based upon the waste products of other forms of agriculture. It follows therefore that a fish production enterprise should not be considered unless an appropriate agricultural enterprise is already in existence, and producing wastes, and there is a need to maximise the production from resources already economically employed. To make fish production the point of departure in the planning of an integrated production system represents a reversal of the logical order of planning. This was the basic weakness in the integrated unit developed at Tyefu, which led to several errors and inappropriate assumptions. For example the labour demand for fish production was in fact very low, but the total labour demand for the supporting enterprises was well beyond the capacity of a single family to provide. Ironically, the economic return from the "supporting" agricultural enterprises was so high compared to the potential for the fish, that the latter barely warranted the effort diverted to them. For these and other reasons detailed below, the enterprise did not achieve the levels of output planned for, though it did appear to satisfy the tenant.

One of the key reasons why full potential was not achieved was the delay in the supply of infrastructure, due to administrative problems on the Tyefu estate and the Department of Nature Conservation. The lack of security arising from the fact that the tenant could not move into her house, meant that the livestock component could not be introduced and consequently manure had to be collected off the scheme to feed the mullet and tilapia. Growth rates consequently could not be taken as indicative.

The major value derived from the unit was in experience and in clarifying the central issues involved in integrated production. These are firstly that fish production is properly viewed as an addendum to an existing production system, and not the prime reason for the development of such a system. Secondly, given that such a system exists, the presence of fish can actually be inhibiting in terms of convenient water management and in limiting other forms of production, for example ducks. Thirdly, the technologies and level of management skills necessary for such an enterprise require an advanced level of understanding and organisational ability. It must be concluded, therefore, that integrated crop/animal/fish production units will have little general application in Ciskei. The combination of resources and activities required, and the level of knowledge and skill required to succeed are strongly inhibiting factors.



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## CHAPTER 7

### FISH SEED STATIONS

"On the supposition that an expanding industry does become a reality, one of the basics will be the provision of suitable fish seed for distribution throughout the region. One or more fish seed stations will therefore have to be established" (ARDRI 1981 p 7).

It became apparent at the outset of the project that the supply of fish seed in one form or another was vital for the success of the project. The present seed stations in the surrounding area of South Africa are not geared to supplying fish seed to commercial fresh water operations, as is apparent in three problem areas:

#### 1. Cost

The cost of seed delivered to production sites, including transport from distant seed stations is high enough to invalidate the economics of fish production.

#### 2. Quantity

Based on stocking rates culled from the literature, seed is simply not available in quantities sufficient for more than experimental stocking.

#### 3. Timing and regularity of supply

While hatcheries do on occasion offer seed for sale the supply is completely erratic and unpredictable, and frequently available at too late a stage in the summer. This means that stock have to be held over all autumn and winter before production proper can get under way.

These factors bear out Caulton's (1980) comment "In South Africa anyone contemplating an aquaculture venture must also produce his own seed ...".

It was determined, therefore, that the establishment of a seed station would receive priority. Early in the project the consultant, together with the Department of Nature Conservation set about selecting a suitable site. Two sites were selected. The first having been rejected on technical grounds. Both, however, are reported on here.

The principle factors to be borne in mind in the establishment of a seed station are the following:

1. The unit must be capable of producing seed in sufficient quantities to satisfy the needs of Ciskei.
2. The cost of seed must be low enough to make fish production viable.
3. Seed must be available at the stage of growth and time of the year desired by the producer.

Both site selection and construction therefore must be considered with these factors in mind.

## 7.1 BRIGHTON SEED STATION

### 7.1.1 General Description

The farm, Brighton, falls within a broken escarpment area of the lower Keiskamma river. As all the agricultural land was to be used for coffee production, siting of the unit had to be on non-agricultural land. To avoid incurring the high costs of pumps and piping it was envisaged that the hatchery would be tied in with the agricultural irrigation network.

The hatchery site was on a dominant ridge which was to be used for header dam facilities for irrigation, and the unit was designed so that the irrigation water would pass through the hatchery. As all the falat agricultural land was to be used for coffee production, siting of the unit had to be on non-agricultural land. To avoid incurring the high costs of pumps and piping it was envisaged that the hatchery would be tied in with the agricultural irrigation network.

The design for the hatchery included:

2 sedimentation tanks, totalling 1549m<sup>2</sup>. These would provide a back up water supply in addition to the design function of water purification.

2 production/holding ponds totalling 1575m<sup>2</sup>. These would provide overwintering facilities as well as being available for production research.

4 holding ponds totalling 1920m<sup>2</sup>. These would be available for holding juvenile and overwintering.

3 fry nursery ponds totalling 216m<sup>2</sup> for raising fry.

1 tilapia breeding arena 106m<sup>2</sup> for breeding tilapia.

10 x 3,6m diametre tanks - for fry rearing of other species eg mullet.

10 x 1,15m diameter tanks.

### 7.1.2 Phasing

Due to the urgency to provide seed, and to fit into Ciskei Government development plan for Brighton it was decided to separate the establishment programme into 3 phases, as follows:

Phase 1:

- 2 Sedimentation ponds
- 1 Tilapia breeding arena
- 20 Nursery tanks
- Caravan site with ablution and storage facilities

This would allow the unit to capture and raise mullet fry and breed Tilapia during 1982, thereby providing stocks for the envisaged experimental units in 1983.

Phase 2:

- 2 Production ponds
- 4 Holding ponds
- 3 Fry ponds
- Fencing

This phase concentrated on the construction of all the earth ponds and was based on the assumption that Government earth moving equipment located on site would be utilized. The development of this phase was also designed to be completed in time to offer facilities for fry rearing and overwintering.

Phase 3:

- House
- Laboratory
- Store



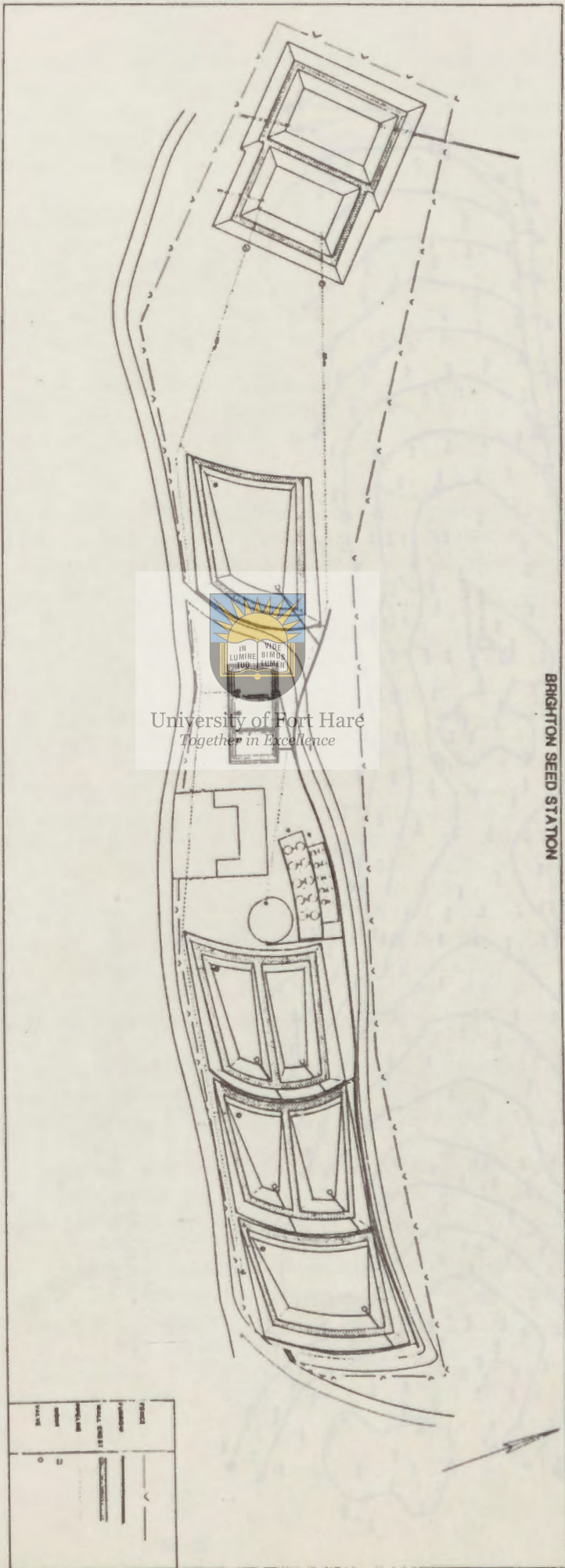
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As the primary task of the hatchery was to produce seed the establishment of this phase was left till last. To overcome any inconveniences, a caravan was included in the Phase 1 and, in addition to this, housing was available on the farm should the caravan be inadequate.

The cost and quantities are presented in Appendix 3 and the unit plans are given as Figures 7.1 and 7.2.

On submission of these plans and estimates to the Department for approval it was ascertained that not only had the Department's plans for Brighton been changed, thus removing the possibility of a "free" water supply, but the limited funds originally promised were no longer available. In addition, during the period in which the plans were prepared and submitted and the response awaited, the researchers were able to conduct water quality tests at the proposed extraction site. These revealed that not only was the water temperature frequently as low as 10° to 11° celcius, but the turbidity constantly present would have required elaborate and costly sedimentation procedures.

These factors combined to cause the abandonment of the Brighton site and an investigation was launched by the researchers to discover an alternative site. It was intended that a purpose-



BRIGHTON SEED STATION

FIGURE 7.1

Designed hatchery would be approved by the  
 submitted through the Department of  
 Ministry for Economic Development  
 Department of Fisheries Affairs  
 the following section.

7.2 THE WINDING RIVER SYSTEM

The planning of the proposed project  
 reconsider both the flow of the water  
 for the establishment of a small  
 the benefits of a small station would

1. To supply currently used  
 reservoirs for commercial  
 water fishing and other  
 time.
2. To provide suitable  
 along as well as  
 ration, and  
 low degree
3. To give clear  
 structure
4. In the course of  
 quality as well as  
 opportunity
5. A reciprocal arrangement could be  
 city of Toronto for the supply and  
 the temperature differential  
 other.
6. It was anticipated that the  
 the following system  
 fish). There is  
 breeding of  
 breeding
7. A small reservoir  
 tigate catch  
 Figure 7.2  
 of the  
 The basic design of the  
 later towards the  
 industry zone  
 practical

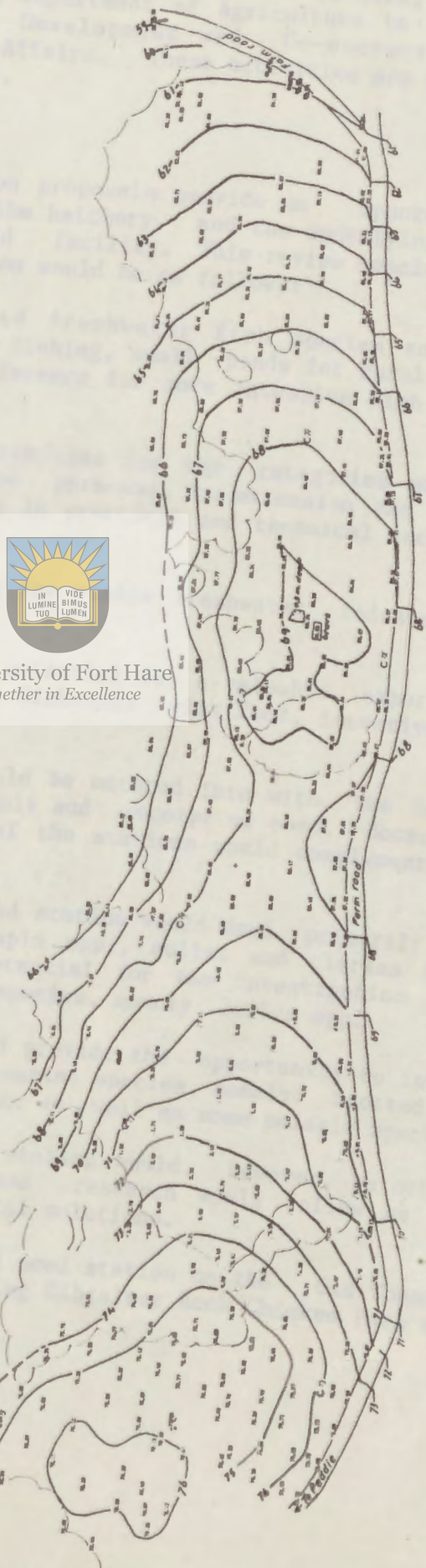


FIG 7.2 Contour map of Brighton site

designed hatchery would be proposed for this site, and a bid submitted through the Department of Agriculture to the Committee for Economic Development and Co-operation of the Department of Foreign Affairs. These activities are covered in the following section.

## 7.2 THE GIBRALTAR ROCK STATION

The abandoning of the Brighton proposals provide an opportunity to reconsider both the scale of the hatchery and the underlying reasons for the establishment of a seed facility. This review concluded that the benefits of a seed station would be as follows:

1. To supply correctly bred freshwater fish species to large reservoirs for commercial fishing, small ponds for rural subsistence fishing and fish farmers for more intensive fish production.
2. To provide training opportunities for the categories mentioned above as well as fisheries personnel in extension and conservation, and opportunities in practical and technical techniques for degree students.
3. To give Ciskei one of the valuable freshwater industries in Southern Africa.
4. In due course to have University of Fort Hare for a valuable export commodity as well as supplying Ciskeians with food, incentives and opportunity.
5. A reciprocal arrangement could be entered into with the University of Transkei for the supply and receipt of seed. Because of the temperature differential the stations would complement each other.
6. It was envisaged that the seed station would deal primarily with the following species: Tilapia spp., mullet and clarias (catfish). There is further potential for the investigation and breeding of local endangered species, namely Barbus spp.
7. A small mariculture unit would provide the opportunity to investigate certain marine and estuarine species, namely: Spotted and Pignose Grunter, Kob and Mullet, as well as some pelagic species.

The basic thrust of the seed station would, however, be orientated towards the industry, and research would follow as the industry tends towards practical solutions.

A site was selected for the proposed seed station on the Old Woman's River, located below the then existing Gibraltar Rock Chicken Farm and Moyeni Maize Project Headquarters.

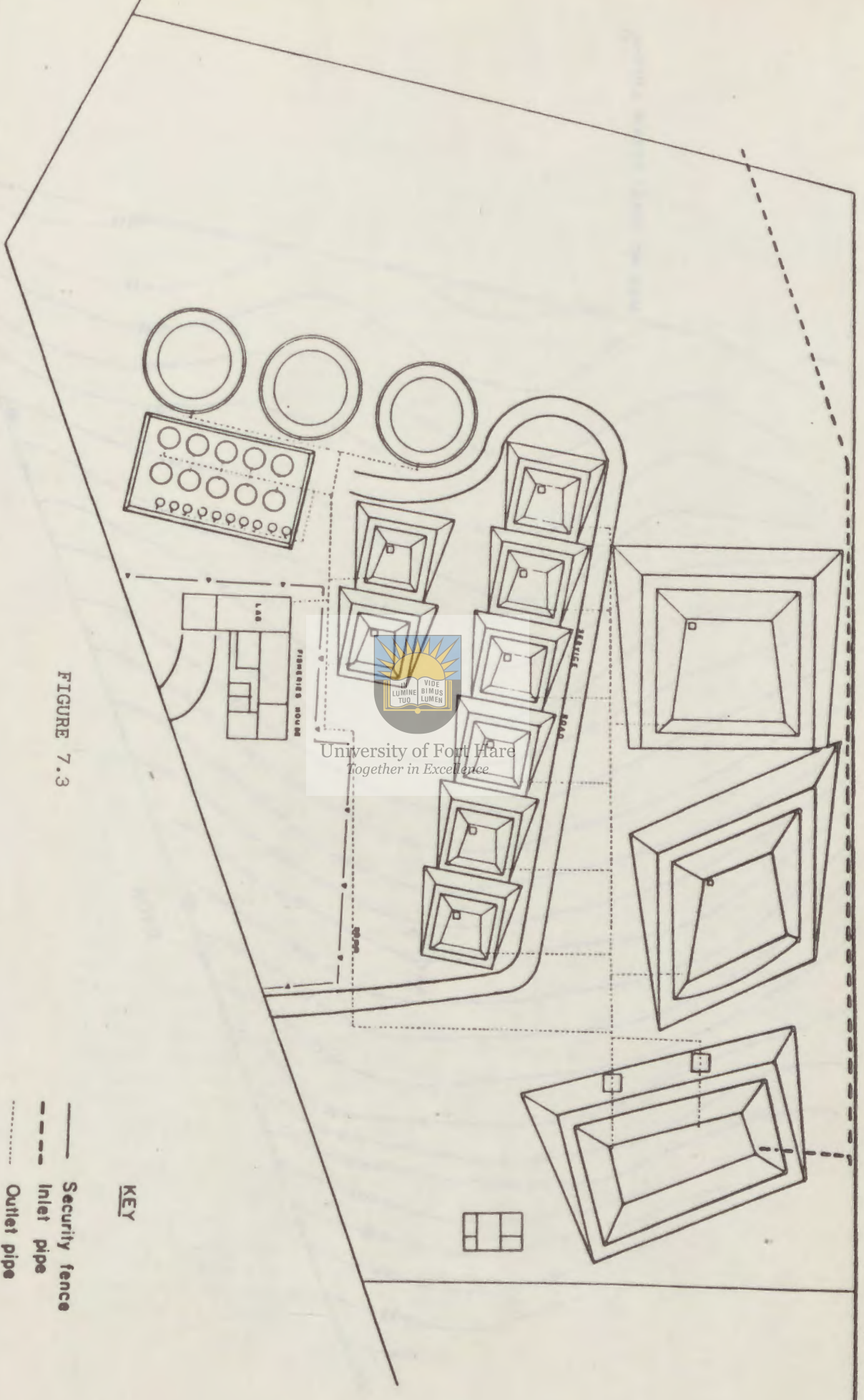


FIGURE 7.3

**KEY**

- Security fence
- - - Inlet pipe
- ..... Outlet pipe
- Biological filter

FULL WATER LEVEL OF DAM

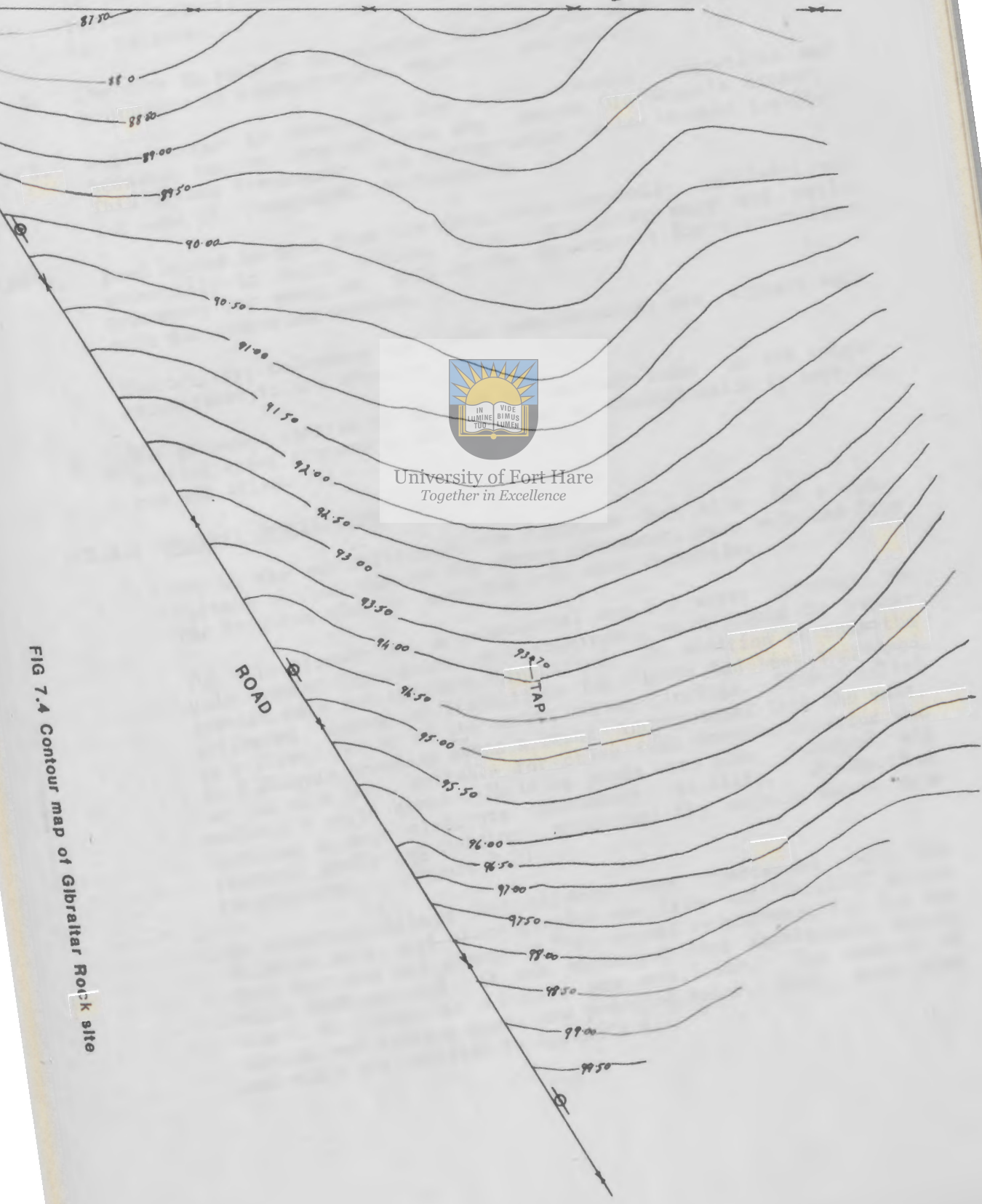


FIG 7.4 Contour map of Gibraltar Rock site



The site chosen had the following advantages:

1. It lies in the warmer coastal area below 300 m AMSL. Therefore it is protected from the lower temperatures that are found further inland, limiting breeding of certain species, particularly tilapia.
2. The site is part of an existing State project with the attendant advantages of communication, security and staff.
3. Ample water is available for the freshwater operations and seawater can be obtained from the nearby Old Woman's estuary. This allows freshwater and marine units to be located together for ease of management and financing.
4. Road access is good from the site, both internally to Ciskei and externally to South Africa, thus providing easy and swift transport for seed, as well as the opportunity for a quarantine unit for imported species.
5. Electricity, telephone and radio communications are already well established in the area.
6. The proposed species to be used are already found in the neighbouring river systems so the problems of contamination by exotics can not arise.



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#### 7.2.1 General Description

Due to the suitability of the Gibraltar Rock site for a wider variety of fish species the design parameters were modified from the Brighton site to make the unit more versatile.

The site already had a substantial dam for water storage, so only header facilities were required which could be incorporated into the hatchery functions. In addition to this the estimated number of fingerlings for Ciskei had been increased as a direct result of the market survey findings. This resulted in 3 Tilapia breeding arena's being incorporated into the unit. As the site was suitable for other fish species (clarius and mullet) 8 earth breeding/holding ponds were also designed, and involved a more elaborate laboratory facility. Production research ponds cum holding ponds and fry raising tanks were incorporated. (Figure 7.2)

As numerous delays had already been experienced with the Brighton site, and since finance was from an "outside" source this unit was not phased. The urgent requirement for fry was still dominant and it was envisaged that development should start as soon as finance was available. The summary of capital and running costs are provided below. Full quantities and costs are detailed in Appendix 4.

## 7.2.2 Estimated Requirements and Costs of Project

### 7.2.2.1 Capital

The following items and structures are required for the development of the proposed seed station.

1 x Header dam	2 489,00
2 x Polyculture ponds	2 927,00
8 x Breeding ponds	2 087,00
3 x Tilapia tanks	17 534,00
20 x Fibreglass tanks	6 800,00
1 x Laboratory and house	65 800,00
1 x Labour house	
Monks, pipes and fittings and fencing	7 937,00
Machinery and equipment	28 000,00
Labour	813,00
Other (leveling and concrete work)	13 475,00
	<b>R147 891,00</b>

### 7.2.2.2 Running costs

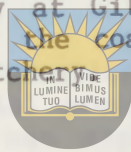
	83	85	86	87
1 Staff	10 000,00	10 500,00	11 000,00	12 000,00
Technician				
Labour	1 860,00	1 956,00	2 040,00	2 220,00
2 Travel and subsistence	1 000,00	1 150,00	1 322,00	1 749,00
Vehicle costs	12 000,00	12 000,00	12 000,00	12 000,00
3 Consumables	9 500,00	10 982,00	12 629,00	16 702,00
	34 410,00	36 582,00	38 991,00	44 671,00

Running costs shown above are for a 5 year period, with items under Travel and Subsistence and Consumables showing a 15 percent increase per year.

Further maintenance costs must be included from 1984 at R2 800 per year.

This was the form in which the proposal was submitted to KEOSSA as an application for funds. After a series of meetings and evaluation visits the hatchery was approved in principle, with the proviso that Ciskei Government formulate a fisheries development programme, and establish a fisheries development infrastructure. Due to staff changes at all levels in both the Departments of Agriculture and Nature Conservation this has not been possible as at the time of writing. As a result no funds have been granted.

The successful development of both the Ciskei Fish Farming Project and the future of fisheries in Ciskei is dependent on a supply of seed (fingerlings). It was to satisfy these demands that the first hatchery, Brighton, was designed, i.e. it was necessary for the project that a hatchery was established early on in its life. To this end the design features were simplified as far as possible in order to ensure the quickest results. Once the Brighton hatchery had been rejected, a completely different view was taken on the design and siting. As the financial input for the hatchery was being sought outside of Ciskei it became imperative that the design catered for the most efficient form of fingerling production, and the immediate aims of the project had to be reconciled with the long term future of fish production in Ciskei. Consequently the Gibraltar Rock Station is seen as the main section of a complex of stations distributed over Ciskei. Three sub-stations have been sited in three major production areas, namely Bridle Drift, Sandile and Oxkraal, act as service centres from which seed can be distributed from the main hatchery at Gibraltar Rock. The fourth production area, the coastal zone is covered by the Gibraltar Rock hatchery.



### 7.3 CONCLUSION

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The lack of any hatchery facilities in Ciskei not only limited the scope of the project, but continues to hinder on-going development in Ciskei. This fact serves to emphasise the importance of the role that Government must play in providing the necessary infrastructure to ensure the success of the project. If interest in and enthusiasm for fish production is aroused before this infrastructure is in place, the subsequent disillusionment at lack of follow-through is certain to have a negative impact on fresh water fish production.



A net mounting industry  
Nets displayed at the Ciskei  
Agricultural Show



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A test fish smoking unit with smoke  
box and three tier fish rack



Fish rack is inserted into smoke box.  
Note the dried maize cobs used to  
"create" smoke

imately R2,75 or R2 750 per consignment of 1 000 blanks. Only the two most popular mesh sizes were ordered involving a total cost of some R5 500. The other raw material requirements, foot and head roes and the two components of the polyurethane foam involved lesser, but still significant amounts.

Patently the indigent people involved in the manufacture of the nets could not carry this order of cost. The manufacture was therefore structured as a labour contract, with payment being made to the workers on a piece-work basis. All materials, tools and moulds were supplied by the project, and training and supervision were provided by project staff.

## 8.2 MARKETING

From the feasibility study it was determined that sales of 300 units per annum at a price of R40,00 would justify the formal establishment of a cottage industry, using the normal channels available through the Ciskei Small Industries Development Corporation.

No market information existed since nets had never before been available as required at a competitive and realistic price. Uninformed estimates of demand as high as 5 000 units per annum had been made, on the basis of estimating the requirements of Government and research organisations.



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Both to get the product and service known, and in an attempt to establish the demand, an article was placed in the popular journal "Farmers' Weekly" (Nov 1984), describing the industry and its background. This elicited four orders for nets which were supplied. Later an information pamphlet was prepared and 50 copies distributed to Universities and Government institutions involved in fisheries development. Three organisations responded to this circular requesting nets for research purposes in mesh sizes outside the range available. A final effort to increase sales was made by the insertion of a series of advertisements in the "Farmers' Weekly".

In the "production-year" of 1984 a total of 3 500m of net was made to order and sold, to the value of R3 500. The bulk of this amount was accounted for by two commercial fishing operations using gill-nets in the popular sizes available from the project.

## 8.3 OVERALL ASSESSMENT

As has been said, it was envisaged that the net-making project would evolve as a large cottage industry, properly funded and commercially managed. Patently, the size of the market is a major determinant of success in such an operation, and it was estimated in the feasibility study that break-even would be achieved with sales of 300 units per annum. Sales in the first year amounted to 140 units of which 40 percent were bought by research institutions whose usage tends to be light. The annual demand is obviously dependent largely on commercial

activity since the heavy usage associated with continuous fishing will require constant replacements. The relatively low demand therefore is a factor of the low level of activity in commercial freshwater fishing in Southern Africa.

The net industry does not lend itself to reduction in scale to accommodate the lower demand, primarily because of the investment required in stocks of raw material:

1. In order to achieve acceptably low unit costs, net blanks must be ordered in lots of no less than 1 000 per mesh size. At this rate the landed cost per blank amounted to R2,75 or R2750 per mesh size imported.
2. Most of the research applications demand a wide range of sizes, well outside the popular commercial sizes of 90 and 110 mm which, if the industry is to satisfy, means the investment of R2 750 per mesh size. A total of 7 mesh sizes has been demanded implying an investment of some R20 000 in stock.
3. Since at present rates of offtake it would be several years before a batch of 1 000 of even the popular sizes would be exhausted, the cost of financing stock at present interest levels is likely to exceed the initial purchase price. With capital service costs recovered through sales the price per net would become uneconomic.
4. The low offtake, wide range of sizes required and cost per mesh size result in an unbalanced capital structure, relative to annual sales.
5. The sheer size of the initial capital investment in stock is inappropriate to a cottage industry.

The absence of a netting tradition in Southern Africa is an anomaly in a continent where numerous communities derive their living from it. Part of the reason may be found in the rigid control exercised by the various nature conservation departments, and the image of illegality which has become associated with gillnets. Even in Ciskei, it was made a condition by the Department that any Ciskeian purchaser had to be in possession of a gillnet permit before he could be supplied with a net. Since such a permit is required for every magisterial district in which netting is to be carried out it is not unexpected that not a single net was sold in Ciskei.

#### 8.4 CONCLUSION

Whatever the reason, it appears that the demand for gillnets in the Southern African region is very limited. While therefore the net industry is a technical reality the level of demand for nets created by the present level of fishing activity is insufficient to sustain even a cottage industry manufacturing nets.

## CHAPTER 9

### TRAINING

"Wholesale training will be required." ARDRI (1981, p 8)

#### 9.1 BACKGROUND

At the time of the preparation of the original project report the degree of understatement contained in this quotation could not possibly have been foreseen. The scale of the problem arises out of two main factors:-

1. Aquaculture is a totally new and unfamiliar venture in Ciskei. Consequently even the body of knowledge and channels of dissemination which exist for agriculture, rudimentary as they may be, do not exist for fish production. Every single practical daily operation, from seeding, through on-going care of growing fish, to harvesting, has to be taught from fundamentals. The pressure of advice and the dissemination of knowledge must be so constant and at such a high intensity that the ratio of extension officers to producers would need to be extraordinarily high. With no quantitative basis for estimation, but based upon intuitive judgement it would seem that an extension officer would be required to every 10 or 20 fish producers, compared to 1 to approximately 800 to 1 000 farmers currently available in the agricultural sector. (Bembridge & Pemberthy 1980)
2. Fish production is not a simple technology. On the contrary, it is an involved operation, requiring as it does the integration of management systems for water, fish stock and feed supplies. The sensitivity of fish to conditions in their environment and the complexity of that environment require highly developed levels of skill. It is noteworthy that aquaculture in the West is associated with producers with a high level of formal education and competence and in the East with producers backed by centuries of tradition. In both cases primary producers are supported by an infrastructure staffed by a preponderance of people qualified academically up to doctoral level. This is a reflection of both the complex technology of the system and the high level of entrepreneurial and managerial skills it demands.

Bearing the above in mind it does not need emphasising that a Third World country proposing the establishment of a fisheries industry ab initio, would need to proceed cautiously, from a base of simple low-cost, low-productivity production systems and capture fisheries, until such time as a body of technical expertise and managerial skill has been accumulated. The exception to the foregoing appears to be the marketing and distribution of the product. Apparently the simple presentation of a high-quality protein source at the prices adopted in the survey was sufficient to release the commercial instincts necessary to bring about efficient distribution. The widespread

established usage of fish meant that little promotion or training on the consumption side was necessary, and training could be concentrated on production.

Two levels of training were proposed:

1. At tertiary level through the introduction of specialised courses within existing agricultural courses at Fort Hare and training at diploma level for selected candidates at Tompi Seleka.

An outline of a set of lectures to be presented as part of the Production Systems course within the Animal Science degree was presented to the Board of the Faculty of Agriculture at Fort Hare and accepted as an integral part of this option. The purpose of the course is to introduce the various production options available, and to sensitise students to their potential. The lectures were presented by staff of the Institute and the test questions set and marked by them.

In regard to the Tompi Seleka training, after a delay of a year as a result of selection difficulties, four candidates were selected from the staff of the Department of Nature Conservation, and started training in 1983. Contact was maintained with these students during the course of their training and it appeared that they would be able to fulfil meaningful roles in the Department once fully employed.



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2. The second level of training was "farmer" training for which a functioning seed station and training facilities were required. The delay in construction of the seed station meant that this level of training was confined to those two individuals actually engaged in the project, namely the fisherman and the tenant at Tyefu. While the fisherman could be said to be comprehensively trained, and competent to conduct his own business in the right circumstances, the tenant received only the most rudimentary training in the capture and disposal of fish, and in the feeding and monitoring of the introduced populations of mullet and tilapia. Since at the time of writing the fish had not reached harvestable size she has not had the opportunity to harvest and dispose of her own crop.

Since the project was conceived as an investigation into the feasibility of a development project involving fish in Ciskei, its value in the field of training has been inestimable. It has illuminated vividly the vacuum in knowledge of basic procedures in fish production at all levels in the country, a condition which is likely to exist in all Third World countries lacking a fishing tradition. In development terms, the following guidelines would be useful in assessing training requirements and facilities.

1. Where fisheries production is to be introduced ab initio into a country devoid of a fishing tradition the depth and intensity of

training eventually required is likely to exceed the most realistic planning estimate. It will certainly exceed the training required for example in programmes to uplift production from traditional crops.

2. Appropriately designed training will be required at policy making level i.e. ministers and senior civil servants, at the level of the advisory services and at farmer level.
3. Since established technologies can seldom be transferred to a new environment without modification, technical training must sensibly be based on local installations. Since the cost of error can be high if major programmes are set in motion without prior local experience, pilot schemes must be considered. Not only do these serve to test the local conditions, but they provide the facility at which both advisors and farmers can be trained as the foundation of any planned extension.
4. Since in the form of development envisaged for Ciskei, home production and consumption of fish will feature strongly, home economics practitioners will need to be involved. Training in cleaning, preparation, cooking and short-term preservation will be necessary.



## 9.2 FUTURE TRAINING REQUIREMENTS

Based upon the above, future training will be required at three levels for three different target groups. The facilities for each differ in requirement so alternative sites are suggested. Table 9.1 lays out the combination of training, site and target group.

**Table 9.1:** Training levels, sites and target groups for Ciskei

Type of training	Site	Target group
1. Tertiary	Fort Cox	Agricultural officer, degree, students, ministers senior staff
2. Farmer training	Nursery sites	Farmers
3. Home economics	Fort Cox nursery sites	Housewives
1. Tertiary training		

The course incorporated into the Production Systems course in the Animal Science Department is to be continued at Fort Hare. Regrettably, the Fisheries Management course for Agricultural Officers pioneered at Tompi Seleka has been discontinued and there is at present no suitable course available anywhere in

South Africa. It is proposed therefore, that facilities including appropriate production ponds should be established at Fort Cox. This will permit aquaculture to be included into the standard Diploma Course for Agricultural Officers, as well as facilitating specialised training for Fisheries Extension Officers. The availability of fish will also allow for the expansion of Home Economics training.

With the lack of background in Ciskei of fishing or aquaculture as an organised activity, there exists a lack of knowledge and conviction of the potential for fish production at all levels in the Department up to and including Ministerial level. To ensure that the essential departmental support for fishing and aquaculture is forthcoming it is proposed that visits and special field-days for high-level officials should be arranged on a regular and continuing basis. The venues for these visits could alternate between the nursery or hatchery sites (Chapter 7) and Fort Cox. Unremitting public relations work at this level will be an insurance of success in fisheries development.

## 2. Farmer training

Particularly in the early stages regular training and visits among participating farmers will be essential. It will at times be necessary for them to gather at intervals for short courses on specific production aspects. It is intended that both these aspects will be centred on a Fisheries Extension Officer based at a regional nursery (Chapter 7).



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Such an arrangement will make it possible for the officer to be involved continuously with farmers throughout the production cycle, and particularly will allow deliveries of live seed fish over short distances to be made with his vehicle. He will not only be responsible for the running of the nursery but will use this facility for the conduct of short courses. For this purpose each regional nursery will require, as well as the basic growing-out tanks, production ponds for demonstration purposes. The courses and on-farm training will be designed and co-ordinated by a Senior Fisheries Extension Officer (Chapter 14).

## 3. Home economics training

Home economics practitioners are primarily engaged in improving the life-style of their target groups. In a condition where dietary deficiencies are common, emphasis is placed on improving both quality and quantity of diet and in this facet, fish consumption can play an important role.

It is proposed that the Home Economics practitioners be trained in the preparation and preservation of fish and in its promotion as a low-cost alternative to meat. Emphasis must be placed on the variety of ways in which fish can be prepared and consumed, but

particularly on the use of small fish (50 to 120 grams). This size of fish is a staple in Central Africa, widely used both in the dried bought form and the fresh captured form as a relish to enhance the main meal of the day. Because the market for fish as it exists in Ciskei at present is dominated by marine fish of a larger size, there is an unnecessary prejudice against small fish. Particularly in the case of tilapia the yield of pond fish might well be primarily small in size and there is a need to recognise their worth.

It is intended that Fort Cox be used both for formal training of practitioners in the value and use of fish and for short courses or field-days for housewives. The regional nurseries will form a useful centre for "in-field" training of housewives as well. Users are likely to be clustered around the nursery sites for obvious reasons. Both the planning and coordination of programmes of visits with the Fisheries Extension Officer, and visits by housewives to the nursery site will be facilitated as a consequence.

### 9.3 FORMAL TRAINING UNDERTAKEN TO DATE

Apart from the informal training given to the tenant farmer and fisherman, formal training was provided at two levels during the life of the project. Two students taking the Animal Science option at Fort Hare were given an introduction to aquaculture during the Production Systems Module. Four officers of the Department of Agriculture qualified at diploma level at Tlopi Seoka. These officers represent a valuable human resource for the development of the fisheries programme, and will be candidates for the posts of Fisheries Extension Officers (Chapter 14). in this role they will have the dual function of both promoting aquaculture and controlling the four regional nurseries.

### 9.4 CONCLUSION

Because of the complexity of the technology and its strangeness in the Ciskei environment, intensive training of officials, farmers and housewives will be essential particularly in the initial stages of the project. It is intended that this training should be carried out at Fort Hare, Fort Cox, at region nurseries and in the field. Staff competent to set up the courses and oversee the training are already available in Ciskei.

## CHAPTER 10

### ECONOMIC ASPECTS

"Ultimately there is only one justification for development. It is embodied in the question 'Will the community that pays receive a fair return for the cost?'" (Bross 1982, p 6)

The economic evaluation of development must cover both the micro-aspect of the individual enterprises and the macro-aspect of cost and benefit to the state. In the absence of real models to supply hard information for evaluation purposes, the bulk of this chapter is based upon realistic assumption, and estimates of the scale of operation which might ensure from a fisheries development programme.

It is not possible to overcome the problem of estimating the price of the product since no established market exists for either intermediate (seed) or final products. Crude models of cost of production are provided and simple comparison made with other competing products already in the market, mainly marine fish

#### 10.1 ENTERPRISES

##### 10.1.1 Provision of Seed

A hatchery or seed station is intended to fulfil the need of providing the raw product for the industry, in this case fingerlings or juvenile fish. The methods that may be employed can be sub-divided into three levels of intensity.

###### 10.1.1.1 Extensive fish capture

Prior to the advent of commercial hatcheries fish seed or fingerlings were collected from wild stocks and simply re-located. This practise still applies in many areas of the world, more especially when the species required cannot be easily spawned artificially. In areas where there is an abundance of fish seed this manner is cost-effective, the main disadvantage being the lack of genetic selection for desirable characteristics. With reference to Ciskei, this method of fingerling collection can only be applied to the mullet species whose juveniles migrate into freshwater at the onset of summer. If timed correctly these fingerlings can be stocked directly into production units, without the necessity of nursery management. The costs involved are summarized below.

All the estimates below are based on an assumed offtake of 100 000 juveniles per annum, a figure considered acceptable by the Ciskei Department of Nature Conservation. It is further assumed that the capture operation is a once-a-year affair, possible only when the mullet are migrating.



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### Capital requirements

1 Fish transporter	R500,00
1 Oxygenator	300,00
1 Push net	100,00
Miscellaneous equip	200,00
Total	R1100,00

Assuming that the capital is recovered over five years with an interest rate of 12 percent applying, the annual capital service cost is R306 (Table 10.2).

### Operating requirements

Because of the sporadic nature of the operation it is assumed that a vehicle is hired, rather than purchased.

2 Labourers R3,00/day for 5 days	R30,00
1 Driver R10,00/day for 5 days	50,00
Vehicle hire costs 600 km for 5 days at 30c/km	900,00
Total operating cost	980,00
Add capital service cost	306,00
Total annual cost	R1286,00

Based on the capture of 100 000 fingerlings p.a. the cost per fingerling is therefore R0,0127.

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These costs are well within the means of fish producers and will not encroach on production costs. If this capture were carried out by an agency, and a commercial mark up allowed, the sale price could still be met by producers.

From this type of extensive capture of fry there is a natural progression to breeding fish for "own" use. This has been attempted within the project with *Oreochromis mossambicus* as described below (10.1.1.2).

#### 10.1.1.2 Semi-intensive breeding

This method of fish breeding could be considered, for the small scale farmer, as a means of satisfying his immediate needs for fingerlings.

Small plastic tanks or earth dams approximately 4m x 4m x 1m are stocked with 2 breeding pairs of *O. mossambicus* which can between them produce approximately 4 000 fry under these conditions. The water in the tanks may be naturally enriched and only supplementary feeding of fry is required.

Three tanks are required, one for each breeding pair, and one for on-growing the fry.

### Capital requirements

3 Small tanks or earth dams R100 each	R300,00
Piping or furrows as required (allow)	100,00
Miscellaneous	200,00
Total	500,00

Capital service at 12 percent interest over 5 years = R139.

### Operating requirements

Labour at 1hr/day for 365 days at 37c/hr	R135,00
Feed (Table 10.1) 4 000 fingerlings 17c	R680,00
Total operating cost	R815,00
Capital service	139,00
Total annual cost	R944,00

Assuming a net production of 4 000 fingerlings at 80 g each from two breeding pairs, the cost per fingerling is R0,24. Although this figure is high, it is conservative, and acceptable in view of the high value of the tilapia family as food fish.

Table 10.1: Tilapia feeding rate

Fish	Feeding rate Percentage of body mass
5-10 grams	6,7
10-20 grams	5,3
20-50 grams	4,6
50-70 grams	3,3
70-100 grams	2,8



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Source: Gaigher and Geyser 1984)

#### 10.1.1.3 Intensive breeding

This model is based upon full scale commercial production of seed as is envisaged for the Gibraltar Rock Station. It involves intensive breeding in specially constructed arenas, and a high level of management, with a projected output of 1 million fingerlings per annum.

Capital requirements (Appendix 4)	R185 635
Capital service (12 percent over 10 yrs)	R32 851
Operating costs (Appendix 4)	R61 655
Capital service	32 851
Total annual cost	R94 506

This will result in a cost of R0,09 fingerlings at 80 gram mass.

However, as this is a commercial hatchery, a certain proportion of the fingerlings may be required by producers at larger than 80 g. To increase the fingerling mass to 180 g would require a further R0,11 in feed costs giving a cost of R0,20 per larger fingerling. At this size the fingerling should be capable of growing to saleable mass over one summer.

#### Summary of costs of seedling production

	Capital Cost	Operating Cost	Seed produced	Cost/fingerling
Extensive	R1 100	R1 286	100 000	R0,01
Semi intensive	500	954	4 000	0,24
Intensive 80g	185 635	94 506	1 000 000	0,09
Intensive 180g	185 635	204 506	1 000 000	0,20

#### 10.1.2 Production Units

There is a great variety of types of production units which could be described. Those covered below, however, are considered to be most promising.

It is not possible to predict a yield from these systems as the lack of tradition of fish production in Southern Africa means that no local data is available. As an indication therefore the yield per hectare required to achieve breakeven is calculated using as a basis the wholesale price of three types of fish commonly stocked in the local outlets.

Hake	R1,50 per kg
Baby hake	0,90 per kg
Maasbanker	0,65 per kg

These prices are for fish which is "table-ready" and consequently a loss must be allowed for to arrive at an equivalent "ex-pond" price and yield. A factor of 50 percent is allowed for to cover this loss, based on McKance and Widdowson (1973). Because of inherent difficulties with full economic analysis, only "break-even" yields are provided as indicators.

10.1.2.1 Production from agricultural wastes in constructed ponds

Assume one hectare production area.

Capital requirements

Dam - (1 ha) 3802 m <sup>3</sup> earthworks	11 406
R3,00/m <sup>3</sup>	
Monk - allow	20
Piping - 50 m x 90 m R4,24/m	212
Labour - 42 days R3,00/day	126
Sub total	11 764
15 percent contingency	1 765
Total	13 529

Assuming that the farmer will live "on site", housing costs will need to be allowed for.

House - 60 m <sup>2</sup> R70/m <sup>2</sup>	4 200
Fencing - 440 m R15/m	6 600
Miscellaneous equipment	500
	11 300

Total development cost (13 529 + 11 300) R24 829  
 Capital service (12 percent over 20 yrs) R4 390

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Annual operating cost

No direct cost of food is allowed.

Fingerlings 20 000 @ 9c	R1 800
Labour 1hr/day average 37c/hr	135
Miscellaneous equipment	100
Total operating cost	R2 035
Capital service	4 390
Total annual cost	R6 425

Break-even yields

	Annual costs (R)	Sold mass (R)	Ex-pond (kg)
R1,50/kg	6 425	4 283	8 566
R0,90/kg	6 425	7 139	14 278
R0,65/kg	6 425	9 884	19 768

The literature from countries where this system has been in use for many years, indicates growth rates of 20-30 kg/ha/day. If it is assumed that Ciskei could expect a 180 day growth period, then yields of 3 600 kg - 5 400 kg may be expected. None-the-less data from Amalinda Fish Seed Station list yields of only 153-190 kg/ha. (Bok 1978, pp 171 & 172). Even the higher

overseas yields would not render this system economic, under the South African price structure.

10.1.2.2 Production from waste products in existing ponds

Improvements to pond: Flood protection	
Pipes, excavation, allow	R3 500
Housing (as in 10.1.2.1)	4 200
Fencing	6 600
Miscellaneous equipment	500
Total	14 800
Capital service cost (12 percent, 10 yrs)	2 620

Annual operating costs

Fingerlings 20 000 @ 9c each	R1 800
Labour 1hr/day @ 37c/hr	135
Miscellaneous equipment	100
Total operating	2 035
Add capital service	2 620
Total annual costs	4 655

Break-even yields

	Annual costs (R)	Sold mass (kg)	Ex-pond yield yield (kg)
R1,50/kg	4 655	3 103	6 206
R0,90/kg	4 655	5 172	10 344
R0,65/kg	4 655	7 162	14 324

In both these models the cost structure is dominated by the high cost of capital and seed. Major reductions in both these items will be necessary before either can become economic. Since the underlying assumptions are held to be realistic neither system can be recommended in Ciskei at this stage.

10.1.2.3 Production from commercial harvesting of larger dams

In this case more realistic figures are available from the operation conducted for some months on the Laing Dam. The model proposed for Laing Dam (section 5.3.2), has been generalised by allowing for full cost of house and sheds.

Capital cost

Two groups of capital cost are recognised for this model. Short term capital for items with a limited life is held to be obtained under Small Business Development Corporation terms, and long term capital, which is obtained at the same cost as for the previous models.

Short term capital	
Boat and equipment	R500
Nets	300
Transport (used motor cycle)	500
	R1 300
Annual capital service cost	R 815
Long term capital	
House and sheds	R4 200
Water supplies	200
Total	R4 400
Capital service (12 percent 10 yrs)	R 778
Annual operating cost	
Total direct costs (section 5.3.2)	1 950
Annual capital cost - short term	815
- long term	778
	R3 543

Assuming an annual quota of 14 000 kg of which 10 percent is sold as smoked fish and 90 percent as basic wet fish the following annual gross income is earned.

Sales	
12 600 kg	R0,50
1 400 kg	R0,96
14 000 kg	R7,64



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This allows a margin of R4 100 as owner's salary and profit, which in the circumstances is very attractive. At the yield level used for Laing Dam other dams such as Bridle Drift, Sandile and Kat River could also support fishermen entrepreneurs.

#### 10.1.2.4 Fish related support business

While an intensive aquaculture industry would undoubtedly spawn a support industry, the models outlined above indicate that there is little likelihood of such an industry developing. The capture fisheries require primarily boats and nets. The new and used market for light GRP boats in the Eastern Cape is flooded with vessels costing as little as R200, which is below the purchase price of materials for the construction of even a simple wooden boat. No potential for a boat industry can be seen therefore. In regard to nets, the establishment of a cottage industry mounting gill nets is described in Chapter 8.

#### 10.1.2.5 Subsistence production

The production of fish for home consumption at little or no cost has considerable potential. This model is based upon work

done by van den Berg, Gaiger & Lenyai (1972), who stocked improved carp varieties into very small ponds (0,1 to 0,25 ha) on Honeydale Farm at Fort Hare.

In subsistence production, economics seldom dictate that yield per hectare is important. The value of the food produced, or return per unit of labour or money invested frequently take precedent and in this model these factors are very favourable.

From van den Berg et al (1972) it can be calculated that the final mass of individual fish varied from 0,7 kg to 1,3 kg, with an average mass of 1,1 kg. For the purpose of the subsistence model it is assumed that a contribution of 50 to 100 such fish per annum to a family's diet would be a significant improvement (in practical terms 1 or 2 fish per week). Van den Berg et al (1972) have shown that this can be achieved from a pond as small as 0,25 ha in surface area. In Chapter 2 (section 2.1.6) it is shown that some 9 000 dams of less than 10 hectare are available in Ciskei each of which could support at least one family, and in the case of the larger ponds, more than one. Assuming for the purpose of a crude estimate that the capacity exists to support 10 000 families, each producing and consuming 50 to 100 fish per annum, the potential exists to contribute 500 000 to 1 000 000 kg of fish to the rural diet, and to support up to 70 000 people. This is a very considerable input, challenging the more traditional production from small stock, cattle and crops.

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While van den Berg et al (1972) used 20 g fingerlings, for the purpose of the model, the 80 g size proposed in 10.1.1.3 is used. The lack of attention they are likely to suffer makes the more robust size desirable. The cost of this size is R0,09 (10.1.1.3). For comparability the price of the output should be kept constant at R0,50 per kg, which in this case, means R0,50 per fish. In remote rural Ciskei, however, cabbages cost up to R1,00 per head, and it is inconceivable that a large fresh fish could have a lower value than this. In the van den Berg et al (1973) trial the fish were stocked in March and cropped in November in the same year, thus making use of the winter period when growth rates could be expected to be at their lowest. It is proposed here that the fish be introduced in spring and cropped as they become ready for consumption over the next summer and winter. Assuming a recovery of 75 percent of the fish stocked, the family would be required to lay out R12 for 135 fingerlings, and within 6 to 18 months from making this investment, could expect a return to the value of R100,00 at local equivalent prices. The real value in nutritional terms to the family is far higher, and few options available to the subsistence operator can be as attractive.

Harvesting remains a problem. Van den Berg et al (1973) drained the ponds, which would be quite unacceptable in the rural

areas. Angling, netting and trapping provide quite practical options.

## 10.2 INFRASTRUCTURE

No agricultural operation can flourish without a measure of infrastructural support from the State, and a new enterprise such as aquaculture is particularly dependent. This would represent an addition to existing costs which need to be estimated and evaluated against benefit.

### 10.2.1 Extension Services

One of the primary needs of agricultural enterprises is qualified, motivated extension workers. As has been shown by Bembridge & Penberthy (1979), the existing extension service does not adequately serve the rural community, and could not therefore be expected to carry the additional load of further development. A new branch would be required.

The costs and breakdown of this unit are given below:

- a) One senior post to handle policy and administrative decisions (R24 000 per annum)
- b) Four extension posts to cover field work in all areas of Ciskei (R10 000 per annum)
- c) Two unit management posts to cover hatchery management within Ciskei (R15 000 each per annum).
- d) Eight labour and casual posts for hatcheries (R1 000 each per annum).
- e) One typist/clerk (R6 000 per annum).

In addition to this, housing, office and transport will be required, some of which is already available from the existing infrastructure at Pirie Hatchery. The list below includes only those items (extra) to what is available from Pirie.

#### Capital costs

4 houses at R10 000 (Extension officer)	R40 000
1 house at R30 000 (Management officer)	30 000
8 houses at R4 000 (Labour)	32 000
3 LDV at R9 000	27 000
4 motor cycles at R2 000	8 000
	R137 000

This is the setting up cost, and allowance would need to be made for replacement of the vehicles at 3 yearly intervals.

Table 10.2

Annual repayments of capital and interest per R1,000 borrowed.

Years	Rate of interest												
	8½%	9%	9½%	10%	10½%	11%	11½%	12%	13%	14%	15%	20%	25%
1	1085	1090	1095	1100	1105	1110	1115	1120	1130	1140	1150	1200	1250
2	565	569	575	576	580	584	588	592	599	606	617	658	694
3	392	395	398	403	406	409	413	417	424	430	439	476	513
4	305	309	311	316	319	322	326	330	336	343	351	388	425
5	253	257	260	264	268	271	274	278	284	291	299*	334	373
6	219	223	226	230	233	237	240	243	250	257	265	301	339
7	195	199	202	206	209	212	216	219	226	233	240	278	316
8	177	181	184	188	191	194	198	202	208	216	223	261	301
9	163	167	170	174	177	181	184	188	195	202	210	248	289
10	152	156	159	163	166	170	174	177	184	192	200	239	280
11	143	147	150	154	158	161	165	169	176	183	191	231	274
12	136	140	143	147	150	154	158	162	169	177	185	226	269
13	130	134	137	141	145	148	152	156	163	171	179	221	265
14	125	129	132	136	140	143	147	151	159	167	175	217	262
15	120	124	128	132	135	139	143	147	158	163	171	214	260
20	106	110	113	117	122	126	130	134	142	151	160	205	253
25	98	102	106	110	114	119	123	128	136	146	155	202	252
30	93	97	101	106	109	113	118	124	133	143	152	202	252
40	88	93	97	102	107	111	116	121	131	141	150	200	250

Example: The annual repayment on a 5 year term loan of R6,000 with an interest rate of 15 per cent is  $6 \times 299^* = R1,794$  per annum.



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### Annual operating expenses

Salaries	R108 000
Vehicles LDV 72 000 km at R0,17 direct costs	12 240
M/cycles 144 000 km at R0,10 direct costs	14 400
Sub total	R136 640
10 percent contingency	13 664
	R150 304

Say R150 000 p.a.

### 10.2.2 Other Infrastructure

A fully operational fisheries sector would require other supporting functions such as training, and distribution networks including transport cold storage and processing. It is assumed here that the training would be provided at existing centres, using the staff allowed for above. The incremental cost would be low enough to be ignored. The other functions are strictly those of private enterprise and with the cost structures adapted for the production models there is enough leeway for them to be conducted profitably by the private sector. No costs are included for them, therefore.

### 10.3 SUMMARY

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This chapter has shown that with present factor prices the intensive production of coarse fish in especially constructed ponds cannot be considered on economic grounds. On the other hand, there are several promising opportunities for artisanal fishermen operating from existing impoundments, and very considerable potential for subsistence production, as is the case with most other agricultural enterprises.

The cost to government of the infrastructure is high, but not unrealistically so considering the potential for subsistence production which at its ultimate could approach an on-site value of one million rand per annum. Especially in view of the fact that control services which are essentially economically unproductive, such as the Department of Nature Conservation, are already accepted and financed, the cost of the service described here does not seem unrealistic. It must be emphasised that without this infrastructure, no start can be made on the realisation of the potential for fisheries in Ciskei.

## CHAPTER 11

### PART II EVALUATION OF FINDINGS AND RECOMMENDATIONS

#### 11.1 THE POSITION OF AQUACULTURE IN THE DEVELOPMENT OF CISKEI

From Part I it is apparent that the development of aquaculture cannot be considered in isolation from the economic environment in which it is to occur. If healthy and non-artificial growth is to be achieved, it is most likely to be so if aquaculture is placed in a symbiotic relationship with other related sectors, as a natural subsystem of the whole environment of resource development. Given this framework, the most critical influence impinging on aquaculture in Ciskei is the fact that Ciskei is a developing country. The problems and special demands of a developing country have, therefore, to be added to and reconciled with the industry-specific demands and problems of aquaculture, in evaluating it as a development option.

Part II of this document will be devoted to this process, but it is appropriate here to consider in general terms the function which fish production can be seen to fulfil in the development thrust of Ciskei. First and foremost, in the context of the investigation carried out, and this report, aquaculture has been held to be an economic activity, intended to satisfy specific objectives in regard to diet, unemployment and commercial opportunities. The natural consequence of this is that it must compete on its own merits for the resources required to sustain it, principally land, water, capital, manpower and expertise. Nowhere in the Southern African group of countries are these resources over-abundant and Ciskei is no exception. This point is made to emphasise that the aquaculture industry cannot occupy a position of privilege in regard to access to resources, and that resources diverted to use in fish production have an economic value in the enterprises from which they have been diverted.

In respect of resource-use, it is of interest that while in the East there is a steady growth in fish production, due primarily to the increasing efficient use of abundant water supplies, in Israel, the most highly developed of the "aquacultural-intensive" countries, there was a secular decline in the area of artificial ponds, from 1974 (4823 ha) to 1980 (3407 ha). This is attributed by Laing (1979 p 91) to increasing intensification of fish production to release "land and water for other agricultural purposes". One of the results of this pressure to intensify has been an increasing expertise in the use of low quality water to produce crops, thus narrowing even further the resource base available to aquaculture. (Sprig 1977 p 81)

In local terms, Tapson (1982) evaluated fish production under conditions which were "intensive, involved feeding of formulated rations, and a high level of management in especially constructed ponds" against other potential forms of production using the same resources. He found that on a per hectare basis, aquaculture required 23 percent more water than an irrigated maize and wheat system, allowing for no

losses due to seepage in the fish pond. The maize/wheat system produced 1,9 times as much protein, and 11,1 times as much energy. Conceding that fish protein had a higher value than grain protein he pointed out that the maize output could be used to produce a greater output of animal protein than the fish and that the wheat would still be available for direct human consumption.

In regard to food consumption he found that while feed-conversion ratios were similar, fish rations required a higher level of protein than broiler rations, and that the animal protein content of fish rations was as much as three times as high as that required for broilers. On the other hand, primarily as a result of the moisture content of fish, chicken meat had advantages in terms of both protein and energy. The specialised environment demanded by fish involves high capital costs estimated by Tapson (1982) at R5 800 per hectare and by Caulton (1982) at R9 000 per hectare. At current Land Bank rates the financing of such a capital cost is prohibitive in comparison to the output, and even at the applicable rates for development loans available from the Development Bank of Southern Africa (8 percent interest over a 20 year recovery period) the capital service charge is the major element in the per kilogram cost structure.

As is the case with Israel, Ciskeian natural resources suitable for fish production are limited and in view of the findings outlined above its role must be carefully and precisely defined. To do this it is useful to restate the major characteristics of aquaculture as they apply in Ciskei.



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1. It is less efficient in the use of water and land than alternatives in the form of irrigated crop production.
2. The specialised nutritional requirements of fish require that artificial feeds be complex and of high quality approaching and even exceeding the standards required for human consumption. This not only makes the rations expensive, but the introduction of an extra converter at this high level in the food chain quantitatively reduces the amount of food available to humans.
3. The capital cost of the specialised environment required for fish production is very high compared to monetary output.
4. Fish on the other hand are the only effective mechanism for harvesting highly nutritious algae and benthic organisms otherwise unavailable or unattractive to humans.
5. Provided the water is not required for human consumption, fish introduced to existing water bodies neither consume water nor change it materially in quality. In fact they might enhance water quality for irrigation.
6. In remote areas of developing countries where the distribution and storage of perishable products are inhibited by lack of both

transport networks and refrigeration, the production and storage of live fish in local water bodies provides a very apt solution to the provision of high quality protein to local populations.

From the above, the circumstances where fish production can rationally be considered, describe themselves:-

1. Where water is being stored and used for some other function and the capital cost and evaporation losses are carried by that function. In this case quite low levels of output per hectare are acceptable, as no standing cost has to be met.
2. Where low-quality, low-cost food resources capable of being converted by fish are available. Typically this could be animal or vegetable wastes from agriculture, or naturally occurring organisms in nutrient-rich water.
3. Where very high-value animals commanding luxury prices are produced. In the case of Ciskei, freshwater potential in this direction is limited to trout since temperature limitations preclude tropical species such as prawns.

Stated more specifically then, excepting the option of trout, aquaculture in Ciskei is likely to succeed economically when:

1. It occurs within the storage and transmission works of existing irrigation schemes or in existing storage ponds.
2. Low-cost food sources are available.
3. There is a subsistence demand for fish which could be satisfied by growing out and storing fish in stockwatering ponds.
4. Where naturally occurring populations in existing impoundments can be harvested either with or without stock improvement.

All of the foregoing places aquaculture in the role of a sub-system of agriculture, with a functional agricultural sector as an essential precondition for its existence. Its primary function is to extend or improve the use of agricultural resources. It appears that it cannot stand alone as a production entity as it does in the far East where water supplies are abundant and fish is a dietary staple, or as in Israel and the United States where specialised demands create a market. The fact of aquaculture occupying a niche in agriculture, and Ciskei's commitment to the concept of individual enterprise and the free market, means that if aquaculture is to succeed it will be by means of individual entrepreneurs operating in the agricultural milieu. There is no place for state or institutional involvement in the enterprise, except in the normal supporting role afforded to other economic sectors.

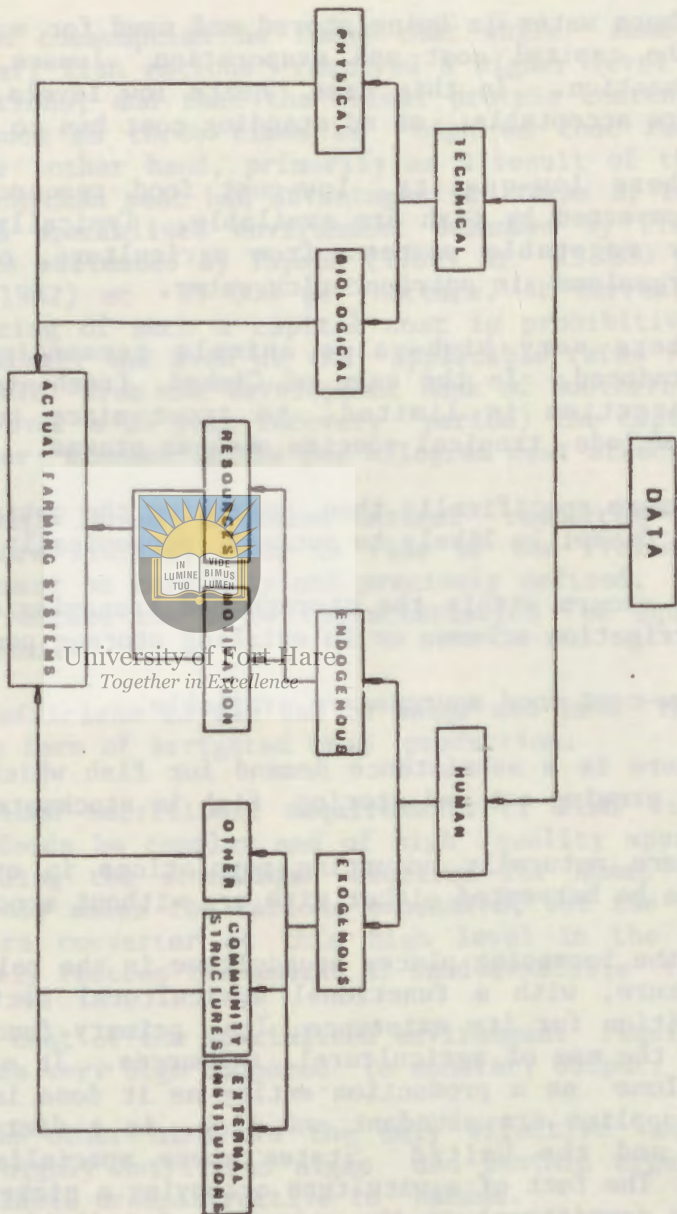


Figure 11.1: SCHEMATIC REPRESENTATION OF SYSTEMS RESEARCH MODEL  
(AFTER NORMAN 1978)

## 11.2 THE SYSTEMS RESEARCH APPROACH

If the concept that fish production should properly be in the hands of individuals is accepted, then a particularly apposite approach to solving the problems of establishing fish production would be through the medium of the farm systems research methodology. Farm systems research (FSR) has been in use in developed agriculture for decades and is steadily gaining recognition for its value in unravelling the complexities of agricultural production in the peasant and subsistence sector. In the field, when combined with the findings of research into household economics, it promises far greater potential than any of the many other development methodologies practised in the past. It is proposed therefore to use the FSR framework as an analytical tool to expose the potential and problems of aquaculture in the hands of individual producers, having regard to the findings described in Part I.

Fundamental to the systems research approach is that the centre of research is the individual producer. The reasons for this are clearly set out by Luning (1984 p 112).

"It is the farmer ..... and his family who make decisions on what to produce (choice of activities) how (choice in techniques) how much (intensity) and when and where to dispose of the eventual product. These decisions are made, based on objectives which include such aspects as self-sufficiency, risk aversion and money income. These decisions at the micro level are influenced by (dis)incentives generated at the macro level, such as services rendered by rural institutions (agricultural research, extension and training, credit, cooperatives and marketing) and by other government and private sector interventions (for example food, employment and price policies) and by the legal framework. Cultural and political factors play a role as well and it is obvious that historical events, which have led to changes in land use, can be an important factor in understanding present patterns of land use."

Norman (1978) has provided a schematic framework for FSR, which can be used to disassemble the complexities of the issues in any development activity, not the least fish production (Figure 11.1).

The technical element, i.e. physical and biological factors, defines the set of options available to the producer. These options are what and how much to produce, how to do it or whether effort and investment should be withdrawn from production altogether. On the other hand, the human element consisting of endogenous and exogenous factors, is the sufficient condition for the selection of a particular subset of the options available. The endogenous factors are controlled by the farmer or emanate from his socio-psychological make-up, for example capital and labour on the one hand or personal ambitions and objectives on the other. The exogenous factors are those largely beyond

his control and which must be viewed as constraints within which he must operate. They include external institutional factors largely arising from government action, such as extension, credit, input - distribution, marketing, and community structures, norms beliefs and cultural values.

Since each of these will influence the production decisions, each must be evaluated individually, and if necessary, in due course each must be recommended. It is proposed therefore in the balance of this document, to present the findings in the format of the FSR framework, and to evaluate each factor according to its affect on the decisionmaking process. Chapter 12 will cover the Technical Element, Chapter 13 the Human Element and Chapter 14, the Conclusions and Recommendations.



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## CHAPTER 12

### TECHNICAL ELEMENT

This chapter describes the physical and biological factors which apply in Ciskei and which between them determine the set of options from which a farmer may make his choice. The physical factors have largely been described in Chapter 2 of this report, so only their effects are summarised below.

#### 12.1 PHYSICAL FACTORS

- a) **Climate:** Ciskei falls within a temperate to sub tropical zone of the Southern African continent. As such, the country experiences a variety of temperature and rainfall patterns. These tend to aid fish farming in that the variations in climate increase the number of potential species to be cultured.
- b) **Water Quality:** In general the water quality in Ciskei is acceptable only to lower intensity fish production as a direct result of high silt loads in river systems. The chemical water quality is acceptable to fish production at various degrees of intensity and would not appear to be a limiting factor.
- c) **Water Quantity:** Ciskei has numerous impoundments or water holding facilities of widely varying sizes, which may lend themselves to various forms of fish production. For the pre-seable future the availability of water is unlikely to constitute a constraint.

In physical terms it would appear that Ciskei is adequately endowed with resources with which to develop an aquacultural industry. The technical element presents no barriers except to the production of luxury products such as trout and prawns.

#### 12.2 BIOLOGICAL FACTORS

##### 12.2.1 Candidate Species

Chapter 2 has described the commonest fish species that occur in Ciskei at present. It may be noted that all the recognised candidate culture species are represented in Ciskei by one or more family or group members. These include: Trout, carp, clarius, tilapia, mullet and eel. It is feasible that at least five of these recognised groups show potential, namely: Carp, eel, clarius, tilapia and mullet and to this should be added the indigenous *Labeo umbratus* or moggel, which is the basis of the capture fishery sector.

## 12.2.2 Potential Systems

Most of the recognised systems available, are grouped and described below in order to gain a perspective on what is available and to indicate the broad range of options from which selection can be made.

### 12.2.2.1 Intensive systems

#### 1. Raceways

A raceway may be described as an advanced form of a running water pond, where water in large quantities flows in at one end of the structure and out at the other.

The principles that apply to this system are:

- a) Certain fish species require high levels of dissolved oxygen, and without running water could only be stocked at low densities. A large throughflow of water increases dissolved oxygen and thereby allows more fish to be stocked per unit volume.
- b) Some fish are prone to crowding in static water, but when grown in running water, lose these characteristics, without having any detrimental effects on their feeding habits. (Bardach et al 1972 p 12)
- c) Running water removes metabolic wastes from the system that could otherwise build up rapidly, creating adverse water quality conditions and an ideal medium for disease transmission. (Bardach et al 1972 p 12)
- d) The cultured taste of fish species that are grown in static water, often referred to as the 'muddy' taste of fresh water fish, is easily combated when fish are placed in a running water system. This has a "flushing" effect on the fish which need not be grown in the raceway but merely be placed there for a short period prior to sale. (Bardach et al 1972 p 199).

The size, type and method of construction are largely dependent on the species of fish involved. For most warm water fish species, neither the volume of water, nor the type of construction, are as critical as would be for some of the cold water fish species, as warm water fish generally have much wider tolerances ranges.

Of the species mentioned only *Labeo umbratus* could not be grown successfully in raceways, as this species is specifically adapted to static water bodies, and feeds on organisms that grow in these bodies. However, the most successful of the

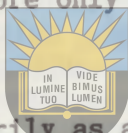
species mentioned in the literature on raceway production are *Angiulla* sp., *Clarius* sp., certain tilapias, the American catfish and the salmonide family.

For developing country application and more specifically Ciskei, raceways would appear to have numerous disadvantages:

- a) They demand large amounts of good quality running water of which Ciskei has limited resources both in terms of volume and quality (silt).
- b) They imply large capital investment in terms of unit construction.
- c) The type of food used in the system is by necessity of good quality, containing a high proportion of animal protein.

These factors generally infer a high quality, luxury product which would possibly be out of the reach of the average Ciskeian, and would therefore only fulfil an 'export' role.

## 2. Tanks



Tanks were developed primarily as an intermediary between pond and raceways in order to balance the advantages and disadvantages of each system, and therefore be applicable to a wide variety of species and techniques.

Running water is also used in intensive tank systems generally, although not to the same degree as in intensive raceway systems, also depending on the type of fish to be cultured in the system.

The general advantages of intensive tank systems are:

- a) They are relatively easy to erect, and are more versatile for indoor or outdoor construction and therefore lend themselves to controlled environment conditions. This may be particularly necessary for certain stages of specific culture systems.
- b) Tanks lend themselves to a variety of water inflow and outflow devices which offer a greater degree of control of the water and also facilitate the timely removal of waste matter.
- c) Tanks may easily be linked up to other systems including water purification and recycling, which adds to the flexibility of the culture system utilized. (Balarin & Haller 1982 p 306)

At present tanks form an important part of intensive culture for most of the major aquacultural fish species. This is borne out by the reported success of 'Baobab Tilapia Farm' in Kenya which achieves growth rates of 10 kg/m<sup>3</sup>/month. (Balarin & Haller 1982 p 314). Clarius, American catfish, carp and mullet may be grown in tanks, and in Japan a considerable degree of success has been achieved with eels.

However, as is the case with raceways, the disadvantage of costs would tend to limit the value of these systems in a developing country such as Ciskei.

### 3. Cages

Cage culture is one of the more recent developments in aquaculture that shows particular promise at all levels of intensity.

'Floating cages combine the advantages of small and large enclosures. When fish are crowded into small spaces they burn fewer calories, consequently food conversion is more efficient. In conventional pond culture the limit of a pond is set by chemical factors, principally, the oxygen capacity of the water. While fish in cages are physically restrained in a very small area, the amount of clean, oxygenated water available is theoretically unlimited' (Bardach et al 1972 p 559).

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Cages are constructed from netting material, mounted on a box form. The size of the cage and the diameter of the net mesh are largely dependent on the species of fish to be cultured, and the size of the water body into which the net is going to be placed. "Cage Culture permits the more intensive exploitation of a water system with a low capital expenditure." (Balarin & Haller 1982 p 320).

There are other advantages, especially for a developing country. The most important of these are with regard to the social structure, economy and management, rather than the purely biological aspect.

- a) Fish ownership is guaranteed. This is an important consideration where most of the main water bodies are owned by Government or groups (tribal authorities).
- b) As the intensity of a cage culture system increases there is a direct increase in food costs, but only a marginal increase in structural costs, effecting a considerable saving in unit margins.

- c) Cage culture lends itself to easy management, an important consideration where management qualities may be a constraint.

#### 4. Ponds

Intensive culture in ponds could be described as a simplified method of raceway or tank culture. In this system the pond is not generally designed to accommodate a large throughflow of water due to the methods of construction (earth). Therefore, being an intensive system other methods need to be employed to sustain the optimal conditions of water quality. The two major considerations in this case are the dissolved oxygen content and the accumulation of metabolic wastes.

To increase the dissolved oxygen content various methods are used to agitate the surface of the water. The removal of metabolic wastes is achieved by recirculating and filtering the water, often through very complex processes (Reay 1979 p 14/15).

The advantages of intensive pond culture are centered around the fact that the establishment costs involved are less than would be the case in intensive raceway or tank culture systems.

The disadvantages compared to the other systems described are:

- a) Due to the type of materials used in construction (i.e. earth) the upkeep on the unit may be more frequent than that carried out on concrete or similar constructions.
- b) In an intensive unit where large quantities of fish are stocked per unit area, there is a danger of lower levels of dissolved oxygen and a build up of metabolic wastes.

#### 5. Aquaria

Growing fish or producing fish for aquaria is an intensive form of fish production. Although little mention has been made of fish species, either indigenous or exotic, that could be utilized in aquaria, it is necessary to mention this as a form of fish production, and its status in economic potential for developing countries.

There are numerous fish species indigenous to Ciskei which can make interesting aquarium specimens, apart from the standard and well known aquarium species. Some of the indigenous species are:

- a) Cape mooney (*Monodactylus falciformis*) - Although this is basically a marine species it does occur in adjacent fresh water bodies and makes an interesting aquarium fish.
- b) Banded tilapia (*Tilapia sparrmanii*) - This fish is a more cold tolerant species of the tilapia group, but its small size makes it generally unsuitable for food culture. However, its attractive colouring makes it ideal for the aquarium.
- c) Tank goby (*Glossogobius giuris*) - An unusual fish that is becoming less frequent in some of the river systems due to chemical pollution
- d) Border barb (*Barbus trevelyani*) - This species in appearance is not an ideal aquarium pet; however, it is an interesting fish in that it only occurs in the Buffalo and Keiskamma Rivers of Ciskei. It has been declared an endangered species, and therefore it is an important species to preserve (this species has been bred in captivity).



The aquarium trade can be very lucrative (Safriel & Bruton 1984 p3), and it is important that this option is not disregarded in the light of general fisheries development.

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#### 12.2.2.2 Semi-intensive systems

In this section, although certain of the structures are the same as has been described under 'intensive systems', the methods of managing the units are different in varying degrees. These revolve around the intensity of operation i.e. the stocking rate, type and amount of feed and the turn around time from stocking to harvest.

##### Pond units

Pond units would appear to be the most numerous type of semi-intensive systems in operation in the world today, more especially in third world countries. A large number of different fish species and techniques are employed in this method, mainly revolving around waste utilization

Ponds are the most common form of water storage found in any area, and are primarily used for agricultural and domestic water use. It is therefore understandable that as fish culture became more and more popular, ponds began to be used for fish production.

Intensive pond culture of fish refers to ponds that have been specifically designed and built for this purpose. However, in

contrast, semi-intensive production normally takes place in ponds that have been designed and built primarily to fulfil other functions, and therefore may not have the necessary refinements such as monks, catchbasins, and constant depth. Fish production per se is unlikely to be the principle activity of the pond owner and this has led to this type of fish production being operated as a waste utilization system. Examples of this are numerous especially in countries like China, Taiwan, Philippines and other eastern countries. In these cases the ponds are mainly built as irrigation storage areas, and where fish are stocked they are fed primarily on crop or livestock residues.

This has led to more specific integrated aquaculture units being evolved. In South East Asia rice is the principle cereal crop. Fish culture in rice fields was introduced from India 1 500 years ago.

"For centuries, the small farmers have sustained themselves by practicing various kinds of crop diversification and integrated farming systems. Most small farmers have such livestock as a few head of cattle or buffalo, one or two pigs and a small flock of ducks or chickens. Where there is adequate water, a small fish pond is maintained (Delmendo 1980 p 59)

Research for developing country application has centered around integrated systems, and the pond has become a very important aspect in these semi-intensive production units. Integrated production is not the only method employed, and in comparison to intensive pond culture, many systems rely solely on supplementary feeding and lower stocking rates. This applies particularly to countries that have not as yet come into contact with eastern methods of aquaculture.

The system has been described fully in Chapter 6 of this report.

#### 12.2.2.3 Extensive systems

These systems apply where there is minimal capacity for capital outlay and where any capital which is expended in structures or food must be recouped over a short period.

Extensive systems have been the forerunner of most aquacultural units in the same way that hunting and gathering forms the basis for development in agriculture (Reay 1979 p 1). Although most extensive operations are generally connected with marine harvesting, it also applies to the fresh water aspect. It may seem logical to assume that this process will be continued in developing countries that have no history or prior knowledge of fish culture.

## 1. Ponds

Extensive utilization of ponds may take the form of harvesting naturally occurring populations of fish either with nets, or in the form of traps, hook and line, and spearing. As and when these populations are depleted, it is a relatively simple task to re-stock the pond, at very low density rates and allow the fish to grow on the natural food available.

Research on the utilization of this type of pond in Ciskei has been carried out at the University of Fort Hare (Van den Berg, Gaiger and Lenyai 1972). Their work was carried out on small stock watering ponds, where fertilization was from the manure of animals which came down to drink at the ponds. The ponds were stocked with Aischgrund carp at a rate of approximately 500 fish per ha. The harvests from the ponds were calculated at between 310 kg per ha and 792 per ha. This clearly showed the potential for this type of extensive system.

## 2. Dam impoundments

Due to their size, these water-bodies offer the potential of producing meaningful yields, although variations in size will obviously occur. Once again naturally occurring populations are used and attempts are made to structure harvesting to the inherent potential of fish stocks.

The successful utilization of these water bodies has been the subject of research in Southern Africa and has covered a variety of sizes of water bodies, varying from small ponds approximately one hectare in size to large water bodies extending over many hundreds of hectares.

Stemming from this work has been the successful implementation of certain natural fish harvesting operations. Of particular note for Ciskei is the commercial fishing enterprise on the Laing Dam in Ciskei reported on in Chapter 5.

## 3. Rivers

Rivers have always formed an integral part of fisheries operations around the world. Most of these operations are centered on the trapping of fish or simply by using hook and line. Of great significance here is the distinct lack of these types of fishing operations in Ciskei or for that matter in the surrounding provinces of South Africa.

A possible reason for this is that the indigenous species found in the catchments are mostly small minnows. The few

larger species that do occur are extremely difficult to catch by using a hook and line (notably *Labeo umbratus*). With the advent of introduced species (carp and clarius), it is becoming increasingly popular amongst the local population to fish for these species.

It is of interest to note that this lack of activity amongst the local population in utilizing naturally occurring fish populations (due to the difficulty of catching them) could have contributed to the misconception that the local population do not eat fish.

#### 4. Sport fishing

This is an extremely viable proposition in certain areas where water bodies and streams are correctly managed. The trout fisherman would appear to come from a fairly affluent background and is prepared to pay reasonable sums of money to do his fishing under pleasant surroundings during the season.

#### 5. Trout ranching

Trout feed is the single most expensive item in trout production costs, and many efforts have been made to find means to lessen these costs. One of these is trout ranching which has been developed by the Scottish Marine Biological Association who, after the work carried out on the ranching of salmon, adopted similar approaches in efforts to try to recall trout.

This has led to water bodies being stocked with trout which are then fed from set feeding stations at regular times. These may be used in rotation in an effort to encourage the trout to move all over the water body and thus collect natural food along the way (Phillips 1982).

This method has four advantages:

- It increases the 'carrying capacity' of the water body by supplementary feeding of the trout and at the same time, lowers the feed cost that would normally be applicable.
- It congregates the fish in certain areas at certain times to facilitate harvesting.
- It requires a far lower level of management.
- It also allows sport fishing to take place at the same time and produces quality fish.

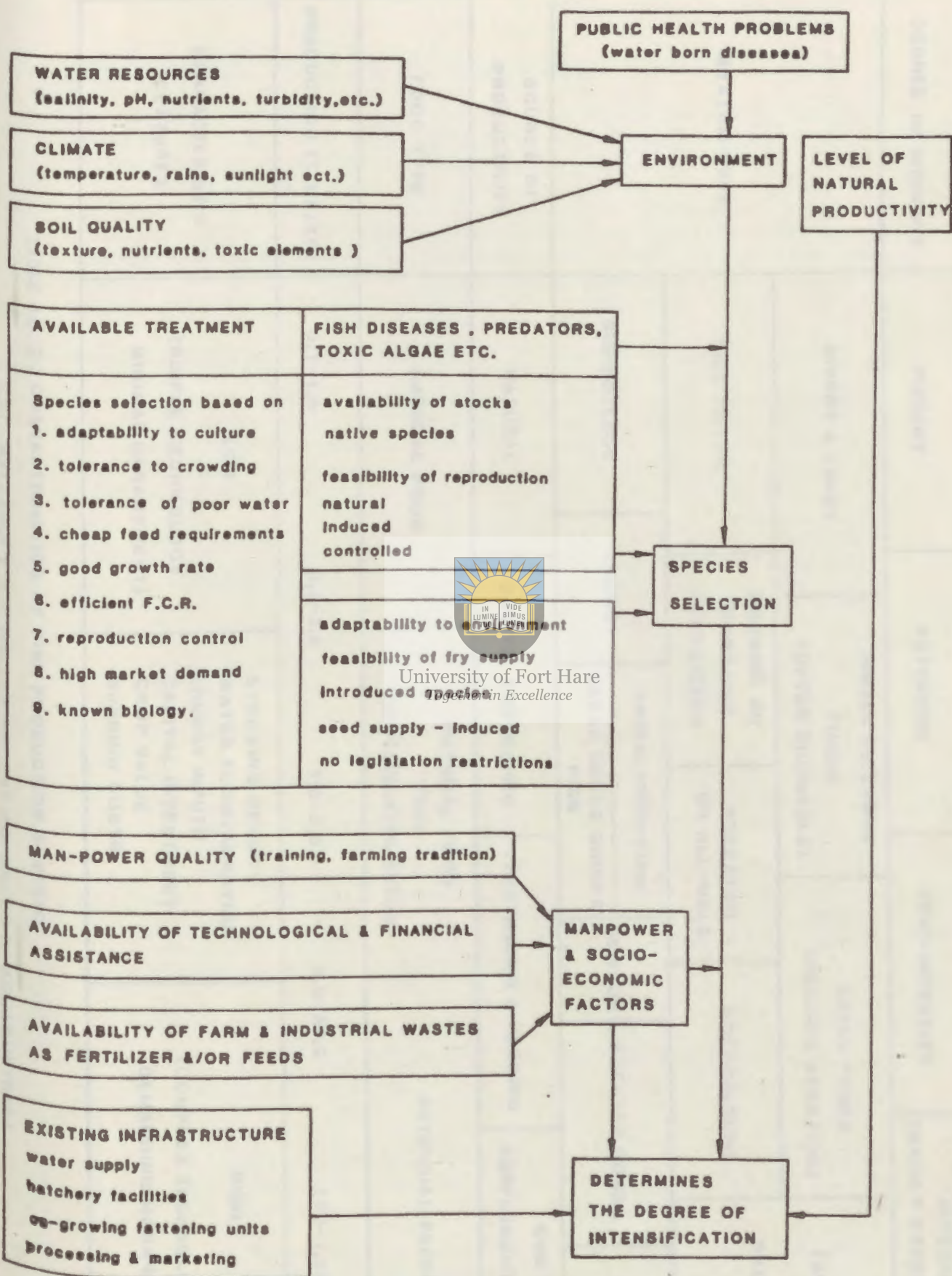


TABLE 12.1: FACTORS AFFECTING CHOICE OF SYSTEM

DEGREE OF INTENSITY	FISHERY	EXTENSIVE	SEMI-INTENSIVE	INTENSIVE (MAINLY EXPERIMENTAL)	
SYSTEM TYPE	RIVERS & LAKES	SMALL TO LARGE PONDS (OFTEN DRAINABLE)	SMALL PONDS (REQUIRE AERATION)	TANKS & RACEWAYS	
	RICE FIELDS	ORGANIC OR INORGANIC FERTILIZERS	PREDATOR OR ALL-MALE	POLYCULTURE	
	SUBSISTENCE	LIMING	ANIMAL-CUM-FISH GEESE DUCKS CHICKS PIGS	SEWAGE AERATED PONDS	CAGES
SOURCE OF PRODUCTIVITY	NATURAL	DUE TO FERTILIZING	FERTILIZING & FEEDING	DUE TO SUPPLEMENTAL FEEDS	
FOOD TYPE	NATURAL FOOD	NATURAL FOOD PLUS SUPPLEMENTAL FEEDS	ARTIFICIAL FEEDS		
PRODUCTION (T/HA/YR)	0,1-1,5	0,3-3,0	1,5-5,0	5,0-30,0	200-1,000 →
CHARACTERISTIC FEATURES	LOW  (SIMPLE TECHNOLOGY MINIMAL MANAGEMENT)	STOCKING DENSITY WATER FLOW/AERATION ENERGY INPUTS CAPITAL INVESTMENT CROP VALUE RUNNING COSTS	HIGH  (COMPLEX TECHNOLOGY DEMANDING MANAGEMENT)		

TABLE 12. 2 : CHARACTERISTICS OF FISH PRODUCTION SYSTEMS

(J.D. BALLARIN & R.D. HALLER RECENT ADVANCES IN AQUACULTURE)

## 12.3 SUMMARY OF THE EFFECT OF THE TECHNICAL ELEMENT

This chapter has shown that not only does Ciskei have the necessary resources of water and fish, but also that there is a variety of systems that can be applied to beneficially use the resources.

Since it is unlikely that all will have similar degrees of potential it is necessary to grade the systems and fish species according to potential and to arrive at an applicable set of options for a prospective fish farmer. Based on the foregoing and Tables 12.1 and 12.2, the systems are evaluated as follows:

### 12.3.1 Extensive Production Systems

Extensive fisheries has proved itself an effective forerunner in most developing countries. Ciskei has the resources to be able to accommodate at least three such "harvesting" enterprises, and therefore this is seen to be the primary area of development.

The extensive use of the small dams scattered throughout Ciskei by simple stocking as described by van den Berg et al (1972), is seen as a natural progression from the above.

Fish species that could be utilized in extensive systems are: *Labeo umbratus*, *Clarius gariepinus*, *Oreochromis mossambicus*, *Mugil cephalus*, *Myxus capensis* and *Carrinus carpio*.

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### 12.3.2 Semi-Intensive Systems

There is limited potential for small semi-intensive integrated systems within Ciskei as this potential is dependent on the successful establishment of normal agricultural operations.

The fish species involved in this type of system would be the same as for the extensive systems although there would be greater dependence on seed availability. This is as a result of the greater quantity of seed required for these units, and the present paucity of breeding units.

### 12.3.3 Intensive Production

At present it seems unlikely that intensive systems have any potential within Ciskei. This is due to the following reasons:

- a) Private capital is scarce in Ciskei and it would appear that this position will continue for the foreseeable future.
- b) The production cost of the final product will price the fish out of the Ciskei market.

- c) The quality of feed required for the fish is probably higher than that of the food the average Ciskeian uses at present.
- d) There are other better-established methods of achieving bulk protein production than aquaculture, which as a system is still under research in Southern Africa.

#### 12.4 SUMMARY

To summarise, the evidence of this Chapter suggests that at present the most promising options are:

- a) Capture fisheries based on indigenous fish populations in existing storage works.
- b) Extensive production for subsistence based upon improved species in stock watering ponds, which are naturally highly fertile and productive.

As fish production becomes established more elaborate systems may be considered but at this time, circumstances favour these two methods.

In Chapter 13, the human element will be analysed. It is the human element which determines which of the options set by the technical element, if any, will be adopted.

## CHAPTER 13

### THE HUMAN ELEMENT

"The farming system that actually evolves, however, is a subset of what is potentially possible as defined by the technical element. The determinant that provides the sufficient condition for the presence of a particular system is the human element ....." Norman (1978 p 814)

Research into fisheries development in Southern Africa has traditionally been centred on the technical element. Emphasis has been placed upon the biological aspects of reproduction and to an extent the technologies of fish production under controlled conditions. (Bok 1980, Bruton 1979, Gaiger & Geysler 1984, Hecht 1981, Jackson & White 1982, Prisloo & Schoonbee 1984, van der Waal 1978). The body of data has grown but it has not been accompanied by a complementary growth in fish production, either in the developing states or in South Africa. In Chapter 10 it was argued that the system research approach would yield benefit as an analytical tool, and fundamental to this methodology is the concept that the technical element only determines the set of options available. The technical options were assessed in Chapter 12. The human element determines which, if in fact any, of the options will be selected. The purpose of this chapter is to examine the factors comprising the human element to ascertain where limiting constraints exist.

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Socio-economic aspects receive considerable attention even in countries where fisheries are an established activity. Pollnac, Peterson & Smith (1982) describing the elements involved in the evaluation of success or failure of aquaculture projects, barely mention technology. Stress is placed on market demand, natural resource evaluation, cost/benefit comparisons of aquaculture and other sources of animal protein, infrastructure, "biosocioeconomic" cost/benefit analysis, skills and capital. Pollnac (1981 p 12) describes an event which graphically illustrates the social complexity of the development process. Developers in Indonesia perceived that crewmen on fishing boats were being unfairly exploited by boat owners, who in turn were bound to moneylenders. Seeking to break this strangle-hold, the developers offered new equipment and credit directly to the crew members to set themselves up as independent entrepreneurs. The crew members did not perceive the existing arrangement as unfair, but saw the developer's action as a threat to an established system within which they were safe. Their response was to destroy the equipment and assault a project administrator. Some of the serial complexities of introducing technology are illustrated in Figure 13.1.

Two major categories of human constraints to development exist, and these are dealt with separately below, with a view, it must be recalled, to establishing why individuals may or may not engage themselves in fish production. The options available have been identified in Chapters 10 and 12 as capture fisheries and extensive subsistence production.

# Introduction of Aquaculture Technology

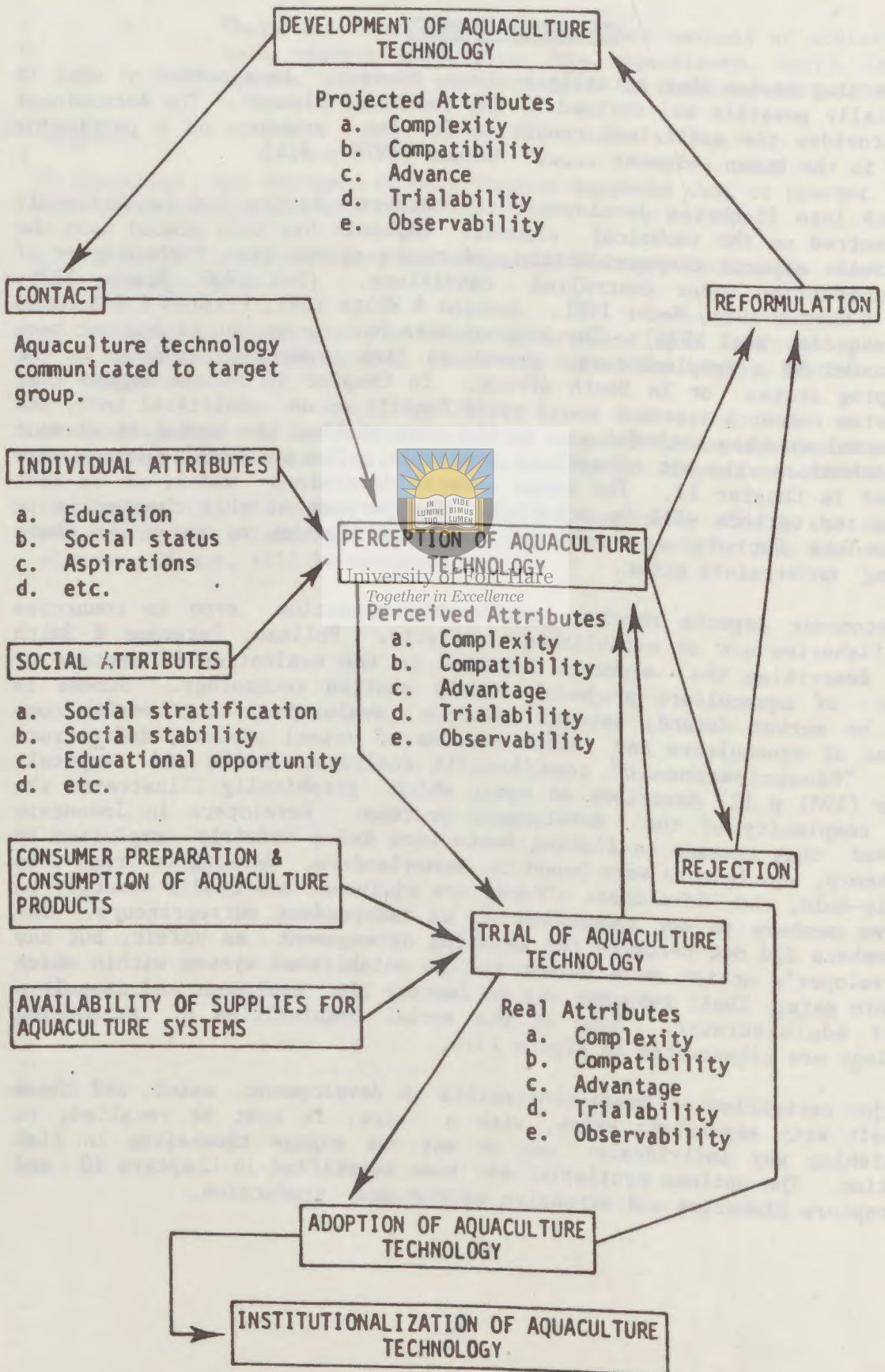


FIG 13.1: Pollnac, Peterson & Smith 1982

## 13.1 ENDOGENOUS FACTORS

The endogenous factors are, as stated in Chapter 12, those which are basically under the control of the farmer himself, or are a part of his make-up. The most important factors to examine are the farmer's resources, and his goals and attitudes.

### 13.1.1 Resources

It is useful to consider resources in terms of the factors of production, land (including water), labour, capital and management, and to add technology as an extra factor.

#### Land and water

In all agricultural effort in the developing states, access to land is one of the most severe constraints which requires particular attention to solve. In aquaculture the requirement for access to water adds an extra dimension. Considering the two forms of fish production indicated as having merit in Chapter 10 and 12, the particular problem of the capture fisheries lies in its novelty, in the lack of an operational policy in the use of national water bodies, and in the conflict seen between the interests of recreational and commercial fishing.

Because there is no tradition of commercial fishing in Ciskei, there is no body of policy and precedence within the administration which would make the granting of fishing permits and rights of access to sites a matter of routine. The absence of a plan of use of the fish resource leads to uncertainty as to whether the granting of a permit at the present may not jeopardise some unforeseen form of use in the future. Finally there is uncertainty both at administrative and political levels as to whether an individual should be permitted to make use of a national resource for personal gain. The conflict between recreational and commercial fishing is well illustrated by the extraordinary action of anglers from South Africa, in confiscating the Ciskeian commercial fisherman's catch at Laing Dam and declaring that he had no right to fish there, in what to them was a foreign country. All of this makes the issue of a commercial licence impossible as a routine clerical matter, and requires that it be determined at Cabinet level, resulting in understandable delays.

The case of subsistence production is beset with more intricate problems as it involves the use of a community resource, namely a stock watering pond. In view of the existence of accepted community rules in regard to the use of such resources, however, the likelihood of overcoming the problems with minimum difficulty seems better. The main problem is again the novelty of the system to be introduced. Assuming that a family or

families would wish to make use of a community stock-watering dam to produce fish for their own use, an extensive community approval procedure would have to be gone through before the chief or headman would ratify the group decision by giving permission for the activity. Without condonation by the traditional authority it is doubtful whether a family would proceed, and if it did it would almost certainly suffer the same unchecked interference as the Laing Dam fisherman. Well recognised procedures exist within the tribes for controlling access to such natural resources as clay, reeds and thatching grass and it does not seem impossible that a satisfactory procedure would evolve in response to a demand for access to water. The single likely exception is the introduction of carp to ponds used for domestic water, where the turbidity caused by carp would not be welcome.

### Labour

The amount of labour and the level of skill required for capture fisheries at the scale proposed presents no problem. The labour of the fisherman himself plus one other would be quite adequate, and casual labour is freely available. Again in the case of subsistence production the labour demand is low enough that the family could quite easily supply it.

In both cases, the high economic return to labour is of particular importance. In the case of commercial fishing the potential cash return is much greater than in other forms of agricultural activity, and in the subsistence model the output of high quality food is disproportionately large for the input of labour required. While no direct evidence is available from Ciskei, evidence from Swaziland (Low 1983) and KwaZulu (Lenta 1982) indicates that return to labour is a strong determinant in selection of activity. Since rural conditions are so similar it seems likely that the same would apply in Ciskei, and consequently subsistence production and capture fisheries would be attractive economic options.

### Capital

It is assumed here that the major capital cost of works such as hatcheries will be borne by the State, and that consequently seed both for stocking subsistence ponds and improving fish stock in lakes would be available at economic prices. This being so the capital required presents no constraints. The economics of capture fisheries make them attractive candidates for support by the Small Business Development Corporation. The very low requirement for subsistence production should be well within the command of subsistence fishermen.

## Management

For convenience the function of the entrepreneur is included here, as it is likely that at the scale of activity involved, both will be found in the same individual. It is safe to say that both are completely absent in Ciskei at present as far as fish production is concerned, as fish production is a completely unknown entity. However, the very great number of both small and large enterprises owned and operated by Ciskeians indicates that both expertise and the entrepreneurial spirit are present in a general sense. It is one of the functions of the extension service to expose the potential for fish production to them, and given that an extension service exists, no constraints can be identified.

## Technology

Two levels of technology are recognised here.

At the level of the individual operator the technology is very basic, well known and quite within the capacity of the likely candidates to master. At the hatchery and training centre level the technology is complex and demanding. The basic requirements are, however, well established and much of the aquaculture research in South Africa in the past decade has centered on hatchery techniques. Given a satisfactory staff structure and trained personnel hatchery management for the basic varieties such as tilapia and carp is a routine matter.

In the context of these proposals, technology does not present a constraint.

### 13.1.2 Goals and Attitudes

Since there are no existing fish producers it is not possible to examine their goals and attitudes empirically. It is possible, however, to draw supportable conclusions from indirect evidence.

1. The strongly positive tone of the response to the market survey (Chapter 4) suggests that no inherently negative image can be attached to the consumption or production of fish.
2. Evidence from the vicinity of Alice (ARDRI unpublished survey results 1984) indicates a strong motivation to improve both the quality and quantity of the diet. Considerable interest exists in activities such as poultry, vegetables and small scale dairy production, much of it for home consumption. It would seem that subsistence fish production would fit in well as another option.

3. On both occasions that the project mounted a display at the Ciskei Show, great interest was aroused. Numerous requests for information were received, specifically as to how questioners could get into fish production. Letters of enquiry were also received and are on file.
4. The capture fisheries represent a promising commercial opportunity, and it is unlikely that they would remain neglected once exposed.

Based on the above it cannot be argued that the goals and attitudes of potential fish producers are inimical to the development of the activity.

### 13.2 EXOGENOUS FACTORS

Norman (1978 p 814) describes these as "The social environment, largely outside the control of the individual farmer, (which) will influence what he will, and/or is able, to do."

Three groups can be described:

#### 13.2.1 Community Structures Norms and Beliefs

As has been written in the context of other factors, the absence of a fishing tradition means that no structures or norms regard fish acquisition or usage exist for empirical evaluation. The arrangements which govern access to arable land and the use of crop residues for example, have no parallel in fish. The role assignment and division of labour between the sexes in agriculture has no counterpart in aquaculture. Where fishing is a tradition, quite elaborate customs have evolved for the exploitation of the resource as is the case in the Kosi Lakes. It is possible to speculate that if subsistence production evolves as an angling or netting function, this may be viewed as a form of hunting and therefore within the purview of the men, but no prediction can be made with any certainty.

In regard to beliefs the issue of the river spirits has to be addressed. Although Hunter (1936) reported certain beliefs and ceremonies in regard to people drowned in rivers, it is only recently that the existence of this spirit world, which is of deep significance to traditional rural Xhosas, has been discovered by whites (Mertens and Gay 1973 p 30, Elliot 1970 p 97). It is held that an entire tribe of river people, vastly superior in both wealth and wisdom to earth people, inhabit the water, together with large herds of cattle. Victims of drowning are believed to be taken in by these people, and should they be returned to earth, to be endowed by them with their wisdom. Consequently, resurrected victims of drowning,

on their return to earth became leaders or spirit-mediums of great power and renown. It cannot be questioned that these beliefs are still held, on the evidence of the report on the Laing Dam fisherman (Chapter 5). Their existence has led academic anthropologists and ethnologists to argue that freshwater fish production activity in Ciskei has little chance of starting, let alone of success. The researchers have frequently been exposed to the (verbal) opinion that it would be an anathema in the context of the river-people beliefs.

Whether this is so, and if it is, the degree to which it will act as a block are open to question, however. Once again, no empirical evidence is available on this specific issue, nor is it likely to be obtainable, in view of the sensitivity of the matter. A number of observations which contradict the "professional" view can be made however.

1. Wherever netting for survey purposes has been done in rivers, the appearance of the fish has been a signal for a crowd to gather in the hopes of obtaining an unexpected luxury.
2. Despite the poor angling quality of river fish in Ciskei, anglers have been observed in some places. One of the authors' gardeners, by his own estimate over 80 years old, declared himself to have been an angler from boyhood, and lamented bitterly that age and infirmity prevented him from continuing. At Tyefu on the Fish River an individual was found whose main source of income for a period was commercial angling.
3. In the major river estuaries where good angling fish occur, numerous fishermen of all ages are found. Fish "poaching" by net in rivers is widespread enough to receive the attention of the rangers of the Department of Nature Conservation.

While this evidence is strictly anecdotal, it is sufficient to suggest that to forego the potential of freshwater fish production or capture, on the grounds of spiritual beliefs would be an over-reaction. It is widely recognised by developers that ways of reconciling possible conflict with cultural values are invariably found by communities wishing to adopt a new beneficial practice.

### 13.2.2 External Institutions

These are mainly those infrastructural activities supported or conducted by the State - credit, extension service, markets, co-operatives, and input distribution. In the case of the Ciskei freshwater fish sector they are the crux of its future development.

## Credit

While credit normally plays a pivotal role in agricultural development, in the circumstances which apply and amounts required, it is not a key issue in the case of fishing development in Ciskei.

## Extension service

A trained and motivated extension service is an essential ingredient in the upliftment of a stagnating agricultural system. Given that the other two ingredients, economic opportunity and a workable technology are present, the extension service provides the essential link between the specialist researcher and the producer, and creates the pressure to ensure that the economic opportunity is taken. In the case of Ciskei, the technology is available both for subsistence production and capture fisheries, and the economic returns to both activities are worthwhile. It is essential that the third factor, the extension service, be brought into existence before progress can be made.



## Input distribution

The supply of inputs to farmers in developed countries is strictly a commercial industry. Here, the large number and small size of the customers, and their physical dispersion makes the supply of inputs unattractive and prohibitively expensive in commercial terms. In the case of Ciskei only one input, namely fish seed, needs to be considered, but the same strictures apply. The peculiar requirements of live fish seed exacerbate the normal problems. Agricultural crops typically require 20 to 120 kg of seed per hectare and this is the mass which has to be transported. It is stable, inert and can be carried in unspecialised transport. Aquaculture by comparison requires from 5 000 to 20 000 fingerlings per hectare, and, if these weigh 180 g, which seems advisable, may require several tonnes of water to transport. The seed itself is delicate, liable to damage, and requires specialised transport if carried over long distances.

These factors put the production and distribution of fingerlings in conflict with economies of scale. In terms of simple production costs a large professionally run hatchery is likely to produce fingerlings at a low unit cost. In terms of distribution, however, the dispersion of the customers and the small size of individual consignments make transport prohibitively expensive. A further issue is that a hatchery provides a logical site for farmer training, and with the immobile nature of the bulk of potential farmers, a single central hatchery does not lend itself well to this role.

The essentiality of a hatchery service is beyond discussion. It is, together with the extension service, a cornerstone of the infrastructure required to initiate fisheries development. The scale and siting of the hatchery or hatcheries require specific study, which is beyond the scope of this investigation.

### Marketing

Both empirical evidence (Chapter 4) and practical experience indicate that the marketing aspect presents few problems, at the level of output envisaged. A practical and straightforward progression through the various levels of sophistication is feasible should the output warrant it. Immediate sale of wet fish could give way to simple processing and later cold stores and distribution networks, but no elaborate provision is necessary at this stage.

### 13.3 SUMMARY

In the context of the two levels of activity selected, the main constraints to the development of fish capture and production occur within the human element.

Contrary to expectation, the most important impediments are not found in cultural values. Practical problems do exist however, in that no established procedures are present in tribal custom by which exploitation of water resources through fish production could be accommodated. Since such arrangements exist for other resources, it seems possible that they could evolve on demand for fish production.

There are three critical constraints each of which individually presents a total block on progress.

1. A cohesive national operational policy on fish capture and fish production is yet to be drawn up.
2. There is no extension service for the fish sector.
3. There is no local source of fingerlings.

Without the solution of all three problems, fish production in Ciskei will not get under way.

None of them however, is inherently insoluble. All can be resolved by administrative action and planning of a relatively simple order.

## CHAPTER 14

### RECOMMENDATIONS

Chapters 12 and 13 dealt with the systems analysis and identified constraints to the development of a freshwater fish industry. Only three serious constraints were identified, but each of them alone is sufficient to frustrate the development of the industry. The three constraints are:-

1. The lack of a national operational policy on freshwater fish production.
2. The absence of a properly constituted and functionally efficient extension service.
3. The lack of infrastructural facilities both to provide seed and sites where in-service training and farmer-training could be carried out.

The recommendations are aimed at these problems.



#### 14.1 POLICY

It is recommended that a national operational policy designed to encourage both capture fishery and subsistence production be formulated. It is not intended here to make detailed policy recommendations, as it is not the function of an outside organisation to draw up policy on national matters. The points below are made as guidelines for the National Water Commission, which may wish to include them in its national water policy. This body is seen as the natural authority to both draw up and administer the policy.

##### 14.1.1 Approach

In keeping with Ciskei's declared policy of private enterprise and individual economic endeavour the policy should be aimed at encouraging individuals to engage in freshwater fish production, with a minimum of State intervention. In other words it should be more an enabling, and less a regulating policy.

##### 14.1.2 Access to Public Water

It is likely that the National Water Commission will decree certain water bodies as public water. Since these will also include the major economic concentrations of fish it will be necessary for access by commercial fisherman and for recreational use to be arranged. This could be done by limiting the use of certain water bodies to specific uses, or by physically demarcating separate areas in water bodies by means of floating booms. It will also be necessary to make provision for parts of the shoreline to be dedicated to commercial production.

### 14.1.3 Tourism and Recreation

The isolation and attractive surroundings of the bigger water bodies present attractions which have value in promoting tourism and fee-paying anglers. The policy will need to ensure that there is provision for both recreation and commercial fishing, without clashing.

### 14.1.4 Protection of Interests

Hostility between recreational and commercial fishermen is a universal phenomenon, the incident at Laing Dam providing a good illustration of this. For both to be active without conflict in the same area, a regulating presence in the form of wardens or rangers is necessary. Since it will be necessary for the Water Commission to have staff on site for other purposes it seems reasonable that the dam rangers should be administered by the Commission as well.

### 14.1.5 Subsistence Production

The prime requirement in regard to subsistence production is to recognise that it belongs administratively in the Department of Agriculture and Forests and not in the Department of Nature Conservation. Fish production in this form is in every sense an agricultural operation, and therefore its promotion must be the function of a specialist group within the Department of Agriculture.



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## 14.2 EXTENSION SERVICE

Neither South Africa nor any of the developing states has a service devoted to the promotion of fish harvesting and production, and there is therefore no precedent which can be followed. It is proposed that within the Department of Agriculture, a Fisheries Division be established to administer the development of fisheries production. The structure outlined below is proposed as a starting point which may be amended in the light of experience.

Senior Fisheries Officer			
Fisheries Officer	Fisheries Officer	Fisheries Officer	Fisheries Officer
Gibraltar Rock	Bridle Drift	Sandile	Oxkraal

### 14.2.1 Affiliation and Function

Since the Fisheries Division is seen as a specialist extension service, dealing with the same people, problems, and resources as the agricultural extension service, it properly belongs in that department. It can be viewed as a functional as opposed

to a regional division of the department and the Senior Fisheries Officer would report to the Director of Extension in Ciskei.

The function of the Division would be to introduce fish production as an option to rural dwellers, to support new producers by extension visits and training, and to provide the seed essential to the industry. The service it provides therefore is seen as comprehensive and integrated.

#### 14.2.2 Senior Fisheries Officer

This individual would need to be qualified appropriately at degree level, with experience in both fish production and the administration of a department. It is probable that an individual possessing extension training will be difficult to find, but this could be provided through Fort Hare.

His functions would be:

1. To administer the national policy as it relates to subsistence and/or commercial aquaculture.
2. To control the activities of, and train the Fisheries Officers.
3. To provide supervision and technical expertise to the hatcheries.
4. To advise from time to time and in the light of experience, on amendments to the national policy.



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#### 14.2.3 Fisheries Officers

Four fisheries officers are proposed, each associated with a hatchery. They will be qualified at diploma level in their subject matter, and will be required to obtain further extension training, at best to diploma level which is available on a part time basis from Fort Hare.

Their functions would be:-

1. To supervise and control the hatchery.
2. To stimulate interest in aquaculture primarily as a subsistence activity, but also in commercial terms where the opportunity offers.
3. By means of a training-and-visit programme to provide the back-up needed by new and inexperienced producers.

4. To provide formal on-site training for farmers, using hatchery facilities as venues.

5. To supervise and control hatchery labour.

### 14.3 INFRASTRUCTURE

The provision of fish seed at an appropriate price, and when and where required is an essential prerequisite for the success of an aquaculture development programme. The peculiar problems that affect this issue have been outlined in Chapter 13. To overcome these it is recommended:

#### 14.3.1 Siting

A network of small, basic hatcheries be established, distributed throughout Ciskei, rather than a single large hatchery. Suitable sites are at Gibraltar Rock and Bridle Drift for tilapia to serve the warmer areas, and at Sandile and Oukraal to serve the colder areas with cold tolerant species.

#### 14.3.2 Scale of hatcheries

Two orders of hatcheries should be considered. A more comprehensive "headquarters" type hatchery with laboratory and good facilities for preservation and production of brood-stock, is required at University of Port-Hare. Second order hatcheries of a completely basic nature only, are required at the other three sites. For example a single breeding arena for tilapia and supporting ponds would be required at Bridle Drift, and similar facilities for carp at the other two sites.



#### 14.3.3 Functions of hatcheries

The principle function of the hatcheries is to provide on a decentralised basis, fingerlings of the right size at the right time to potential producers and for stock improvement in major impoundments. Secondary functions are to provide a base from which the Fisheries Officers will operate and facilities both for in-service training of staff and farmer-training.

#### 14.3.4 Supervision

Daily supervision will be performed by the Fisheries Officer, under the control of and according to programmes set by the Senior Fisheries Officer.

#### 14.3.5 Transport

The economic transport of live fish over long distances presents specific problems as detailed in Chapter 13. It is proposed here that transport be done by the Fisheries Officer

in the course of his duties. The small individual consignments and short distances involved mean that simple containers, charged with oxygen, will suffice.

#### 14.4 SUMMARY

An essential feature of these recommendations is the integration of the hatchery and extension function. Not only does this facilitate the provision of a complete service to the producer, but it also entails certain economies and efficiencies by virtue of locating the Fisheries Officers on the hatchery sites. There are manifest advantages in this arrangement which will enhance the probability of success of the freshwater fish sector.

It must be re-emphasised that all three recommended actions are essential to the development of fresh water fish production in Ciskei. The development of policy, however, must be considered a pre-requisite, and should be attended to before the others are considered.



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## CHAPTER 15

### CONCLUSIONS AND EVALUATION

Since the Ciskei Freshwater Fish Project was initiated with a set of clear objectives in view, it was appropriate at the inception to state how the project was to be evaluated. To this end, three types of expenditure were ascribed, each from funds of a different source, and each to be evaluated by a different measure of effectiveness (ARDRI 1981 p 14).

The three types of expenditure, and the evaluations that can be applied in view of the experience of the project are as follows:

"Capital development which would normally be considered as part of the public sector investment programme ...."

In the event no capital was invested by the state, but a major bid for development funds was made to KEOSSA, which has to all effect been accepted. The knowledge and experience gained in the conduct of the research project contributed in a major fashion to the preparation of the supporting document. Further, **than** that it increases the confidence with which such investment **can** be accepted, in the expectation that the investment will be soundly made. The recommendation under 14.3 indicates the pattern which might be followed.

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"Commercial capital raised to finance the individual enterprises ...."

The enterprises listed fall clearly into two widely separated categories according to investment potential - those in which operating costs exceed income and which cannot therefore be considered, and those in which benefit is so high relative to cost that only the crudest evaluation comparisons need be considered. As predicted in the project proposal, funds for the latter category are available from the Ciskei Small Business Development Corporation, which stands ready to support them.

"Operating funds to provide the expertise which will be the impetus to the project."

These were identified as specifically donor's funds and the difficulty of evaluating return from this investment by the donor was pointed out. It was held that most of the benefit would accrue to rural Ciskeians, through an upliftment of the human and economic condition in Ciskei. The statement that "A number of small entrepreneurs, and a range of jobs requiring skill and training will be created" was, in retrospect, naive and optimistic. The constraints described in Chapter 13 show clearly why this was so. What has been achieved by the project is the accumulation, from a zero base, of an enormous body of practical experience and information on the establishment of fish production from scratch in a developing country. Were the task to be approached de novo at the present state of knowledge, a much higher probability of success could be anticipated.

The major achievement of the project has been to clarify the constraints to aquaculture development which are probably universal in Southern Africa's developing states, and which account for the singular lack of progress in fish culture in all of them. This is so, despite substantial investment in research and considerable effort in some countries. Not only is Ciskei placed better to succeed as a result of this project but other countries planning fisheries development programmes will benefit by shortening their development lag-time. To this extent then, it can safely be said that the generous investment by the donor in this project has been well justified.



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INTERGRATED UNIT DESIGN FOR TRANSKEI AGRICULTURAL  
CORPORATION

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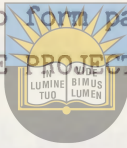
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## 1. INTRODUCTION

ARDRI has been approached by the Transkei Agricultural Corporation to investigate and draw up a proposal for establishing a "Fish Farming Demonstration Unit" along the lines of integrated agriculture/aquaculture. This unit is to form part of the AMAZIZI HEALTH WELFARE AND EDUCATIONAL MODEL VILLAGE PROJECT in Butterworth, Transkei.



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### 1.1. LOCATION

The proposed unit is to be developed within a triangle bounded by the main East London-Umtata road, the Gcuwa river and location number 1, (Butterworth).

Access to the site is by dirt road, from a turn off immediately after the main road bridge across the Gcuwa river on the Northern side of Butterworth.

The total area of the site is approximately 7 ha, including four existing dams (varying from 2750m<sup>2</sup> - 425m<sup>2</sup>).

1.2. PHYSICAL CHARACTERISTICS

		J	F	M	A	M	J	J	A	S	O	N	D	
TEMPERATURE (°C) IDUTYWA	MAX	25,2	25,7	24,7	23,5	21,7	19,7	18,9	21,0	22,0	22,5	23,4	24,4	
	MIN	13,9	14,8	13,8	11,7	9,1	6,5	6,2	7,1	8,6	10,2	12,2	12,8	
	MEAN	19,5	20,3	19,3	17,6	15,4	13,1	12,5	14,1	15,3	16,3	17,7	8,6	
UMTATA	MAX	27,8	28,1	27,3	25,7	24,1	21,8	21,3	23,1	24,1	24,9	25,5	26,4	
	MIN	15,6	16,1	14,9	11,4	6,5	2,9	2,6	5,2	8,0	11,2	13,1	14,3	
	MEAN	21,7	22,1	21,1	18,5	15,3	12,3	11,9	14,1	16,1	18,1	19,3	20,6	
EAST LONDON	MAX	25,2	25,6	24,7	23,5	22,6	20,9	21,0	21,3	21,4	21,6	22,8	24,0	
	MIN	17,9	18,3	17,5	15,1	12,8	10,5	10,2	11,2	12,5	14,2	15,4	16,7	
	MEAN	21,5	21,9	21,1	19,5	17,7	15,7	15,6	16,2	16,9	17,9	19,1	20,3	
EVAPORATION (mm)	EAST LONDON	198	185	155	107	86	94	94	127	130	165	180	193	(1714)mm
	UMTATA	163	137	132	104	81	74	81	102	114	147	150	165	(1450)mm
RAINFALL (mm)	IDUTYWA	76	71	87	40	26	15	17	20	41	56	74	71	(592)mm




## 2. DESIGN CONCEPTS

In an effort to increase the utilization of natural resources, or to maximize production from limited land areas, diversified agricultural systems are becoming increasingly popular in the rural sector of most developing countries. With particular reference to the Transkei, the rural areas have reasonably small allotments of good arable soil per family unit and virtually no stored irrigation water. It would also appear that the present conventional rural agricultural practices are, in general, not affording an acceptable standard of living.

It has therefore become necessary that developing "agents" investigate methods, whereby the available land and water resources are used to their optimum potential, while at the same time providing a reasonably high return with minimim risk.

To do this, integrated agriculture/aquaculture systems with diverse activities on a small area are being investigated. This concept revolves around waste utilization from conventional agricultural production units as a means of maximizing the use of the other resources.

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- Example:
1. Fish are stocked in irrigation dams (an area previously unexploited)
  2. The fish are fed on manure from one or other form of livestock
  3. The livestock are fed from cropping wastes and supplemented if necessary with conventional animal feeds
  4. The manure enriched water is used to irrigate the cropping area

While it may be argued that production from established aquaculture units is noticeably higher, (especially overseas U.K., U.S.A., Denmark, Holland, Germany, Israel) the costs involved are higher.

Therefore although one or more facets of an integrated unit may have a lower production output, the costs are appreciably lower and generally a more efficient use is made of the available resources. It would appear that this method is more applicable to rural peasant situation.

## 2.1. INTEGRATED UNIT PLAN

The primary concerns involved in planning a unit of this nature have been centered around the following points:

1. How much land is available
2. How much water is available
3. How much time/labour is available

Due to the nature and diversity of enterprises in such a unit, a gross margin analysis was done for 7 different enterprises, (these being fairly common and accepted agricultural production units.) Even at this early stage of planning, fish are presumed to be a bonus within the system, and no particular consideration is given to them at present and the livestock component is planned to maximize waste utilization.

These enterprises are:

1. Cabbages
2. Potatoes
3. Beans
4. Maize
5. Ducks
6. Pigs
7. Fish

For ease of management, 3 dams with a total surface of +5 ha are taken as being available to the unit, and will, with a supplementary supply, meet the irrigation requirements of 1 ha of land.

## 2.2. CROPS

Within the cropping programme, planning has been formulated around existing conditions in Transkei, i.e. mechanical operations tend to be very seasonal and it is unlikely that certain operations, eg. those of cultivation, planting, fertilizing and harvesting will be done mechanically, therefore, these have been planned as hand operations. (See appendix 1).

The crops that have been selected are all widely accepted in Transkei, as it is felt that at this stage it would be far easier to use standard crops within this type of unit, than to go for lesser known crops, that might require additional inputs other than management i.e. marketing and new technology.

From experiences both in Transkei and Ciskei, it seems that cabbages are by far the most acceptable and profitable crop. However, at the same time, it requires high labour inputs, both in the seedbed and field conditions. This has tended to limit the area to 0,25 ha (2 500m<sup>2</sup>) for two crops/annum, as being a manageable unit within this system.

Potatoes were selected as a second crop, also with a very high labour inputs in ridging and harvesting, and has been limited to 0,125 ha (1 250m<sup>2</sup>).

Beans have been selected primarily as a legume crop to fill in as part of the rotation. (It might be possible to use lucerne - however it is an expensive crop to establish and does not fit in well on small area crop rotations).

Maize, as part of the traditional crop, takes up the remaining area of 0,5 ha (5 000m<sup>2</sup>) and this particular unit could do fairly well in the form of "green mealies", especially with regard to its close proximity to Butterworth. However, this is not going to apply in all cases, and as this is a demonstration unit, budgets have been calculated on a maize grain basis.

### 2.3. WATER REQUIREMENTS

It is assumed that 550 mm of irrigation will be required to successfully irrigate any crop that is planted.

	mm	(area)m <sup>2</sup>	
Maize	550	5000	= 2750m <sup>3</sup>
Cabbage	550	2500x2=	2750
Beans	550	1250	= 688
Potatoes	550	1250	= 688
Garden	550	1250	= 688
		13750	= 7564m <sup>3</sup> water consumption

The dams have a surface area of 5 000m<sup>2</sup> and should have an average depth of 1m, giving a basin capacity of 5 000m<sup>3</sup>.

Evaporation from the dam is +1 500mm per annum, whereas the rainfall is only 500 mm per annum. This would result in the net annual requirements being equal to WC + EV -R.

(where WC = water consumption

EV = evaporation

R = rainfall)

Water consumption	7564m <sup>3</sup>
evap. from dam	7500m <sup>3</sup>
	15065m <sup>3</sup>
rainfall	3000m <sup>3</sup>
	12064m <sup>3</sup>
	12064m <sup>3</sup> per annum

There will be a peak period during summer when the total demand will be +1 300m for a 4 month period, and thus pumps should be purchased to cater for this flow.

Therefore at:

\* 43,3m<sup>3</sup>/day - pumping over a 12 hour period per day will equal 3,6m<sup>3</sup>/l or ,001m<sup>3</sup>/sec.(1 liter/sec.)

### 3. ESTIMATES OF CROP RESIDUES AVAILABLE FOR LIVESTOCK CONSUMPTION

#### Cabbages:

It can be assumed that waste from cabbages could amount to +150-200 grams/plant (planted at 22 000 plants/ha) = 5 000 plants/crop or 750-1000kg of waste/crop.

In order to get maximum utilization from this waste, bottom leaves will have to be picked as and when they are available over the cropping period, this should amount to (+50% of the waste) and the remainder on reaping. To get further benefits planting could be staggered for better waste utilization.

#### Therefore:

375-500 kg for 30 days in May/June

375-500 kg end July

375-500 kg for 30 days in Sept/Oct

375-500 kg end Oct.

1500-2000 kg - giving a maximum of 16,6 kg/day

#### Therefore:

Gives a waste supply for 200 ducks or 3 pigs for 3 months.

#### Potatoes:

The waste supply from potatoes can be calculated at approximately 500 grams/plant therefore: + 12 500 kg. However, as all this will be available at the same time, and cannot be stored, very little will be consumed before it decays. It may then be assumed that 250 kg may be available over 30 days or +8 kg/day. This will be available in February and will be able to feed 100 ducks or 1 pig for 30 days.

#### Beans:

Much the same situation arises with beans, in that, what waste is available, all comes at one time. Approximately the same amount of waste as with potatoes will be produced i.e. 8 kg/day for 30 days. Therefore food for 100 ducks or 1 pig in October.


### Maize:

Very little in the form of "waste" will be produced from maize, and this should be seen more as a "feed" item for any form of livestock, if it is surplus to sales and home consumption.

### Garden:

This will provide a regular but limited amount of waste throughout the year. This has been estimated at +1-2 kg/day, if the garden is properly managed and rotated. Therefore this will provide food for +12 ducks on a constant basis.

### Greenfeed:

To increase feed, and regulate flow, it is suggested that the dam walls be utilized as grazing areas on a rotational basis. Intensive grass/clover pastures could form part of a ration at the rate of 4,5 kg/100 ducks/day.  Pigs will be able to utilize this at the rate of 1,5 kg/day/pig. If the area available is +1000m<sup>2</sup> of dam walls, a yield of 10 tons/ha, will yield 1 ton of green feed. This should supply part of the green feed requirement as follows:

$$\frac{1\ 000\text{kg}}{365} = 2,7\text{kg/day}$$

Sufficient for

50 ducks per day

OR 2 pigs per day

The total waste produced, will produce sufficient food for 22 320 duck days or 504 pig/day. If a duck is kept for 90 days before sale, this will mean a total duck holding of 248 ducks for one 90 day period or 61 ducks of four 90 day periods, for pigs this is almost 1 pig/year - with scope for feeding a litter. This level of animal production is insufficient to supply enough manure to feed an intensive fish component. A fully utilized 0,5ha body of water i.e. 10 000 fish, would require the equivalent of 1 001 105 duck days per annum (a shortfall of 78 785 duck days or 3 293 pig/days).

At certain periods, there will be excess waste. However, this could be disposed of by three methods:

1. As compost
2. Directly as fish feed
3. As green manure



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## GROSS MARGIN ANALYSIS

The dilemma in selecting the best waste utilizer is twofold:

1. Which will achieve the highest gross margin?
2. Which will utilize the waste to the best advantage?

Obviously ducks have the highest gross margin, however, they will not consume any "stale" waste - which pigs might be able to. It is possible that the choice lies in the location of the unit i.e. if concentrate feed is available from close to the unit, then the choice should be ducks and conversely, if concentrate feed is not locally available, then with the correct cropping regime (staggered planting) pigs should be used.

The primary concern when planning a unit where the objective is to maximize resource utilization with a minimum of mechanical input, is the amount of labour time available to perform the wide variety of tasks encountered.



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To calculate this, it has been assumed that all tasks and activities would be performed during an eight hour day. It may be argued that certain activities such as "breakfast" would take place outside this period, however, it is suggested that calculations are based as including everything into an eight hour day. This will result in an operation, more in keeping with rural conditions, and that when dealing with this type of plan, success or failure of the unit could possibly rest on not pressurizing the operator, who will be trying to cope with many new ideas, concepts and management requirements. Further to this it is important that the best possible use is made of the time available to increase the returns per unit effort within a fairly standard agricultural crop selection programme. The land areas allocated for this unit is as follows:

Dams	0,5
Agricultural	1,0 (,5 maize/,5 conventional vegetables)
House	1,0
Sheds & animal housing	
Garden	0,125
Trees	0,025
Roads, contours etc.	<u>0,25</u>
TOTAL	2,00 ha

This figure falls within the standard holdings found generally throughout the rural areas, i.e. 3 ha.

#### 4.1 CROPPING UNITS

##### Maize (0,5ha)



Variable costs	per ha University of Fort Hare <i>Together in Excellence</i>	Per 0,5ha
Ploughing	14,00	7,00
Discing	8,00	4,00
Ridging	12,00	6,00
Seed	44,00	22,00
Fertilizer	394,00	197,00
Pesticides	110,00	55,00
Labour	<u>124,00</u>	<u>62,00</u>
TOTAL	706,00	353,00
GROSS INCOME ( 7t/ha)	1172,50	586,25
GROSS MARGIN per ha	466,50	
per 0,5 ha		233,25
per R100 VC		66,01
per R100 labour		376,21

Beans (0,125ha)

Variable costs	per ha	per 0,125ha
Ploughing	14,00	1,75
Discing	8,00	1,00
Ridging	12,00	1,50
Seed	134,00	17,00
Fertilizer	153,00	19,00
Pesticides	79,00	10,00
Packaging	22,00	3,00
Labour	<u>305,00</u>	<u>38,00</u>
<b>TOTAL</b>	<b>727,00</b>	<b>91,25</b>
<b>GROSS INCOME ( 1,5t/ha)</b>	<b>1200</b>	<b>150</b>
<b>GROSS MARGIN per ha</b>	<b>473,00</b>	<b>58,75</b>
per 0,125 ha		58,75
per R100 VC		University of Fort Hare Together in Excellence
per R100 labour		154,61



Potatoes (0,125ha)

Variable costs	per ha	per 0,125ha
Ploughing	14,00	1,75
Discing	8,00	1,00
Ridging	12,00	1,50
Seed	1575,00	197,00
Fertilizer	384,00	48,00
Pesticides	143,00	18,00
Packaging	240,00	30,00
Labour	<u>244,00</u>	<u>30,50</u>
<b>TOTAL</b>	<b>2620,00</b>	<b>327,75</b>
<b>GROSS INCOME (20t/ha)</b>	<b>3700,00</b>	<b>462,50</b>
<b>GROSS MARGIN per ha</b>	<b>1080,00</b>	<b>134,75</b>
per 0,125 ha		134,75
per R100 VC		41,11
per R100 labour		441,18

Cabbages (0,25ha)

Variable costs	per ha	0,25ha
Ploughing	14,00	3,50
Discing	8,00	2,00
Ridging	12,00	3,00
Seed	84,00	21,00
Fertilizer	261,00	65,25
Pesticides	71,00	17,75
Packaging	365,00	91,25
Labour	244,00	61,00
<b>TOTAL</b>	<b>1059,00</b>	<b>264,75</b>
<b>GROSS INCOME (40t/ha)</b>	<b>4000</b>	<b>1000</b>
<b>GROSS MARGIN per ha</b>	<b>2941</b>	<b>735,25</b>
per 0,25 ha	University of Fort Hare Together in Excellence	
per R100 VC		277,71
per R100 labour		205,32

Two cabbage crops will be harvested per year therefore yielding a yearly gross margin of R1470,50.

4.2. LIVESTOCK COMPONENTS

Gross margins have been prepared in two forms for both the duck and pig units. Firstly as a conventional unit for each, utilizing commercial feeds, and secondly as waste consumers with supplementary feeding where necessary.

4.2.1. DUCKS

(a) Conventional Production:

Duck holdings have been calculated on the maximum manure applications possible on a body of water for fish production

i.e. 50kg per half hectare (100 kg/ha) on a daily basis. This would necessitate a continual holding of 300 ducks at any one time, divided into 3 groups.

- (i) 100 ducks purchased.
- (ii) 100 ducks fattening.
- (iii) 100 ducks saleable.

This would require the purchase of 100 ducks per month continually, and the sale of 100 ducks after +80 days.

<u>Variable costs</u>	per 1ha water	per 0,5ha water
Seed (Ducklings)	1680	840
Transport	350	175
Feed	3120	1560
Labour	278	139
<b>TOTAL</b>	<b>5428</b>	<b>2714</b>
<b>GROSS INCOME</b>	<b>12000</b>	<b>6000</b>
<b>GROSS MARGIN per ha</b>	<b>6572</b>	



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per 0,5 ha	3286,00
per R100 VC	121,08
per R100 labour	2364,03

**(b) Duck production from available waste**

From the figures quoted in Chapter 3, waste production from the units will be able to support the equivalent of 22 320 DUCK DAYS, although this will not supply adequate manure for the fish. The gross margin has been limited to this concept i.e. maximum utilization of waste products, with possible lower productivity but certainly a lower risk factor.

22 320 DUCK DAYS for a continual duck holding will necessitate a daily quantity of +62 ducks, on hand at any one time. Therefore resulting in:

- (a) +20 chicks purchased
- (b) +20 ducks fattening
- (c) +20 ducks saleable  
i.e. a monthly purchase of +20 ducks

Variable costs

Seed	176
Transport	175
Feed (as 25% of normal feed)	81
Labour	<u>30</u>
TOTAL	462

GROSS INCOME 981

GROSS MARGIN 519

per R100 VC 112,34

per R100 labour 1730,00



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4.2.2. PIGS

(a) Conventional production

Pig holdings have been calculated to supply the maximum possible manure loadings for 0,5ha of water (50kg of manure/day). This would be supplied by 2 sows producing 1,8 litters per year with 8 pigs/litter grown to baconer weight.

<u>Variable costs</u>	per 1ha water	per 1/2ha water
Feed	5954	2977
Vet	102	51
Labour	198	94
TOTAL	6254	3122
GROSS INCOME	5628	2814
GROSS MARGIN	626	
per 0,5 ha		(308)
per R100 VC	(10,01)	(9,85)
per R100 labour	(316,16)	(311,11)

(b) Pig production from available waste

From figures quoted in Chapter 3 waste production from the unit will satisfy the equivalent of 504 "pig days" (adult pigs). Therefore 1 sow could be supported all year with the remaining waste (696kg) being available for part of the requirement of 1 litter. It is then assumed that this litter of 8 pigs is taken through to baconer weight.

<u>Variable costs</u>	
Feed	82
Vet	16
Labour	<u>27</u>
	125
GROSS INCOME	804
GROSS MARGIN	678
per R100 VC	543,20
per R100 labour	2514,81

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4.2.3. FISH

As two different principles have been used in the calculation of the livestock components, the results of the subsequent choice of which unit to use will affect the size of the fish component.

If it is taken that the livestock component is only used as a means of waste disposal, then the level of manure produced will not be sufficient to sustain a high level of fish production.

The following figures have been taken as standard for intensive fish production from ponds.

1. 20 000 stocked fish fingerlings per hectare of water surface
2. The equivalent of 600 ducks per hectare of water surface  
(a daily "manure loading" of 100 kg of wet manure)

Therefore for the pond area available (0,5ha) the maximum possib-

le stocking if manure loadings were sufficient, would be 10 000 fish fingerlings. It is generally assumed that 20% of the fingerlings will not survive a full production period, therefore 8 000 fish will be available at harvest. These are taken to average 170-200 grams each at the end of the production period, giving a potential harvest of 3 200kg.

Variable costs

Fish fingerlings	600
Transport	150
Labour	<u>79</u>
	829

GROSS INCOME @ 50c/kg	181,33 or
dressed (2/3 of wet	213,33
fish harvest)	197
GROSS MARGIN	-632
per R100 VC	28,70
per R100 labour	30,26



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If fish are only stocked to the level of manure produced from the livestock (as a waste disposer only), then the number of fingerlings can be reduced using a scale of fish to manure loading. So that if 10 000 fish can be stocked in 0,5ha of water with 50kg of manure, then for 60 ducks producing 8kg per day only 1 600 fish may be stocked.

GROSS MARGIN

Fish fingerlings (R6/100)	96
Transport	150
Labour	<u>32</u>
	278

GROSS INCOME @ 50c/kg dressed	
(2/3rd wet fish harvest)	256
GROSS MARGIN	(22)
per R100 VC	(7,9)
per R100 labour	(68,75)

#### 4.3. GROSS MARGIN SUMMARY

<u>Crops</u>	<u>Activity</u>	<u>Area used(m<sup>2</sup>)</u>	<u>GM/ha</u>	<u>GM</u>
Maize		5000	466,50	233,25
Beans		1250	473,00	58,75
Potatoes		1250	1080,00	134,75
Cabbages		2500	2941,00	735,25

#### Livestock

Ducks	(1)	5000	6572	3286
	(2)	5000		519
Pigs	(1)	5000	(626)	(308)
	(2)	5000		679
Fish	(1)	5000		238
	(2)	5000		(22)



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## 5. CAPITAL COSTS

### 5.1. Development Costs (General)

#### 5.1.1. Land cleaning/bush clearing

120 labour days at R3 per day	360	360
-------------------------------	-----	-----

#### 5.1.2. Land levelling, contours initial land preparation

(a) 40 kw tractor travelling at

4,8km/hr will cover ,06ha/hr

Taking at least 3 passes would

require 7,5 hrs to complete

rough levelling of 1,5ha

53

Operator & assistant

27

80

(b) land preparation

ripping University of Fort Hare

27

ploughing

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14

41

(c) contours

±

45

166

#### 5.1.3. Fencing (perimeter)

Bonnox	1060	1600,00	
--------	------	---------	--

corner posts	9	37,80	
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standards	106	180,20	
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droppers	212	106,00	
----------	-----	--------	--

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1924,00

1924

#### 5.1.4. House 8 x 10 80m<sup>2</sup> @ R70/m<sup>2</sup>

5600

toilet

100

---

5700

5700

#### 5.1.5. Shed 3 m diameter

400

400

SUB-TOTAL

8550

5.2 DEVELOPMENT COSTS (allocated)

5.2.1. Ducks

Duck proofing		
chicken wire	430m	402
corner posts	5	21
standards	43	73
droppers	86	43
plain wire	1290	84
anchor wire	100	56

679

Duck house		
3" x 1"x9m x 8 @ ,52/m		37,44
3" x 1"x2m x 16		16,64
3" x 1"x1,5m x 16		12,48
6m x 1,5m x 2"		6,00
54 x 2m cor. iron 3,67/m		396,36
cement x 4 @ R6 each		24,00
nails etc.		40,00

532,92

1212



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5.2.2. Fish

Frog proofing		
concrete paving 400m in 40cm x 40cm x ,05cm		
= ,008cu m/slab x 1000 = 8cu m		
8 cu m concrete = 7,2 cement)		
,65 sand) cu m		
,75 stone)		
57,6 cement		345,60
5,2 cu m sand		on site
5,7 cu m stone @		
R57/cu m		342,90

670,50

labour @ 25% 104,00

5.2.3. Fishing equipment

nets x 25 m	80
baskets 4 x 25kg	100
knives and scalers	20
misc.	100

300

1075

5.3. IRRIGATION

80 mm P V C pipe x		
150400/m	600	
80 mm non-return		
valve	200	
irrigation pipes	1000	
sprinklers 6 x R20	120	
drag lines 6 x 50mm	200	
pump	1000	
	<hr/>	
	3120	3120
<b>TOTAL</b>		<b>13957,00</b>



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6. CONCLUSION

Planning a unit of this nature tends to include factors that might not normally be considered in other business planning ventures, and at the same time disregards, to a degree, factors which would be considered in the same planning exercise.

This unit and many others like it are designed primarily as efficient resource utilizers, and not on maximizing profits. Further, little consideration is given to capital availability at the outset of planning, and even less to capital usage and returns. This creates problems in rural development planning, and this is compounded further by the inclusion of a "Fish" component into the plan, for the following reasons:

1. It has no tried and tested predecessor in Southern Africa in a commercial field,
2. it is relatively new to rural development,
3. it does not compete in prices with other acceptable commodities (in this context), and
4. it has a rather dangerous romantic appeal.



Without going into "planning procedures" on capital availability, but only considering return on capital invested, or even more simply, a gross margin assessment using the stated figures in this report the following results should be considered, assuming that the controls on land and water availability remain as constants.

1. land available for agriculture = 1ha
2. water - 5000m<sup>3</sup> held in 3 dams totalling 0,5ha

Capital investment for the unit can be broken down into:

Basic development costs	8550
Irrigation equipment	<u>3120</u>
	11670

This figure will apply only to the cropping side of the unit. If this capital could be invested at a nominal rate of 15% per annum, this would result in a return of R1 283-70 per annum or +R107/month.

MAIZE the gross margin for 1ha of maize has been calculated as R466 and basic development costs are stated as R8 550 with an additional R3 120 for irrigation equipment if required.

All crops have been taken to have a water requirement of 550mm which would necessitate the storage of 5 500 m<sup>3</sup> litres of water, used in a very short period. The dams are only capable of storing 5 million litres, and therefore an additional 0,5 million litres would be required (pumped from the river).

Therefore the total capital outlay is R11 670 for the annual gross margin of R466,50 which occurs over a +5 month period, whereas the return on investment for this period is R535.



BEANS the gross margin of 1 ha of beans has been calculated as R473 and has the same development costs as maize i.e. R8 550 with the additional irrigation costs of R3 120.

Therefore with a total capital outlay of R11 670, the gross margin is R473 with an interest return of R374 if invested for the same period i.e. three and a half months.

POTATOES the gross margin for 1 ha of potatoes has been calculated as R1 080 and will have the same development costs.

Therefore for an outlay of R11 670 the return of R1 080 over 5 months, represents nearly a 100% increase on the possible return if the capital was invested at 15% for the same period. (R535 for the 5 month period).

CABBAGES the gross margin per crop of 1 ha of cabbages has been calculated as R2 941 with the same development costs.



FISH production of fish from maximum waste loading using the figures stated has a per hectare gross margin of R476. This is possibly a conservative figure, but experience has shown that the market can be very flexible in price, depending on the availability of other products.

The capital needed for fish production is mostly for harvesting equipment, and the total outlay has been calculated as R300. This has an annual interest rate of R45, (providing that the dams have been built for other purposes).

TABLE 1

SUMMARY OF GROSS MARGIN RATIO TO INVESTMENT INTEREST.

	GM/ha	Invest/ha	Interest at 15%	% increase of GM over int.
Maize	473	11670	375	27%
Potatoes	1080	11670	535	102%
Cabbages	2941	11670	428	587%
Ducks	32000	21911	3285	814%
Pigs	25630	346562	51975	-
Fish	476	300	45	958%

TABLE 2

GROSS MARGIN PER R100

	GM	Capital invested	GM per R100
Maize	233	13957	1,67/100
Beans	59	"	,42/100
Potatoes	135	"	,97/100
Cabbages	1471	"	10,54/100
Ducks	510	"	3,72/100
Pigs	679	"	4,86/100
Fish	(22)	"	-,16/100

TABLE 3

GROSS MARGIN PER UNIT EFFORT

	GM	Unit effort(hrs)	GM/hr
Maize	233	177	1,32
Beans	59	104	,56
Potatoes	135	135	1,00
Cabbages	1471	352	4,18
Ducks	579	215	2,41
Pigs	679	215	3,16
Fish	(22)	182	-,12

The livestock and fish figures in tables 2 & 3 have been taken as applying to only a waste utilization production level, and a choice must be made between ducks or pigs firstly, and secondly whether fish should be stocked at all as the manure from either livestock unit could be disposed of in other ways i.e. compost.

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In the choice between ducks and pigs, it is interesting that in the general overview of the whole unit, there will be very little regular income, and by selecting ducks, this could provide the farmer with a handy income on a monthly basis. Pigs have an advantage in that they will consume "stale" waste, which will relieve the farmer of certain management criteria i.e. collecting waste on a daily basis. (However this could also have a negative effect by allowing the farmer less managerial interest in his operation - which might gradually spread to other management areas). With this it would seem that ducks would be the best choice within this system.

TABLE 4

<u>Enterprise</u>	<u>GM per R100 VC</u>	<u>GM per R100 labour</u>
Maize	66,01	376,21
Beans	64,34	154,61
Potatoes	41,11	441,18
Cabbages	277,71	1205,32
Ducks (conven. prod.)	21,08	2364,03
Ducks (from waste)	112,34	1730,00
Pigs (conven. prod.)	(9,85)	(311,11)
Pigs (from waste)	543,20	2514,81
Fish (conven. prod.)	28,70	301,26
Fish (from waste)	(7,9)	(68,75)

From this table, either form of fish production i.e. that of production utilizing the maximum manure loading, or production utilizing manure from a restricted livestock component, fall well down on the list. (7th & 9th on GM per R100 VC and GM per R100 labour).

The fundamental issue within this unit plan is the inclusion of any fish component and towards solving this dilemma. Two questions may be raised:

1. How does the return on investment of labour and capital and VC compare to other enterprises?
2. With these returns, is it worth including a component, that will require new management and marketing techniques, as well as an added dimension of training, and are there personnel available to satisfy these demands?

It is felt and has been stated in this paper, that within the present context of Fish Farming or Aquaculture in South Africa, the National and Independent states, fish within this type of plan should be seen only as a BONUS.

Fish farming can be a PROFITABLE venture, however as has been shown here it is not as profitable as other forms of agriculture, and therefore must be considered carefully. Efforts could be made to make Fish Farming more profitable, i.e. if two very basic items were brought within a commercial field of operations. Firstly the cost of fish seed; this has been costed at prices for tilapia from Amalinda Fish Station. If these fish could be produced by the farmer, this would cost approximately R100 for a 4m diameter portapool tank, which if stocked with an adult male and female tilapia would produce over 2 000 fingerlings per annum under these conditions. This would therefore cost R2 per 100 instead of R6 per 100 and at the same time would cut out all transport costs, which is an expensive item when transported from East London or other hatcheries.

Taking these figures the following would apply:

Fish seedlings  
 Transport  
 Labour



GROSS INCOME	256
GROSS MARGIN	192
per R100 VC	300
per R100 labour	600

This changes the picture rather remarkably - but it will only apply on a small scale.

This would place fish first on the table of GM per R100 VC and fifth on GM per R100 labour. However, as stated this would only apply on a small scale i.e. producing 512 kg of fish.

RECOMMENDATION:

Fish Farming does not compete with the other enterprises in this unit, and therefore it is suggested that it is not pursued at present within this plan unless:

1. As this is a demonstration unit, returns are not considered as important as they normally would be in a commercial unit,
2. That the prospective farmer specifically wishes to go "Fish Farming" and is therefore prepared to accept the lower return,
3. That the constraints on fish farming (conservation, legal, financial, technological, marketing and seed availability) are recognized, and efforts are made to change them.



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UNIVERSITY OF FORT HARE

AGRICULTURAL & RURAL DEVELOPMENT RESEARCH INSTITUTE (ARDRI)

BRIGHTON FISH STATION : COSTS AND QUANTITIES

PHASE ONE

1. SEDIMENTATION TANKS

Dimensions :

- (a) 23 m x 35 m x 2 m (measured centre crest to centre crest)

SURFACE AREA 800 sq m

+ 1,5 million litres

- (b) 24 m x 31 m x 2 m (measured centre crest to centre crest)

SURFACE AREA 740 sq m

+ 1,25 million litres



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(SIDE SLOPE = 2 : 1)

TOTAL of + 2,75 million litres

Minimum consumption of 6 /day = 5 day supply

Maximum consumption of 28 /day = 1 day supply

Construction in Earth Total earthworks involved 2022 cu m

2(a) TERRACES FOR NURSERY PONDS

Dimensions :

- (a) 10 m x 20 m x ,3 m = 60 cu m

- (b) 12 m x 30 m x ,3 m = 108 cu m

TOTAL = 168 cu m concrete

Mix = 7,2 sk cement  
 ,65 m<sup>3</sup> sand      cu m concrete  
 ,72 m<sup>3</sup> stone

Total requirements :

1210 sk cement	@	R3.50/sk	R4 235,00
110 m <sup>3</sup> sand			
121 m <sup>3</sup> stone			

2(b) TERRACE STEPS

Dimensions :

(a) 20 m x ,3 m x ,3 m x 3 m = 1080 bricks

(b) 30 m x ,3 m x ,3 m x 3 m = 1620 bricks

TOTAL BRICKS = 2700 bricks @ R60/1000 162,00

Mix = 33% cement : 200% ( ,2 m<sup>3</sup> sand

Requirements = 380% mix/1000 bricks (1026% of mix)

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Total requirements :

5 sk cement	@	R3.50	17,50
1 m <sup>3</sup> sand			

2(c) PLASTER

Dimensions : 1 cu m of plaster

Mix = 8,8 sk cement      cu m  
 1,27 m<sup>3</sup> sand

Total requirements :

9 sk cement		31,50
1,5 m <sup>3</sup> sand		

# TILAPIA BREEDING ARENA

Dimensions :

(a) Floor area =  $106 \text{ sq m} \times ,15 \text{ m} = 16 \text{ cu m concrete}$

Requirements = 116 sk cement @ R3,50 R406,00  
10,5 m<sup>3</sup> sand  
12 m<sup>3</sup> stone

(b) Side slope  $80 \text{ sq m} \times ,15 \text{ m} = 12 \text{ cu m concrete}$

Requirements = 87 sk cement @ R3,50 304,50  
8 m<sup>3</sup> sand  
9 m<sup>3</sup> stone

(c) Channel  $46 \text{ sq m} \times 3 = 138 \text{ x } ,15 \text{ m} = 21 \text{ cu m concrete}$

Requirements = 151 sk cement @ R3,50 528,50  
14 m<sup>3</sup> sand  
15,25 m<sup>3</sup> stone

(d) Vertical sides of internal area

Dimensions =  $38 \text{ sq m} @ 60 \text{ bricks/sq m}$

2280 bricks R60/1000 136,80

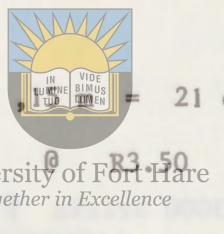
6847 mix

Requirements = 3 sk cement @ R3,50/sk 10,50  
,75 m<sup>3</sup> sand

(e) Reinforcing

6 lengths x  $46 \text{ m} \times 12 \text{ mm} @ ,53\text{c/m}$  146,28

(1532,00)



#### 4. NURSERY PONDS

Dimensions :

(a) 3,6 m x 1,2 m Porta Pool

Requirements = 10 @ R290 each R2 900,00  
Plus R16 each fitting 160,00

(b) 1,15 m x 1,7 m galvanised tank

Requirements = 10 @ R125,60 each 1 256,00  
(4 316,00)

#### 5. WATER FILTER

Dimensions :

3 m x 3 m x 2 m

Requirements = 3000 bricks @ R60/1000 180,00  
5 sk cement @ R3,50 17,50  
1 m<sup>3</sup> sand

Fittings extra 200,00



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#### 6. CARAVAN SITE/ABLUTIONS/STORAGE HUT

Ablutions : Toilet 130,00  
Storage hut 3,7 m dia 315,00

7. PIPES AND FITTINGS

50 mm	class 3	40 m	R3,21/m	R128,40
80 mm	class 3	560 m	3,34/m	1870,40
50 mm	stop cock	20	15,00	300,00
80 mm	" "	5	46,40	232,00
80 mm	elbow	1	10,00	10,00
80 mm	+ join	20	11,00	220,00
80-50 mm	reducer	20	3,50	70,00
80 mm	T piece	2	10,65	21,30

(2 852,10)

8. LABOUR



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Casual labour (Excluding Heavy Earthworks)

+ 200 labour days @ R2,50/day 500,00

SUMMARY OF COSTS

TOTAL REQUIREMENTS :

Cement	1586	@	R3,50 each	R5 551,00
Sand	146,75			
Stone	157,25			
Bricks	7980	@	60/100 (say 8000)	480,00

Ponds	R4 316,00
Pipes and Fittings	2 852,10
Toilet	130,00
Shed	315,00
Reinforcing	146,26
Labour	500,00

**COST PHASE ONE**

**R14 290,36**

**PHASE TWO**

**1. FENCING**

Length of Fence = 1 km

**Requirements :**

Gates - 2	@	R40 each	80,00
proof Bonnox		57c/m	570,00
Posts :			
36 corner posts		R10,00	360,00
50 standards		R3,00	150,00
100 droppers		R0,20	20,00
			(1 180,00)



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**2. SLAB TILES SURROUNDING PONDS**

Dimensions : ,3 m x ,3 m x ,05 m for 710 m = 4 cu m

**Requirements :**

29 sk cement	@	R3,50	101,50
3 m <sup>3</sup> sand			
3,5 m <sup>3</sup> stone			

MONKS

Total = 0,3 cu m concrete

Requirements = 3 sk cement

,25 m<sup>3</sup> sand

,3 m<sup>3</sup> stone

per monk

6 monks

= 18 cement @

1,5 m<sup>3</sup> sand

2 m<sup>3</sup> stone

R3,50

R63,00



Mould = 4 sq m wood @ R6/sq m (University of Fort Hare etc)

24,00

(87,00)

PIPES AND FITTINGS

150 mm	PUC	535 m	R6/m	3 210,00
80 mm	class 3	110 m	R334/m	367,40
150 mm	valve	2	R232,00	464,00
80 mm	"	7	R46,40	324,80
50 mm	"	1	R15,00	15,00
150mm-80mm	T piece reducer	6	R31,70	190,20
80 mm	T piece	2	R10,65	21,30
80-50mm	reducer	1	R3,50	3,50

(R4 596,20)

5. LABOUR

Casual labour

+ 50 labour days @ R2.50/day

R125,00

SUMMARY

TOTAL REQUIREMENTS :

Cement 47 sk  
 Sand 4,5 m<sup>3</sup>  
 Stone 5,5 m<sup>3</sup>

@ R3,59/sk

164,50

Fencing

1 180,00

Pipes and Fittings

4 596,20

Labour

125,00

TOTAL COST PHASE TWO

R6 065,70

PHASE THREE

House/lab/store

Approximate cost

R10 000,00

VOLUME OF EARTHWORKS INVOLVED

Basic dimensions                    2 m wide crest  
   2 m wall height  
   2 : 1 slope on all walls

No spillways involved

Ponds = 4 555 cu m

Sed tank = 2 022 cu m

TOTAL EARTHWORKS    6577 cu m

TOTAL COST

Phase 1                    14 290,36

Phase 2                    6 065,70

Phase 3                    10 000,00

Contingencies            1 000,00

R31 356,06



**GIBRALTER ROCK SEED STATION****QUANTITY AND COST ESTIMATES****1.1 EARTHWORKS****1.1.1 Header Dam**

Dimensions average 27m x 7m x 2m (measured inside crest to inside crest)

Construction earth and plastic lined (full water level 1,5m)

**Volume of Earthworks**

$$\begin{aligned} \text{a) } v &= 0,216 \times H \times Lc (2c + HS) \\ &= 0,216 \times 2 \times 27 (2 \times 2 + 2 \times 10) \\ &= 11,66 (4 + 20) \\ &= 11,66 (24) \\ &279,84 \text{ cu m} \end{aligned}$$

$$\begin{aligned} \text{b) } v &= 0,216 \times H \times Lc (2c + HS) \\ &= 0,216 \times 2 \times 27,5 (2 \times 2 + 2 \times 10) \\ &= 11,88 (24) \\ &285,12 \text{ cu m} \end{aligned}$$

$$\begin{aligned} \text{c) } v &= 0,216 \times 2 \times 8 (2 \times 2 + 2 \times 10) \\ &= 2,59 (24) \\ &62,16 \text{ cu m} \end{aligned}$$

$$\begin{aligned} \text{d) } v &= 0,216 \times 2 \times 8 (2 \times 2 + 2 \times 10) \\ &= 3,45 (24) \\ &82,94 \text{ cu m} \end{aligned}$$

Total ± 711 cu m Earthworks

Total capacity = 405 000 Litres

**1.1.2 Polyculture Ponds**

Dimensions 20m x 20m x 2m (measured inside crest to inside crest)

Construction earth (full water level 1,5m)

**Volume of Earthworks Involved**

$$\begin{aligned} v &= 0,216 \times H \times Lc (2c + HS) \text{ cu m} \\ &= 0,216 \times 2 \times 22 (2 \times 2 + 2 \times 9) \\ &= 9,5 (22) \\ &209 \text{ cu m per wall} \end{aligned}$$

$$\begin{aligned} \text{a) } &1 \text{ full wall} + 2 \text{ half walls} = 2 \text{ walls @ } 209 \text{ cu m} \\ &= 418 \text{ earthworks per dam} \end{aligned}$$

$$\text{b) } 2 \text{ dam } \therefore = \underline{836 \text{ cu m earthworks}}$$

Capacity of ponds = 486 000 litres each or Tot 972 000

**1.1.3 Breeding Ponds**

Dimensions 8 x 8 x 1,5m (measured inside crest to inside crest)

Construction earth (full water level 1m)

Volume of Earth Works Involved

$$\begin{aligned} v &= 0,216 \times H \times Lc (2c + HS) \\ &= 0,216 \times 1,5 \times 10 (2 \times 2 + 1,5 \times 5) \\ &= 3,24 (11,5) \\ &37,26 \text{ cu m per wall} \end{aligned}$$

a) 1 full wall + 2 half walls = 2 walls @ 37,26 cu m = 74,52 cu m per dam

b) 8 dams = 596,16 cu m earthworks

Capacity of ponds = 49 000 litres each = Total 432 000 litres

1.1.4 Earth Structures Summary and Costs

Header dam	711 cu m
Polyculture ponds	836 cu m
Breeding ponds	596 cu m
Leveling	<u>800 cu m</u>
	<u>2 944 cu m</u>

Quoted cost of R3,50 per cu m = R10 304,00

1.1.5 Total Capacity of Units

a) Total water requirements for filling unit for capacity

1 Header dam @ 405 000ℓ	405 000
2 Polyculture ponds @ 485 000ℓ	972 000
8 Breeding ponds @ 49 000ℓ	432 000
3 Tilapia tanks @ 230 000ℓ	690 000
10 3m Fibreglass tanks @ 11 000ℓ	110 000
10 1m Fibreglass tanks @ 1 200ℓ	<u>12 000</u>
	2 621 000ℓ

Of these units, the Tilapia tanks and the fibreglass tanks will be using water constantly requiring a total change of water every 5 days

Thus 812 000ℓ over 5 days = 162 400ℓ per day

OR 1,8ℓ per second

The requirements for a pump needs therefore to supply a minimum of 1,8ℓ per second and preferably a further 2,6ℓ per second to fill a Tilapia tank on a given day

Therefore pump required 1,8 + 2,6 = 4,4ℓ per second

Total distance = 170m

Total head = 25m

1.2 CONCRETE WORK

1.2.1 Tilapia Tanks

Dimensions 14m total diameter x 1,5 total height  
Constructions brick and concrete

### Floor Area

$$D^2 \times ,7854 = 15,2 \times 15,2 \times ,7854 \\ = 181,5$$

$$\text{quantity of concrete} = 181,5 \times ,2 \\ = \underline{36,3 \text{ cu m concrete}}$$

### Inside Wall(B) (Brick and Plaster)

$$\text{area} = dh = x 10 \times 1,5 \\ = 47,1 \text{ m}$$

$$47,1 \text{ m} @ 60 \text{ bricks per m} = \underline{2 826 \text{ bricks}}$$

$$47,1 \text{ m} @ ,04 \text{ m} = \underline{2 \text{ cu m plaster}}$$

### Outside Wall (C) (Brick)

$$\text{area} = dh = x 14 \times 1,495 \\ = 65,7 \text{ m}$$

$$65,7 \text{ m} @ 120 \text{ bricks per m} = \underline{7 884 \text{ bricks}}$$

### Outside Wall (E) (Brick and Plaster)

$$\text{area} = dh = x 15 \times 1,495 \\ = 70,4 \text{ m}$$

$$70,4 \text{ m} @ 60 \text{ bricks per m} = \underline{4 224 \text{ bricks}}$$

$$70,4 \text{ m} @ ,02 \text{ m} = \underline{1,4 \text{ cu m plaster}}$$

### Channel (D) (Concrete)

$$\text{Total concrete} = x 15 = 47,1$$

$$= 47,1 \times ,3 \times ,2$$

$$= \underline{2,86 \text{ cu m concrete}}$$

### Foundations

$$\text{a) } 47,1 \times ,225 = 9,5$$

$$\text{b) } 44 \times ,3 \times ,225 = 2,97$$

$$\text{c) } 20 \times ,3 \times ,225 = \underline{1,35}$$

13,82

14 cu m concrete

### Reinforcing

$$6 \text{ lengths} \times 47,1 \times 12 \text{mm}$$

282,6m

#### 1.2.2 Floor for Fibreglass Tanks

$$\text{area} = 29 \times 14 \text{m} = 406 \text{ m}$$

$$\text{concrete} = 406 \times ,3 = 121 \text{ cu m}$$

#### 1.2.3 Concrete Drainage Furrows (Precast)

+ 390m furrow 30cm side and bottom 5cm thick

$$390 \times (,3 + ,3 + ,3) \times ,05 =$$

$$390 \times ,9 \times ,05 = 17,55 \text{ cu m}$$

#### 1.2.4 Summary Quantities and Costs

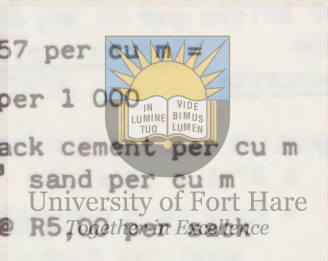
Tilapia tank concrete

36,3 cu m

	2,86	
	14,00	
	121,00	
	<u>17,55</u>	191,71 cu m
bricks	2 826	
	7 884	
	<u>4 224</u>	14 934 bricks
plaster	2,00	
	1,4	
	(3,4)	
plaster for bricks	380¢ per 1 000 bricks	
	(5,7)	9,1 cu m

**Concrete Mix = B**

7,2 sack cement per cu m	1 380,3 sack cement	
,65m <sup>3</sup> sand per cu m	124,61m <sup>3</sup> sand	
,72m <sup>3</sup> stone per cu m	138,0m <sup>3</sup> stone	
1 380 @ R5,00 per sack =		R6 901,50
sand on site		
138 stone @ R57 per cu m =		7 866,00
bricks @ R90 per 1 000		1 350,00
plaster 8,8 sack cement per cu m	80,08 sack cement	
1,27m <sup>3</sup> sand per cu m	on site	
80,8 @ R5,00 per sack		400,00
cement	6 901,50	
	<u>400,00</u>	
	7 301,90	7 301,90
sand	on site	
stone		7 866,00
bricks		<u>1 350,00</u>
Tilapia tanks total R17 534 + R10 673		<u><u>R28 207,00</u></u>



**1.3 OTHER STRUCTURES, PIPES AND FITTINGS, FENCING**

**1.3.1 Fibreglass tanks (SABS)**

10 x 3 m dia x 1mh tanks @ R390 each	3 900,00
10 x 1m dia x 1mh tanks @ R290 each	<u>2 900,00</u>
	<u><u>R6 800,00</u></u>

**1.3.2 Monks**

110mm flexible hose total 28m @ R18 per metre	504,00
90mm PVC pipe 214m @ R4 per metre	<u>856,00</u>
	<u><u>R1 360,00</u></u>

1.3.3 / ...

### 1.3.3 Pipes and Fittings

a) Inlet pipe 170m	90mm @R4,24 per metre	7 208,00
b) Outlet and delivery pipes		
80mm class 3	378m @ R3,84 per metre	1 451,52
50mm class 3	127m @ R3,69 per metre	468,63
		<u>R1 920,15</u>
c) Fittings		
80mm stop cock	13      53,36	693,68
elbow	8      11,50	92,00
T-piece	15     12,25	183,75
+-join	20     12,65	253,00
50mm stop cock	23     17,25	396,75
T-piece	5      8,00	40,00
80-50mm reducer	20     4,02	80,40
		<u>R4 380,53</u>

### 1.3.4 Fencing

a) Boundary Security Fence 567m		
2m h diamond mesh 2,0mm wire @ R2,28 per metre		1 292,76
81 standards @ R3,25 each		263,25
corner and gate posts 84m		336,00
		<u>R1 892,01</u>
b) <u>Internal Fencing</u> 150m		
Bonnox fencing @ R0,57 per metre		85,50
24 corner posts @ R6 each		144,00
25 standards @ R3 each		75,00
		<u>R2 196,51</u>



## 1.4 HOUSING

### 1.4.1 House and Laboratory

a) House 15 x 8	120 @ R280	33 600,00
b) Lab 15 x 5	75 @ R280	21 000,00
		<u>R54 600,00</u>

### 1.4.2 Labour House

5 x 8	40 @ R280	11 200,00
		<u>R65 800,00</u>

## 1.5 LABOUR

Casual labour required for building, fencing and pipe laying

Tilapia tanks	25 labour days per tank
concrete flooring	15 labour days
fencing	46 labour days
pipes	35 labour days
furrows	25 labour days
general	<u>30 labour days</u>
	226 labour days

Total / ...

Total labour days 226

wage labourer	R2,50	181 days	454,50
wage brick layer	8,00	15 days	120,00
wage foreman	8,00	30 days	270,00
			<u>R842,50</u>

## 1.6 MACHINERY AND EQUIPMENT

1.6.1	Transport LDV		9 000,00
	Boat		2 000,00
1.6.2	Laboratory equipment		5 000,00
	breeding tunnel	3 000	
	tunnel frames		
	plastic containers	1 000	
	microscopes	500	
	stainless steel container	500	
1.6.3	Fish transporter	oxygen cylinder and fittings	1 000,00
1.6.4	Pumps and plants	x 2 (1 standby)	2 200,00
1.6.5	Lawn mower		500,00
1.6.6	Demand feeders	13 @ R100 each	1 300,00
1.6.7	Tractor and trailer	for transport of fish and feed	5 000,00
1.6.8	Office equipment		2 000,00

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## 1.7 SALARY AND WAGES

1.7.1	Fisheries officer	(R10 000 x 500 - R12 000)
1.7.2	Labourer (permanent)	(R960 x 90 - R1 320)
1.7.3	Casuals	(R900)

## 1.8 RUNNING EXPENSES AND CONSUMABLES

1.8.1	Transport	48 000km @ R0,25 per km	12 000,00
1.8.2	Fish feed	@ R500 per month	6 000,00
1.8.3	Laboratory equipment	(glassware, chemicals, hormones)	3 000,00
1.8.4	Office equipment, stationery		400,00
1.8.5	Nets	@ R30,00 each	150,00
1.8.6	Travel and subsistence	@ R30 per day for 30 days	1 000,00

## 1.9 MAINTANCE

1.9.1	Ponds and tanks		1 000,00
1.9.2	Buildings		600,00
1.9.3	Laboratory		400,00
1.9.4	Mach and Equipment		800,00

**CAPITAL COSTS**

Item	83	84	85	86	87
<b>(As per Quantity Report)</b>					
1 Earthworks for dams and leveling	5 813,00	1 565,00	2 926,00		
2 Concrete works for tanks, floor slab, furrows	28 207,00				
3 Fibreglass tanks	3 400,00	3 400,00			
4 Monks	372,00	744,00	244,00		
5 Pipes and fittings	4 380,00				
6 Fencing	2 197,00				
7 House, laboratory, labour house	65 800,00				
8 Labour costs and -development	843,00				
1.6.1 LDV	9 000,00				
Boat, engine, trailer	2 000,00				
1.6.2 Laboratory equipment	2 000,00	3 000,00			
1.6.3 Fish transporter	1 200,00				
1.6.4 Pumps and motors	2 200,00				
1.6.5 Lawn mower	200,00				
1.6.6 Demand feeders		1 300,00			
1.6.7 Tractor and trailer	5 000,00				
1.6.8 Office equipment	2 000,00				
	134 712,00	10 009,00	3 170,00		

**RUNNING EXPENSES, CONSUMABLES AND SALARIES**

ESTIMATED

Items	83	84	85	86	87
1.7.1 Fisheries officer	10 000,00	10 500,00	11 000,00	11 500,00	12 000,00
1.7.2 Labour	960,00	1 050,00	1 140,00	1 230,00	1 320,00
1.7.3 Casuals	900,00	900,00	900,00	900,00	900,00
1.8.1 Transport 48 000km @ RO,25	12 000,00	12 000,00	12 000,00	12 000,00	12 000,00
1.8.2 Feed @ 15% increase per year	6 000,00	6 900,00	7 935,00	9 125,00	10 494,00
1.8.3 Laboratory equipment @ 15% increase per year	3 000,00	3 450,00	3 967,00	4 562,00	5 247,00
1.8.4 Office equipment @ 15% increase per year	400,00	460,00	529,00	608,00	699,00
1.8.5 Nets @ 15% increase per year	150,00	172,00	198,00	228,00	262,00
1.8.6 Travel and subsistence @ 15% increase per year	1 000,00	1 150,00	1 322,00	1 520,00	1 749,00
Maintenance					
1.9.1 Ponds and tanks		1 000,00	1 000,00	1 000,00	1 000,00
1.9.2 Buildings		600,00	600,00	600,00	600,00
1.9.3 Laboratory equipment		400,00	400,00	400,00	400,00
1.9.4 Machinery and equipment		800,00	800,00	800,00	800,00
	34 410,00	39 582,00	41 791,00	44 473,00	47 471,00



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NET MOUNTING INDUSTRY STUDY.INTRODUCTION

A five tonne fish gill-net, made-up and ready for use, was seen to be used in South Africa. Throughout the countries of Africa and East Africa, the gill-net is used for catching fish of various types of fish. The gill-net is made-up and ready for use. The main reasons for this are as follows:

**A WORKING PAPER TO ESTABLISH THE FEASIBILITY OF****A NET MOUNTING INDUSTRY.**

The net is made-up and ready for use, and is therefore inexpensive to handle. It does not require the use of any equipment, and is made-up and ready for use. It is not the only way used to fish in the area, which catches itself.

It is possible to make-up and ready for use, and is therefore inexpensive to handle. It does not require the use of any equipment, and is made-up and ready for use.



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BY: P B N JACKSON (J L B SMITH INSTITUTE OF ICHTHYOLOGY)

PROF D R TAPSON

A J ROSE.

## NET INDUSTRY FEASIBILITY STUDY.

### 1. INTRODUCTION

A firm demand for gill-nets, made-up and ready for use, has been found to exist in South Africa. Throughout the continent of Africa, and South Africa is no exception, gill-nets are by far the most popular type of fishing gear both for commercial and research purposes. The main reasons for this are as follows:

- The net is a form of stationary gear, and is therefore inexpensive to operate. It does not require the energy or equipment necessary to move gear such as trawls and seines. Once it is set, the only energy used is that by the fish, which catches itself.
- Besides being cheap to operate it is much cheaper to buy than trawls and seines.
- It is simple to operate, and its use is easily taught to unskilled persons.
- It can readily catch fish on rocky shores, or among dead trees in dams, where moving gear cannot be operated.



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Notwithstanding these advantages and the widespread use of gill-nets, they are not as yet readily obtainable in South Africa. The reason is historical. Gill-nets are an essential tool for both the exploitation of our fresh-water fish resources and the consequent necessary experimental research, and these activities have only recently been started. This is in contrast to other African countries, most of which, even if small, have a gill-net factory. This has resulted in the following constraints and disadvantages being experienced by anyone wishing to buy a gill-net either for industrial or research use in South Africa:

- 1.1. Ready-made gill-nets from coastal vendors are made primarily for the sea fishing market, especially for mullet (harders), and therefore made of heavier twine and obtainable only in one or two mesh sizes.

- 1.2. Proper freshwater gill-nets are usually imported as blanks (not made up with head and foot ropes, floats and leads) from Asia or Europe.
- 1.3. They must either be ordered through an agency, therefore with handling costs added, or imported directly by the operator with all the necessary permits and documentation which this entails. In either case the process is subject to long delays.
- 1.4. They must usually be ordered in quantity, such as 20 or more of each mesh size, which is highly inconvenient and expensive for the operator needing only one or a few nets of any particular size.
- 1.5. Once obtained, the operator must mount the nets himself before he can use them.

These difficulties, and especially 1.5. have induced the Zoology Department of University of the North to investigate the mounting of nets in some detail. As a result (Polling, 1979) detailed instructions for the whole process of gill-net mounting have been developed and can be followed by any proposed industry.



A good opportunity exists for a "cottage industry" to be set up in a homeland for the mounting of gill-nets from imported blanks, to be followed later as experience dictates by the weaving of blanknets locally. It is proposed in this paper that such an industry be established in the Ciskei, preferably in association with the Amatola Basin project. A main objective is the provision of rural employment (see 3.3. below), and the "light industry" nature of a gill-net factory, though having the advantage of being an advance on what is already being done in the Amatola Basin, nevertheless fits in very well with this purpose.

## 2. DEMAND FOR GILL-NETS AND OTHER PRODUCTS.

As a result of enquiries it would appear that most official and academic agencies with an interest in freshwater development, research and conservation are interested in the purchase of ready-mounted nets. The following is a partial list:

Agricultural and Rural Development Research Institute, University of Fort Hare; Buffalo River Study Group, Institute of Freshwater Studies, Rhodes University; Cape Provincial Administration Department of Nature Conservation; Department of Agriculture and Forestry; Nature Conservation Division, Ciskei; Department of Co-operation and Development, South African Government; Institute of environmental Science, University of Natal; J L B Smith Institute of Ichthyology, Grahamstown; KwaZulu Government Department of Nature conservation; Natal Parks, Game and Fish Preservation Board; National Institute for Water Research, CSIR, Pretoria; Orange Free State Provincial Administration, Department of Nature Conservation; Tompi Seleka Agricultural College, Lebowa; Transvaal Provincial Administration, Division of Nature Conservation; Rand Afrikaanse University Department of Zoology; University of Fort Hare Department of Zoology; University of Transkei department of Zoology; University of Zululand Department of Zoology.

A market for net products therefore exists, and there would seem to be a reasonable chance of financial success for such a venture. Further information as to the quantities and mesh sizes required by these institutions and the private sector is needed before and accurate assessment can be made. A Market Survey of these Institutions should therefore be carried out.



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Whatever the demand may be it should be recognised that gill-nets are fragile articles with a short working life, the more they are used the less the life span. The value of the fish caught is high during the life of the net, giving a good return on the relatively minor outlay. For this reason, there is a high turnover rate, and additional services should be offered to consumers (remounting nets onto the old head and foot ropes).

At an early date after the establishment of the industry an advertising programme will be initiated in agricultural journals such as "Landbouweekblad" and "The Farmers Weekly". In this regard it is important to note that the proposed factory will be the only source in the country where nets in various mesh sizes, whether bland or mounted, will be available in ones and twos, rather than bulk as at present.

### 3. MODUS OPERANDI

#### 3.1. Site

It is proposed to site the industry in the Amatola Basin and Tyumie Valley, where other small homecraft industries are being developed, and also for reasons given in 3.3. below. The selected area has been approved and allocated by the local authority and Ciskei Government Department of Planning, and is immediately available for the development of the industry.

#### 3.2. Labour-force

Since the manufacture of gill-nets is not physically arduous (except perhaps for the cutting of the 8-gauge wire, which is a relatively small part of the total work), it is recommended that the work force should exist predominantly if not entirely of women, who will be employed on a piece work basis. Any heavy job of short duration could be done by casual labour.

#### 3.3. Forms of Association

As stated above the primary objective of this project is to promote a simple industry not requiring heavy machinery, access to railways, etc, which will enable the providing of employment in a rural area of Ciskei. This is a main reason for the choice of the Amatola Basin as a site. Like any rural area it faces however the difficulty that continual supervision by an extension officer is not possible. Thus no sort of communal association, such as the simple village community where the workers make the article and sell it directly, or club together to do so, or form a co-operative where the workers have shares and employ a treasurer and/or secretary, is possible. Such associations will almost certainly fail unless constantly supervised, and tend to deteriorate rapidly once supervision so removed for any reason.

Because of these constraints it would appear best for the industry to be initiated through an entrepreneur, advised by a Management Board on which ARDRI, its consultants, and local authority would be represented, as a prelude to the formation of a



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limited liability company with various local interests as shareholders. such a board could be an agency of the Amatola Basin Development Project, an independant body. It would train the intreprenuer using ARDRI staff and consultants, for which a fee would be paid to ARDRI.

### 3.4. Work Procedure

A very high standard of product should be aimed at, through thorough initial training and a good standard of supervision thereafter. This will establish and maintain a good reputation for the product which will greatly help to promote sales, probably even from meighbouring regions.

Working on the task system should be encouraged from the first, to ensure maximum efficiency of out-put. Labour will be paid 6c/float for making the top rope, 3c/metre for cutting and inserting wire for the bottom rope, and R4-00/net for mounting. Giving a total labour cost of R1.00 per net.



Nets will only be made on order, as the requirements of the consumer will tend to differ.

As their skill and efficiency increases the labour will soon be able to take home more pay each day than the minimum wage, while still working fewer hours than the average working week.

### DEVELOPMENT PROGRAMME

It is recommended that development should be stepwise, starting small and developing as experience is gained. Initially the minimum of capital input is envisaged. Despite the fact that prospects of success of the project are good, capital investment should be as far as possibnle of material which can be sold if it proves unsuccessful as a matter of caution. At the same time however, the buildings, though simple and inexpensive, should be capable of being added on to in case of future expansion.

With these considerations in mind the minimum building requirements are a long open-walled shed along which a 20-metre headrope can be stretched while giving protection from the sun, and a portable hut which is lockable to allow the safe storage of materials. This minimum may be regarded as Phase 1, while Phase 2 should allow for a room of 6 metres square to be built at on end of the shed to serve as further store/office space, the provision of a cement floor to the shed, and a wall along its windward side.

A field toilet is provided in Phase 1, but no provision for access roads, fencing or water supply is made.

## 5. ECONOMIC ASSESSMENT.

### 5.1. Capital

The estimate of capital requirements is based on the programme outlined in section 4 above.

#### Phase 1



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1 Altent 3,5m diameter portable toilet	R 400
1 open shed 22m x 6m	2 800
1 toilet	200
small tools	500
	R3 900

#### Phase 2

Concrete floor and brick wall	900
store/office 10m <sup>2</sup> @ R150	1 500

## 5.2. Revenue Costs

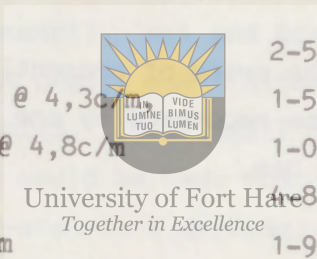
### 5.2.1. Overheads/annum

Rental (1% per month on R6300)	756
Administration and training fee	1 200
Advertizing	500
Consumables	300
Stationary	120
Packaging	1 000
<b>TOTAL</b>	<b>3 876</b>

(All items except Rental will increase with the inflation).

### 5.2.2. Cost per net

Net blank	2-50
35m of 3mm polyethylene @ 4,30/m	1-51
35m of 5mm plyethylene @ 4,8c/m	1-08
40 floats @ 12c/float	4-80
2,4m 8 guage wire @ 8c/m	1-92
Nylon twine 210/6	0-20
Dye	0-50
Labour	7-30
<b>TOTAL</b>	<b>20-41</b>



## 5.3. Gross Margin and Break-even analysis.

In this calculation, three prices are used for establishing gross margin and break-even volume. A total direct cost of R21-00 per net is assumed.

<u>Price per net</u>	<u>Gross margin</u>
R30	R9
R35	R14
R40	R19

Given these gross margin per net, the table below indicates the break-even production levels.

<u>Sales level</u>	<u>Profit/(loss)</u>		
	<u>R30</u>	<u>R35</u>	<u>R40</u>
100	(2976)	(2476)	(1976)
200	(2076)	(1076)	(76)
300	(1176)	324	1824
400	(276)	1724	3724
500	624	3124	5624
600	1524	4524	7524
700	2424	5924	9424

Therefore it would seem that a price of R40-00 per net would draw a reasonable profit at a turnover of 300 nets per annum. This figure is not unreasonable on 2 grounds:

- i) It is lower than the price of presently available nets.
- ii) This cost could be recovered by one or two nettings, in for example, the Laing Dam.

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## 6. RAW MATERIALS REQUIRED.

### 6.1. Importation of Net Blanks

All of the raw materials listed in 5.1. and 5.3. above are obtainable within Southern Africa with the exception of the lengths of netting (net blanks). At a later date, if the project proves a success, a netting loom may be procured and this netting woven on the spot, as is done in Malawi, Zimbabwe, Mocambique and most African countries. In this initial stage, the capital investment involved to do this would be too great, so these net blanks must be imported. A minimum order of at least 100 in any mesh size blanks must be placed, however, since the Taiwanese manufacturers will not accept orders for any less. (2000 nets have already been ordered).

## 6.2. Fiscal assistance required

Although costs have been given for nets, and the sizes margin and break-even analysis, no estimate can be made of the amount of Fiscal assistance required, until more detailed information with regard to consumer demand is available.

## 7. FUTURE EXPANSION INTO RELATED INDUSTRIES.

The Amatola Basin lends itself well to small industries, needing little in the way of tools and infrastructure, which may be developed in association with a gill-net factory.

One is the starting up of a simple blacksmithing works to make items needed in the fresh water fishing industry such as wire clips to fasten gill-nets to ropes (like safety pins, cheap but easily lost and needing constant replacement), net and boat anchors, hooks and gaffs, as well as metal tent pegs, fastening pegs, frames for stretching nets over vegetables. Small simple conventional and Danforth-type plough anchors could be made and only simple tools such as hand-operated forge, oxy-acetylene welding, anvil, hammers, tongs, hacksaws etc. would be necessary. allied to this would be the provision of other types of net, particularly horticultural shading and bird-excluding nets shaped to order, and also seine nets. There is considerable skill in making a good seine net, but this can be taught.

One may conclude, that on the evidence available the authors have every confidence that this venture will succeed, and should fulfil a long-felt need.

It will, however, be necessary to accurately assess to potential market, and a brochure should be sent to the respective institutes and organisations forthwith.

P B N JACKSON

D R TAPSON

A J ROSE

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AJR/j