A SURVEY OF FISH FARMING
IN SOUTHERN AFRICA

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PREFACE

This survey was researched by Giles Hobson and edited by Robert Berold of the Environmental and Development Agency (EDA). It is the result of the tour undertaken in 1977 in which Giles Hobson interviewed people in Southern Africa who have had practical experience of fish farming.

The survey is being published simultaneously by EDA and the Southern Africa Labour and Development Research Unit (Saldu).
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INTRODUCTION

The origins of Fish Farming are very old. There is evidence that fish culture was practiced in China as long as 5000 years ago. Today China remains the largest producer of fresh water fish in the world, and carp culture is as much a part of the Chinese way of life as the paddy fields in which they are grown.

The culture of Tilapia also has ancient origins. A bas-relief found on a 2500 BC Egyptian tomb shows Tilapia being netted from a pond. The bible refers to Jesus directing fishermen where to cast their nets for what was almost certainly a Tilapia species common to the sea of Galilee.

Aquaculture in its many forms has spread across the world and is assuming an ever-increasing importance. Sea fisheries production has already passed its peak and will slowly decline because of the destruction of natural food chains by exploitation and pollution. The world's food production has been unable to keep pace with the population increase, especially in developing nations. There is therefore a need to increase food production by all possible means, firstly by stimulating existing means of production, and secondly by introducing new sources of food. Fish Farming, although still in its infancy in most Third World countries, has an important part to play as an integrated element of the rural economy.

FAO figures show that protein from foods of animal origin is dangerously lacking in the everyday diet of much of the population of Africa. This can cause ill-health, poor growth and susceptibility to disease. Fish culture is one of the best ways of increasing the supply of protein. Fish meat contains as much as 60% high quality protein on a dry water basis, and Fish converts raw food into protein at a far more rapid rate than most land based animals.

It is interesting to consider some of the factors that enable fish to grow so rapidly. The fact that they are cold blooded means that they do not have to use up energy in maintaining body heat. This energy can be used for growth. Fish live in a medium more or less the same density as their bodies, and therefore do not require a heavy bone structure to support themselves against the force of gravity. The ratio of flesh to
bone is therefore high in comparison with land animals. Because they live in a three-dimensional world, they are surrounded by the food they eat, and consequently make better use of a given surface area than terrestrial animals. Many areas of Southern Africa are ideal for the various kinds of fish farming, and it is hoped that the full potential of these areas will be realised in the not too distant future.

One of the aims of this survey has been to enable people involved with fish culture to keep up to date with other developments in the field. It does not purport to be a comprehensive record of all the fish farming efforts in Southern Africa. We have attempted to cover some of the types of fish farming that are being conducted at present, and give some information of a general nature, but have obviously had to be selective.

Trout farming has been omitted completely since it caters for the luxury market, and is a specialised form of aquaculture not suitable for mass food production in rural areas. Trout are flesh eaters, and in trout farms they are fed expensive pellets made from foods that humans could otherwise eat.

We have not specifically mentioned the thousands of farm dams which have been stocked in the past, and which probably constitute the most important areas of fisheries potential in Southern Africa. Statistics about these dams are virtually impossible to come by.

At the end of 1978 EDA will be holding a conference to plan the potential of aquaculture in the context of development in South Africa. This publication is intended to be an introduction to the subject. We hope to follow it up with another publication after the conference.
TALK WITH MR BAR-DAVID, ADVISOR TO LESOTHO FISHERIES AT MASERU

This is a transcript of a discussion with Mr Bar-David in which he explains the fish farming methods in Lesotho.

Government and private sectors
The Fisheries Section of Lesotho is part of the Ministry of Agriculture. It is responsible for all the fisheries activity, starting from the construction of fish ponds and going on to general management.

Today the fish ponds in Lesotho are divided into two sectors. One sector is attached to the government and the other sector belongs to the villagers. The government runs the hatchery in Masery which is used for experimental purposes, and also a farm in Tshakolo near Mafeteng, where a big project is planned. We have done a pilot project at Tshakola on a smaller scale to see if the conditions are all right.

The other sector belongs to the villagers. The village either applies to the Fisheries Section for assistance or the Fisheries Section finds a good site and suggests the village establishes a fish pond in this area. Design and construction is carried out partly by us and partly by an engineer. The engineer draws up the plan; but we indicate to him the size of pond, slope of pond, water supply, etc. Construction can either be done by hand or it can be done by machinery owned by the government's Soil Conservation Section.

Difference between a pond and a dam
There is a big difference between a dam and a fish pond. It's not just a difference in size. A fish pond has a suitable shape for netting and an outlet for draining. You can control the level of water. You can control the fish population. In a dam which has been built for soil conservation purposes or irrigation you can't do all this. You can't easily drain the water if you see that the fish aren't growing or they're sick. Dams often have stones or reeds at the bottom so fish may be difficult to net.

However, we do use many dams in Lesotho for fish production. Sometimes the fish are caught with lines, sometimes with nets. We're not fertilising the dams or feeding the fish in them, but we do stock dams with fish.
Three year establishment programme
During the first year of operation the Fisheries Section does all the stocking and sampling. Sampling is done every two weeks and then the rate of feeding is calculated according to the weight. During the second year of production the village itself should pay for the fingerlings supplied. During the third year the village should pay for the fingerlings, the fertiliser and the food.

We sell the fish at 500 - 700 grams. When the fish are big enough to sell, they are sold to the villagers themselves at about 60c per 1kg live/weight. Each village is expected to appoint one man to be in charge of the daily duties which include feeding, fertilising once a week, general control, fencing, cutting the grass.

Fisheries Committees
In each village there should be a fisheries committee. This committee is chosen by the villagers themselves and is responsible for all the fisheries activities. We work through this committee. We tell them when the fish should be fed and so on. The income from the sale of the fish is put into a bank account. At the end of the year we compute how much the input cost was, and the committee then has to pay the Fisheries Section.

At least, this is done in theory but it doesn't always work very well in practice. The system is difficult to explain and the villagers are sometimes reluctant to pay the Fisheries Section for its technical advice.

Involvement of the villagers
The villagers have to do the work themselves. We used to send the staff from here quite far, up to 90km, to do the sampling. Now most villages (but not all) are doing the sampling themselves. This is a good thing not only because it saves money but also because it increases the villagers' involvement in the fish farming.

Ideally, the villages will be taking full responsibility for the fish ponds after 3 years. But that is not likely to happen since people don't have the education to work out things like stocking rates, feeding rates, etc. We hope to get to that stage eventually but it will require a lot of training.
Small Units
The small units are more difficult. In each village there may be about 5 ponds of let's say 0.1 ha. Now what are the problems concerning such a small unit? First of all, not each village can afford a net and a scale for sampling. These things are quite expensive. To buy a net for each village wouldn't be economical.

We try to improve the villager's knowledge and so most of the fisheries committee members attend courses. Also most of the input has to come from the Fisheries Section, so there is a transport problem.

EDA: What is the average size of carp ponds?
The average size is about 0.2 ha.

EDA: Is that the average size you have in Israel. Don't you have bigger ponds there?
Much bigger. The biggest pond in Lesotho is 0.6 ha.
Finance
The Fisheries Section is financed mainly by the British. Also Israel is helping to some extent. The situation is similar to Israel in that the fish are the same (carp), but for each climate optimum methods are different. You can't apply Israel's methods directly to Transkei, for example, or to Lesotho.

Social acceptability of fish as food
The people here were not used to eating fresh fish. They used to buy tins, maybe, and some frozen fish. One of our first problems was to teach the people to eat fresh fish. We market live fish so you can be 100% sure it's fresh. Many people complain about the bones because the carp is quite a bony fish so we started to mince it.

EDA: Carp is the main species here. Do you have any other species? Trout in the river, and we have also introduced some other species during the past 2 years. We have tried barbel (clarias) and mudfish (Labeo). The results were not very promising. The growth rate was very low. Also there is the problem of spawning. Catfish don't spawn under artificial conditions unless you inject them.

Carp trout rotation
In winter here the temperature is too low for carp. They don't actually die, but they don't grow. We thought of using the fish ponds for trout during winter.

EDA: What size trout would you put in?
Well, when we put them in they must be of such a size (50g) that after the winter they'll be big enough to sell. We would have to sell them at about 250 grams.

We tried this idea under experimental conditions. We had a problem of high mortality with the trout. We're not sure of the cause but we know from our experience with carp that there are a lot of birds here which feed on fish. Also, there is the condition of the water because trout need clear water. The water here is quite muddy.

EDA: Probably because of soil erosion?
Possibly. We add gypsum to precipitate the mud. It helps.
Now there is another species, silver carp, which was imported from Israel. It seems to have a good effect on the carp. Here we are using the principle of polyculture. The idea is to utilise all the natural food and so increase production. In this case production has increased nearly 20%. In Israel, in one pond you can find carp, Tilapia, mullet, silver carp, grass carp.

Here it's too cold for Tilapia. They won't get big enough in one season unless we put in quite big ones. There's also a problem with spawning. The temperature here is not optimum.

Water conditions
We start stocking the fish in about September and we finish from about the end of February to the middle of May. The water is very good compared with other places like Israel. The pH is good; it's nearly 7, a little bit higher. There's very little salt. In Israel you can find sometimes 800 - 1000 mg per litre. On the other hand, the water is usually quite muddy. But we still use it.

EDA: Don't carp make the water muddy themselves?
Yes, they feed mainly on the bottom. They dig in the mud and make the water muddy. But even when you fill the pond the water is dirty.

EDA: But surely in Israel the carp ponds get muddy?
Yes, but not as much as here.

Pond Construction - soil
I personally believe that almost any soil can be good for fish farming. If it's partly clay, partly sand, it's all right. If it's very sandy it's possible to make a clay core in the wall to prevent leaking. But in any case after a year or two, because of the organic matter, the ponds get more watertight. In Israel there are many fish-ponds on the beach. The advantage of a fish pond is that you can use soil which is unsuitable for other agricultural activities.

Tshakolo project
In Israel the fish ponds are much bigger than here, about 4 hectares on average. The project at Tshakolo should be about 350 hectares altogether.
The first stage, which we hope to start soon, should be 40 hectares. We will then have fish not only for canning but also for export. This project will give a push to other fisheries in Lesotho. It will be run on commercial lines, although it will be government owned.

EDA: Where will you export to?
We thought about the mines for example. But we will face competition - there are many sea fish which you can buy very cheaply. You can get hake for 55c/kg. However, we can sell carp at this price. Our advantage is that we use for feed sub-standard wheat, which is very cheap. For super-intensive farming we also use pellets. They used to feed mealies in Lesotho until I came here, but I stopped it. The food conversion rate is much better with wheat. If you crush up maize too fine it can dissolve in the water and it gets wasted.

Productivities
Last year (October 1975 to March 1976) the total production was nearly 19 tons. For this year (1976/77) the figure is 26.5 tons. Mortality is usually about 10%.

EDA: Do these fish ever get disease?
Here the situation with respect to disease is very good. One doctor at the university asked us to bring some diseased samples for a demonstration. We couldn't find any diseased fish for him.

To come back to productivity, in 1975/6 the total hatchery production was more than 20 tons. In 1974/5 it was about 12 tons. The year before it was about 5 tons.

EDA: Is the increase because of more ponds or because of better methods?
Both. But the production/ha has increased. Now, the total production per hectare is about 1800 kg. In 1974/75 it was less than one ton and in 1973/74 it was about 600 kg.

This was actual production, but the potential is much greater because we had a problem with fingerling supply. The new hatchery has been in operation for only one year. We couldn't supply fingerlings fast enough and so most of the ponds were not used for the whole season.

I calculate potential for 1975/76 at nearly 1800 kg/ha. Under the con-
ditions of Lesotho, particularly considering the education level, it's not bad. There are some places better than others. For example in Tshakolo per ha production was over 2 tons and this is quite a big farm: 4.5 ha.

Intensive culture
Now let's talk about intensive culture results. The average was about 4 tons/ha. With aeration it was about 5 tons. In some ponds we tried the experiment of feeding only grain and not pellets with aeration and this gave only 2 tons/ha.

Pellets cost about 11c/kg i.e. R110 per ton. These pellets were not proper fish pellets; they're produced for ducks. They dissolve in the water after 1 minute. So we might find it pays to produce our own pellets.

The villagers scrape the bottom of the pond to see if there's food still there. If the fish don't eat food it can be for various reasons. Here in Lesotho it could be because of a cold day in the middle of summer or else lack of oxygen.

This is a feeding table for the automatic feeder:

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EDA: Will the people out there be able to understand this table? Not in the villages, no. We use this here at the hatchery and at Tshakolo. This is for water over 18°C because we believe when the water temperature is higher they eat more. When the water is below 18°C we use another table. We also have another table for hand feeding. We have worked it out according to Lesotho conditions. We can't definitely say it's the optimum, so we are trying to check with a computer the correlation between the yield and the various factors affecting growth. There are about 30 factors, which include rate of stocking, size of the fish, size of the pond, the village, the date of establishment, mortality, feeding.

Economics

Our policy regarding the villages is that in the first year we supply everything free. If you take R100/ha for fingerling cost (and it's actually less than that), the profit is about R600/ha. That's an average. This doesn't include the cost of transport and labour.

Transport cost is quite high because of the size of the farming units and because of the distances involved. But if you compare the fish farming profitability to other agricultural activities in Lesotho, like crops, maize, wheat, it's much higher. Also the income per employee is higher. The profitability of the intensive farmer is about double. Last year the food conversion rate was 3.1. The previous year it was 3.0. Since I came here we've started better methods of feeding. The food conversion rate of the intensive farming is higher: 4.0. The previous year it was 3.2. We're also trying to reduce the amount of pellets as opposed to wheat and I feel that up to now it's working.

If we consider everything, including the capital investment, the picture will be different. These fish ponds can't compare with Israel because here the cost of investment per hectare is very high. The ratio between the bank size and the water area is very high because the fish-ponds are small. For example, if instead of making two ponds of 2 1/2 hectares each you make one pond of 5 hectares you'll need less ground for the walls. In addition, if you include the cost of laying on water supply and constructing outlets you can see that the more ponds you have the higher your capital investment is but it won't help the production. But still if you compare it to all the other activities in Lesotho including the soil conservation work, I don't think it's more expensive. So it depends
how you look at it. From a point of view of providing a food supply it's all right. But if you want to see this activity covering expenses, including the capital investment on a village level, you'll be disappointed. Perhaps after a period of about 20 years we might achieve this for villages. The plan for Tshakolo, on the other hand, is a commercial one which should cover all the investment costs over a period of five years.
Lowveld Fisheries Research Station, Marble Hall

The Lowveld Fisheries Research Station at Marble Hall was established in 1954 to promote fish farming in South Africa. They have worked mainly with Aischgrund carp originally imported from Germany. The result is that they are able to offer a great deal of really good technical advice to the prospective carp farmer. A comprehensive booklet, "Introduction to Carp Farming" (see References) is available from them and this will be of invaluable use to anyone contemplating any type of warm water fish farming.

This interview with Mr C A L Bekker of Lowveld Fisheries Research Station was conducted by Giles Hobson and Karl Edwards of EDA and translated from Afrikaans.

The Market

Rick Granville and Jack Smith at Boetspruit are the only two farmers who are making a reasonable profit from carp farming. Unfortunately there isn't a market for great quantities of carp. Some farmers, specially in the Vaalwater area, went in for carp some years ago. They built dams and bought fish. Today there are between 180 to 200 thousand carp of about a pound to a pound and a half in the Vaalwater area. The farmers simply can't sell these at the price which Irvin and Johnson sells sea-fish, like hake.

When I was in Israel I discussed this problem and they said that as long as there is red meat available in South Africa they didn't foresee that fish would replace it.

EDA: Now these two men are making a success, are they selling to Blacks?
Yes, they don't even think of Whites. There is a lot of homeland area here; it goes right up to the Rhodesian border. So there would be a big market. There's a fisheries station at Arabie Agricultural College. We will be giving them some breeding carp. Apparently they are trying to produce fish in Vendaland for Vendaland and Nebo. They are also building a big hatchery at Sibasa. However, I don't believe that they can produce a tenth of what they need for the amount of people there. Swaziland also
bought about 50 000 carp from us, including 100 breeders.

EDA: How do you see the future of this station? This station is essentially just a research station I wouldn't mind if we could drop the research and go into production. We have 85 dams here, ranging in size from 0,28 hectares to 5 hectares. We produce enough fingerlings for the farmer; however we can't sell big carp ourselves. If we have extra kurper (Tilapia) at the end of the season we sell it at 35c a kilogram.

EDA: We heard that BIC started a fish farming project? They built a big hatchery at the Klipvoor dam but the project was a failure because they had to pump the water to the ponds. When you're farming fish you shouldn't have to pump water unless there's such a good market that you can afford to.

Tilapia
At one stage we used to sell kurper as a table fish. We couldn't keep up with the demand. On occasions we sold 2 tons in a month. There is a very good market for kurper but unfortunately they take so long to grow that the Highveld farmers can't farm them because they die in the winter. At this stage kurper is preferred to carp as a table fish. We are smoking carp here on a small scale and this is another possibility we must consider.

The farmers here realise that with kurper they won't struggle to find a market. So why do they choose carp? Because if carp are fed fish pellets they can grow from fingerlings to 400 or 500 grams in three months. Moreover, it's a heavy, compact fish and excellent for farm rations.
Hectorspruit

Rick Granville and his brother have a sugar cane farm near Hectorspruit. As a sideline they farm carp. These excerpts from an interview with Rick Granville will give an idea of the problems a carp farmer is likely to encounter. They also show that there is a good market for carp among black people.

The reason why we made these dams originally was because the soil was utterly useless. We built seven originally and we used run-off water from the cane and we stocked up with what we thought was 6 000 fish. We ended up with less than that number either because of an error by the Lowveld Research Station, or else because a lot more died than we thought.

Market

At first we wondered if we would sell the stuff. Well we sold 300 about as quickly as you can snap a finger. We sold them to local black people who came here to buy them. We've never done any travelling or sales work at all. But our price is still higher than Irvin and Johnson. They can produce frozen fish for 60c/kg. We sell fish at a rand a kilo which is the price which was suggested to us and we've been selling it at that price for two years now.

The success of fish compared to meat is probably due to economics rather than taste preference. Although the Shangaans like fish, the Swazis prefer red meat to fish. But you can't buy 30c of red meat unless you go to a butcher which may be miles away in this part of the world. You have to slaughter a whole animal and if you haven't got a refrigerator the whole thing is likely to go rotten.

Transport costs

Last time we bought fingerlings from Marble Hall we bought 20 000 and we paid R400 for them and another R160 for transport. So we've got to breed our own.

Breeding Problems

We've tried some breeding. We had very poor results this year. In fact most of our fingerlings are from wild spawning. We have a problem down there in that the soil contained too much clay. If you want to have a breeding dam you must be able to grow grasses on it; and nothing but kikuyu or water grass will grow in these ponds. And you need a hairy grass
to catch the eggs. Mr Bekker of Marble Hall came up with the idea of using a concrete tank and putting down cypress branches on the bottom. We tried using buffalo grass, but most of the fish died. This was possibly due to lack of oxygen.

**Oxygenation**

You notice that all these dams have aluminium pipes off them, running from each dam to the next below. Now this could be a problem in that if you get a disease in one dam it's going to spread throughout. We've done it for the simple reason that we want to prevent this oxygen problem. We do this with a constant through-flow of water - each time it comes out of one of these pipes it splashes down onto a rock.

**Draining**

EDA: Do you ever drain your ponds?

Sometimes. We don't have any monks weirs. If you have spent a lot of time getting the zoo plankton in your water just right it's a pity to let all the water out. So it's best to get the fish out with a net.

**Growing season**

We can keep our carp in the production ponds right through the year. We don't actually get a very good growth rate in winter. The recommended feed rate is 5% of gross weight. During winter we cut it right down to about 0.5% just to keep them alive. We've stopped using pellets for feeding our fish because we can't get them at an economical price.

**Ducks**

To begin with we ran ducks with the fish with the idea that the ducks would help to fertilise the water. This wasn't successful for a number of reasons, the major one being theft. Another problem was civet cats. We never really worked out the right number of ducks to keep. We had about 16 dams, roughly an area of 8 acres, and we tried to keep about 900 ducks, all at different ages. Well, they just about cleared the water of food. I want to get geese now because they graze the grass.

**Mealies as feed**

We feed this fish on mealies.

EDA: Don't you get very fatty fish if you use mealies?

Well this is what the people like. Local Africans can't afford
cooking oil and pressure cookers and so on. A fatty fish is easier to cook over a fire.

Predators
The platannas are a problem with the breeding because they chew up the fingerlings and eggs.

Our biggest problem among birds wasn't cormorants. It was a blue heron which is supposed to be a toad eater. Well it isn't a toad eater, or it may be, but it's a fish eater too. It's got a razor-like beak about 6 inches long and it knocks holes right through the fish.

Rick Granville with two of his fish ponds in the background.
Barbel are also one of our predator problems. The blue heron is the worst of the lot and then comes this cormorant for young fish and the barbel. There's a natural indentation right down to the river. The barbel scramble up this furrow in wet weather. They hop into the ponds and do tremendous damage.

**Tilapia**

The quickest sales we have are kurper. These are the ordinary Tilapia mossambica. But because they breed so prolifically we don't get them much bigger than about 200 grams. We sell them by weight too but at half the price of the carp because we get them for nothing. The Tilapia get into the water by themselves.

EDA: It will be interesting to know whether having the Tilapia is cutting down on your carp food or improving your productivity? Well I'm of the opinion that the Tilapia actually improve carp growth. They clean up a lot of the things that the carp can't eat.

We started off almost pessimistically with our kurper. We reckoned we'd have to dry the stuff. We put them on wire nets to dry but it was not necessary because people kept on buying them before they'd get dry.

Now look at this pond, which hasn't got carp in it. The water looks more vibrant. I think the thing to do ultimately is to use only male kurper and to alternate between carp and Tilapia. There are probably 4 000 fish in that pond but I like the way the water looks. It's probably got a good concentration of zoo-plankton and various dragonfly larvae. It's got a light colour rather than that murky look where the carp are. So I think we should alternate them.
NATAL

Excerpts from a discussion with Tom Pike of Natal Parks Board

Demand for fish production in Natal
There's not a big demand yet in Natal for freshwater fish for food production but at least we're gearing ourselves for the time when this comes about. There is a general attitude among farmers in Natal that fish is just something you put into the water and it grows. It's difficult to get through to them that a fish is an animal that has to be managed. If you do it properly you can get far better results than you can from, say, cattle. The trouble, I think, in Natal is that the areas which are most suitable for Tilapia are the warmer areas. These are the areas which are utilised for sugar cane. Cane is one of the easiest crops to grow. The farmer is not keen to work hard managing fish for relatively small extra profit.

Grass carp and silver carp
We've got grass carp down at the hatchery. It is not the same species as the common carp. The common carp is a European fish whereas the grass carp is a fish native to only a few rivers in China. It's the same family as the common carp, but not the same genus.

The silver carp is also a Chinese fish. We're going to get some of those too from Israel. We introduced our grass carp from Malaya in 1967. We got the first big spawning from them last year and now we've reared about 4 000 to big fingerling size. We're going to use these for experimental work now, stocking them in selected dams for weed control purposes. We're selecting dams from the coast right up to Underberg because these fish will take big temperature variations; their range is from 0°C to 32°C.

Grass carp spawn only in a few rivers outside their natural habitat. They have been reported to spawn in a few rivers in America. These are big, slow-flowing rivers, the Mississippi for instance. We get them to spawn by intramuscular injections of pituitary extract from ordinary carp. There are various factors against getting a successful spawning; Mr Pruginin says that the Israelis don't get more than about 30% success with their spawning.
We strip the eggs into a basin and then fertilise with a male. The eggs go into a big incubator flask with water circulating in from the bottom so it keeps the eggs in circulation all the time. In the natural state the eggs are just released into the river and they float with the tide. The hatching time varies from 30 to 48 hours; there's no parental care at all.

However in many parts of America grass carp have been prohibited because they've escaped into a few of the rivers. Since they are vegetarians there's a fear that they might cut out vegetation on which other fish rely either directly or indirectly.

The silver carp's biology is much the same as the grass carp's, but they're easier to breed. Mr Pruginin says they're far less trouble than the grass carp. They're algal eaters and I don't think that if they did escape into the rivers, the results would be as violent as for the grass carp.

Carp
We got rid of our carp because we're trying to keep carp out where they don't already exist. There have been carp in the Northern Natal rivers and dams for years. They've slowly crept further south, mainly because of anglers. They introduce them because they like to have them for their competitions.

Tilapia in Klipvoordam
Bantu Investment Corporation have a hatchery at the Klipvoor dam. It's situated very poorly because they have to pump all the water into the hatchery. But the dam itself is terrifically productive. All the sewerage effluent from the Pretoria sewerage purification plant goes into the Apies river and Klipvoor dam is the first dam downstream from Pretoria. The Tilapia mossambica in the dam grow to a size of 5 or 6 pounds.

Growth of Tilapia mossambica
With all male culture of our own Tilapia mossambica I've had a growth of about 450 grams per male over a summer period. In general, Tilapia take two seasons to get to a marketable size. In Israel they spawn them during the first year and hold them over in winter. Then in the beginning of the next summer they put them out into their growing dams and they sell them at the end of that summer.
Feeding habits of Tilapia mossambica
Tilapia don't have the detrimental habit of muddying the water as carp do. They have an algal preference but they eat virtually anything. You can feed them on kitchen wastes and all sorts of things.

EDA: Have you used pellets at all?
Yes, I've got an experiment on the go at the moment: all male cage culture, feeding on pellets. The growth hasn't been as good as when they were in a pond where they were just on a natural diet and we merely fertilised the water with fowl manure. It has been found that Tilapia does better on a natural diet than it does on an artificial diet. The Israelis have had terrific results with liquidised cattle manure in their polyculture. They use that or fowl manure. A lot of the organic matter is eaten directly by the Tilapia and the artificial feeding pellets are mainly for the other fish.

Just with fowl manure, which we buy from the local poultry farms, we've had very good growth. It is a cheap feed - we pay about R10,00 a ton.

All male hybridisation of Tilapia
I don't think it's a good thing to introduce exotic species of Tilapia for hybridisation. They were introduced to Uganda. Mr Pruginin did a
lot of work in Uganda and he advised us against bringing in these foreign species. In Uganda they got into various lakes and caused a degeneration of the local strain to the extent that the growth rates have dropped off quite considerably.

**Potential of Tilapia**

I think our Tilapia is definitely our finest fish for food production. Correctly used, with utilisation of waste products, fowl manure and so on, it's got a terrific potential. The fact that fish are smaller does not seem to affect their popularity as food.

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**Extracts from a conversation with Mr Abel Phelps at Pietermaritzburg**

Mr Phelps farms Tilapia as a hobby in a pond in Pietermaritzburg. His approach is to use urban wastes to feed his fish and he has come up with some interesting results.

**First class protein**

Hickling (see References) tells how in Central Africa, they feed Tilapia on ordinary household wastes. Nothing, even in Hickling's book says anything about feeding them first class protein. According to the book, melanopleura are exclusively water vegetarian eaters. We opened the gut of melanopleura in Nagle dam and we found fresh water shrimps. Some time ago a dove killed itself on the high tension wires. I cut it up with a spade and threw it into the water; within minutes the fish were eating it.

**Eggs**

I feed my fish cooked scrambled eggs. These are all spoilt eggs. In a poultry farm there are always a percentage of addled eggs.

EDA: Why do you cook the eggs?

Just to make them coagulate so they don't disperse. I have aimed at getting my food for nothing and egg seems to be an appetising food; so do embryo chicks. When the water was warm, round about December and January, if I took the dead, day-old chicks and threw them into the dam, within a minute the fish would be nibbling at them. I also get waste from race-horse managers and unsold bread from the bakeries, all for nothing.
Lemna
This in this tank is a water weed the technical name of which is Lemna. It has a very tiny leaf and it multiplies very fast. Daphnia proliferate where you've got this kind of weed.

I fertilise this water with artificial fertiliser. I throw the Lemna into a feeding cage which is simply a floating bamboo frame for positioning floating foods. Now that the fish are eating less the Lemna is starting to establish itself on the fish pond which is a good thing because water
weed takes up carbon dioxide and converts it into food.

**Comfrey**

Russian comfrey is a very interesting plant. It has a very high protein leaf and it's claimed to be the only vegetable source of vitamin B-12. It seems to me that if you're wanting to grow fish, appetising food is the thing. You've got to keep them interested and this is often a case of vitamins. Earlier in the year they ate this stuff very well, but since they got eggs their whole feeding habits have changed. However, if you throw these leaves in, within a day or two they'll nibble all the green off and just leave the central stalk.

**Fish pellets**

I think the egg protein I feed my fish on is probably better than fish pellets which are only, at most, 15% fish meal.

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**Discussion with Paul Colvin, Technical Officer at Valley Trust**

The idea of the Valley Trust is to re-educate Africans about nutrition and to show that they can grow their own food in a very simple way within the resources of the people and without a great deal of money being spent on tractors and fertilisers. We channel from the medical clinic through the nutritional education unit to the agricultural extension service which provides assistance and advice on vegetable gardens, poultry keeping and fish ponds.

**Tilapia management**

The idea was initially that I would help with the fish culture side of things by stocking and cropping the ponds in the area. The ponds have been stocked before but you know that with Tilapia this idea of stocking small ponds with fish and just leaving them doesn't work. You've got to crop the pond intensively all the time taking out the small ones or you've got to do monosex culture or hybridisation. If you just put the fish in a pond, particularly these small ponds, the fish go rampant and you get lots of little stunted fish.

I think that for Tilapia you've got to drain. If you want to manage them properly you've got to start from scratch with dry, empty ponds. You sex properly and try not to make any mistakes. If you make a few mistakes its amazing how quickly they breed up. I've tried to do it in these traditional earth dug ponds. They haven't got monks at all and when you drain them
there's always a little bit of water left in there. So it's very easy to miss one or two fingerlings.

The main problems are getting the fish out of the ponds and demonstrating to people the need to crop their ponds regularly. It's not easy to get a licence for netting and trapping fish. Even if one can get a licence a net is an expensive investment for small pond fish culture. The Valley Trust nets private dams each year and we encourage pond owners to crop their ponds regularly by drainage or rod and live fishing, neither of which require a licence.

Ecological rotation system
Now the concept here, and what Valley Trust's all about, is not using high energy feeding and artificial fertilisers. I want to build up a sort of ecological rotational system where we have a conventional garden here, poultry and perhaps other livestock, with ducks in the top reservoir pond. When you drain a fish pond the silt can go on the vegetable garden and the waste from the vegetable garden goes into the ponds. I also use small Tilapia for feeding the ducks - either whole or mixed with maize. The whole thing is interlinked. The idea is to show people that you don't need to buy a whole lot of food and fertiliser, provided you have an integrated approach and you don't waste anything.
EDA: Is there much organic fertiliser available?
Not as yet, although I do have a supply of chicken litter. This is why I want the ducks up there in the top pond. When I drain a lower pond I can fill it up with enriched water from the duck pond. It will be interesting to see how many ducks I can keep without buying a lot of additional feed. We are fortunate in that we get a lot of waste food from the TB settlement.
Exploitation of Fish in Caprivi and Owambo

by Dr Ben C W van der Waal, Agricultural Advisory Services.

Some developing areas such as Northern KwaZulu, Owambo, Kavango and Caprivi have established mostly traditional fisheries. All these areas are rich in rivers, and floodplains or pans which lend themselves for traditional fishing techniques like fences, funnels and push baskets. In many instances, traditional techniques have been supplemented by more modern gear and innovations are to be found in eg. Owambo.

CAPRIVI
Both the Zambezi and Kwando-Linyanti-Chobe Rivers border this area. Lake Liambezi covers about 30 000 ha of which two thirds is covered by reedswamp. Apart from many permanent channels and oxbows and swamps, the whole eastern part of Caprivi becomes inundated annually by the Zambezi. Under such conditions more than 30 percent of Caprivi may be under water. A variety of traditional gear is used in catching fish especially with receding floods: fences across shallow streams with non-return valved baskets or with kraals; open funnels, employed in fast running streams to catch down-stream migrating fish; earth bunds or small dammings of shallow areas where the water and fish are contained until the floods have receded and the fish then collected through valved baskets. Push baskets as well as pull baskets are also employed in shallow murky or weedy water. Fish spears, traditionally made, are used to collect fish in shallow areas or from fish kraals. Gill nets have been in use for about 15 years and the mesh used varies from 4-6 inches (or 100-150 mm). In some areas a seine net is constructed fitting a number of gill nets together which is then hauled through a large pan or oxbow.

In the fishery of Lake Liambezi only gill nets are used. The following statistics are presented:

<table>
<thead>
<tr>
<th>Year</th>
<th>Fishermen</th>
<th>Nets</th>
<th>kg fish/day</th>
<th>ton per year</th>
<th>kg/ha</th>
<th>daily income per man</th>
<th>Price/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973-74</td>
<td>92</td>
<td>697</td>
<td>1745</td>
<td>637</td>
<td>21</td>
<td>R1-77</td>
<td>9,7c</td>
</tr>
<tr>
<td>1974-75</td>
<td>57</td>
<td>445</td>
<td>765</td>
<td>279</td>
<td>9</td>
<td>R1-43</td>
<td>10,9c</td>
</tr>
<tr>
<td>1975-76</td>
<td>30</td>
<td>187</td>
<td>316</td>
<td>115</td>
<td>4</td>
<td>R1-82</td>
<td>17,4c</td>
</tr>
</tbody>
</table>
Catches of fish consisted for 80 percent of Cichlids, 13 percent of Clarias and 7 percent of other fish like tiger and battlenose.

The department of Agriculture built a cold room at the Lake in order to promote fish marketing which ran into trouble in 1973. This cold room has never functioned but has now been taken over by a white entrepreneur who is exporting some of the fish and ensuring a permanent market.

Ecological studies on this Lake as well as other water bodies in Caprivi showed that commercial gill nets catch only a fraction of the fish present. By using smaller mesh gill nets catches up to 10 times as large as in corresponding commercial gill nets can be made, consisting of altogether different fish species. If these smaller mesh gill nets are employed together with the present nets, this Lake alone may yield as much as 1000 tons of fish per year.

OWAMBO

Owambo does not have any really permanent water bodies but is partly flooded every second or third year by an oshana system from the Olduvoi River system. This river system is wedged between the Kunene and Okovango Rivers and runs south over a very shallow gradient where it divided over a number of channels or oshanas and eventually drains into Etosha Pan. With the water come the fish - small Barbus or minnows and and Clarias as well as a few other species, all young and small migrating southwards from Angola. In years of above/average rainfall, oshanas start running in March and fish are then collected with funnelled traps and recently a new modernised version, a huge funnel made of fine knotless pilchard netting. When the oshanas start drying up, seine nets are used and the whole fish community is utilised because oshanas are dry again by the beginning of summer.

In a survey conducted along the road between Oshakati and Ondangwa the following efforts and catches were recorded:

- Funnel nets : 26
- Anglers : 88
- People with scoop baskets : 10

The total catch over a one day period was estimated at 4,2 tons of fish, consisting mainly of small Barbus and young Clarias. Fish are eaten fresh or dried and fetch prices of 15c/kg at the fishermen. This price is
easily doubled in dry periods. The fishing season lasts 2-3 months. The Okatana Canal was constructed in 1970 in order to alleviate water shortages in dry years. This canal forms a direct link between the Kunene and Olduvoi River Systems and also fills the 2700 ha Olushandja Dam. The Dam is not exploited very much because it is full of dead Mopane trees. A gill net survey showed this dam to have a tremendous fish population and high fishery potential. Here 28 fish species were collected. Owambo is now being invaded by Kunene River fish species that did not occur there previously. The fisheries of Owambo, although largely of a temporary nature, are an invaluable asset to that country. Olushandja Dam as well as Oponono Lake could provide a further more permanent source of protein if managed and cropped correctly. Extensive fish farming in oshanas near the canal is another possibility for the future.
A REVIEW OF FISH EXPLOITATION IN HOMELAND AREAS AND THE POTENTIAL FOR
FURTHER FISHERIES DEVELOPMENT
by Dr Ben C W van der Waal, Agricultural Advisory Services.

One of the functions of the Department of Plural Relations and Development
is help in the rational development of natural resources. This can however
not take place by departments, but should be put into practice by the
people, of course under the necessary guidance of agents such as Agri-
culture departments.

Most developing areas are well endowed with natural resources: Agricul-
tural potential, including grazing and crop cultivation, and Forestry.
Minerals are also found in many homelands and the nature conservation
and tourism potential has just recently been perceived. The fishery
potential forms an integral part of this asset and like nature conservation,
little attention has been given to it in the past.

Any water body that can sustain life has a fishery potential. That includes
estuaries, lakes, rivers, dams but also sewerage reclamation dams, flood
plains, temporary pans and dams.

Once this concept has been accepted, the next question arises: how can
we manage and exploit these water bodies with their potential?

Fishery management is practiced on different levels:
1. Exploitation of natural resources.
   Dams, rivers, lakes and swamps, usually large water bodies are
   usually exploited with a variety of apparatus, depending on their
efficiency, like seine nets, gill nets, trawls, long lines and
   traditional gear. In order to be effective, research has to be
   undertaken to establish aspects of the fish community and effective-
   ness and influence of gear. Monitoring of catches is also a very
   handy tool in management of such an extensive fishery.

   This can include the introduction and stocking of fish, manipulation
   of the environment eg. creating breeding areas, and even limited
   fertilisation. The same fishing techniques as in exploitation of
   natural resources are used and here it is very important that
   catches are monitored and their meaning interpreted. That means
that the fishery activities are controlled and managed as well as the fish populations themselves and also the environment to a lesser degree.

3. Fish farming.
   (a) Extensive.
   Smaller dams or specially constructed ponds are used and stocked with suitable fish species. Ponds may be fertilised to promote natural food and are usually harvested after a growth period.

   (b) Intensive.
   Apart from fertilising, fish are fed to a greater or lesser extent. In the most intensive practices, balanced pelleted food is fed to fish, making use of self feeders. Cages positioned in dams where fish are kept and fed, offers another variation to intensive fish culture.

Status of fishery activities and estimated fishing potential of water bodies in developing areas

Kwazulu
Josini dam
- No research or exploitation
Pongola flood plains
- Traditional baskets and new gill nets ± 5 inch (permanent income to 1-3 persons per pan)
Kosi bay
- Traditional fish kraals (permanent income to ± 50)
- No intensive research - Natal Parks Board report.
- Research needed.
Sibaya
- Very little exploitation
- Research by Rhodes University
- Potential for 10 people
Umfolozi lakes
- Little exploitation - gill and seine net
- little known - NPB surveys
- Potential for 10 people +
Venda
Luphephe - Nwanetsi dams
- (Research started by University of
Planned dams in Mutale River

Fisheries station, Sibasa

Gazankulu
Nwanetsi dam

Lebowa
7 dams near Olifants River

Glen Alpine dam

4 Dams in Lowveld near Bushbuck Ridge

Proposed Olifantspoort dam

Bophuthatswana
Klipvoordam

Houwaterdam

Skuinsdam and smaller dams and pans

Dams in Thabanchu

- Potential for 10+ people
- Research needed before closure of wall
- Production of Aischgrund carp and Mocambique tilapia as well as breeding station for fingerling production
- No fishing
- No research
- Potential for fishery of 10+ people
- Partly exploited by Nature Conservation Division at present
- Basic research and surveys on some of these dams by University of the North
- Potential for 15 fishermen
- No fishing or research
- Potential for 5 fishermen
- No fishing or research
- Potential for 3 fishermen
- Potential for fishery of 20 people
- BED fished the dam for a period
- A fisheries survey is presently undertaken
- Potential for recreation and fishery for 4+ people. Production potential of 140 ton/year.
- Potential for recreation
- All waterbodies can be exploited and pans stocked
- No research done
- Potential for fishery by 1 or 2 people

the North in 1978)
- No exploitation
- Planned: recreation (angling) and exploitation: 5 people and gill nets
- Potential for 10+ people
- Research needed before closure of wall
- Production of Aischgrund carp and Mocambique tilapia as well as breeding station for fingerling production
- No fishing
- No research
- Potential for fishery of 10+ people
- Partly exploited by Nature Conservation Division at present
- Basic research and surveys on some of these dams by University of the North
- Potential for 15 fishermen
- No fishing or research
- Potential for 5 fishermen
- No fishing or research
- Potential for 3 fishermen
- Potential for fishery of 20 people
- BED fished the dam for a period
- A fisheries survey is presently undertaken
- Potential for recreation and fishery for 4+ people. Production potential of 140 ton/year.
- Potential for recreation
- All waterbodies can be exploited and pans stocked
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<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qwaqwa</td>
<td>- Large potential for recreation and especially trout angling by tourists</td>
</tr>
<tr>
<td>Swartwaterdam</td>
<td>- Trout angling potential with stream improvement, stocking and control</td>
</tr>
<tr>
<td>Elands, Swartwater and other rivers</td>
<td>- Trout angling potential</td>
</tr>
<tr>
<td>Ciskei</td>
<td>- Some work has been done by University of Fort Hare</td>
</tr>
<tr>
<td>Dams in higher areas</td>
<td>- Production potential</td>
</tr>
<tr>
<td>Bridledrift and Laing dams</td>
<td>- Ecological study completed with management recommendations</td>
</tr>
<tr>
<td>Caprivi</td>
<td>- Fishery market established by white entrepreneur</td>
</tr>
<tr>
<td>Lake Liambezi</td>
<td>- Production can be trebled, yielded 1.6 tons fish per day in 1973</td>
</tr>
<tr>
<td></td>
<td>- Fished by ± 500 fishermen seasonally which can be improved by making</td>
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<tr>
<td></td>
<td>suitable nets available as well as an organised market. Traditional</td>
</tr>
<tr>
<td></td>
<td>funnells and fences used widespread for subsistence.</td>
</tr>
<tr>
<td>Eastern flood plain</td>
<td>- Survey has been undertaken</td>
</tr>
<tr>
<td></td>
<td>- Extensive local traditional subsistence fishery</td>
</tr>
<tr>
<td></td>
<td>- Potential for gill net fishery, limited as result of over exploitation.</td>
</tr>
<tr>
<td>Kavango</td>
<td>- Potential gill net fishery for 10 people, survey completed.</td>
</tr>
<tr>
<td>Kavango river and its flood plains</td>
<td>- Productivity estimated at 300t/year</td>
</tr>
<tr>
<td>Owambo</td>
<td>- Potential for 10 people using gill nets</td>
</tr>
<tr>
<td>Olushandja dam</td>
<td>- Can be fished intensively when</td>
</tr>
<tr>
<td>Lake Oponono</td>
<td>- flooded with traditional funnel</td>
</tr>
<tr>
<td>Oshanas</td>
<td></td>
</tr>
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</table>
Future planning
It has been estimated in Rhodesia that the natural productivity of eutrophic lakes is in the order of 100+ kg/ha of fish whereas the actual annual crop in the Oligotrophic Lake Malawi is 50 kg/ha. Where our water bodies range from oligotrophic to highly eutrophic, I feel that an average yearly crop of 100 kg of fish per ha is not too unrealistic, provided that our dams and fisheries are managed properly - a valuable asset for any country, that can yield tons of high quality protein annually.

With intensive production techniques production of 5 tons and more per ha can be achieved in ponds in South Africa. This can be 10 folded in cage culture as has been demonstrated in the Far East.

At present nearly all the water bodies in many developing areas are lying there without them being exploited. Fishery development should start here, exploiting the natural fish stocks.

What is needed now is an assessment of what we have in water bodies in homeland areas - and then to do basic research on suitable cropping techniques. More intensive forms of fish production will have to wait until enough technical skills have been developed by local people. Emphasis is therefore not placed at present on fish farming, but rather on development of small local fisheries on reservoirs.

Training of fishery technicians is therefore a high priority if we want to exploit and develop our fishery potential. A one year course in fishery technology has been planned for nature conservation assistants who have obtained the nature conservation diploma, or otherwise, have Form 3 certificate and suitable experience. These fishery officers will then be enabled to train local people in the basic skills of fishery and fish farming. Once the idea of exploitation of natural waters has caught on and a market is established, fishery management of a higher order, like fish farming, might become feasible - the possibilities are multiple.
EASTERN CAPE

Inland Fisheries in the Eastern Cape
Based on a talk given by Anton Bok on 3/4 May 1977

Inland Fisheries in the Eastern Cape includes the breeding and distribution of black bass and Tilapia from Amalinda and trout from Pirie. Work carried out from the Grahamstown office includes:
- general fisheries work
- study of the ecology of Myxias capensis and Mugil cephalus (Mullet species), both of which occur in fresh water in the Eastern Cape.
- Experimental studies at Amalinda

General fisheries work
Where there have been formal requests to commercially exploit fish in the dams, surveys of the fish population have been done. Such dams include the Van Ryneveld's Pass dam on the Sunday's River, Beervlei on the Groot River near Willowmore, Kommando Drift dam, and Lake Arthur on the Tarka River. A commercial netting permit was granted for Van Ryneveld Pass dam where operations started in November 1976.

As large areas of the Cape Province get too cold in winter for Tilapia mossambica to survive, a pilot experiment was carried out in a high lying area to see whether Tilapia stocked in spring could grow enough to reach a marketable size by autumn. A 0.5 ha pond outside Grahamstown was used and male Tilapia with an average weight of 60 grams stocked in November 1976 grew to an average of 431 gram by April 1977. The stocking density was low (532/ha) but no food was added and fertilisation was not very intense and consisted of 500 kg of dry kraal manure and 250 kg of 2-3-4 inorganic fertiliser added in small quantities roughly every two weeks between 13/1/77 and 1/4/77. The cleaned Tilapia were sold by the farmer to a local Fish Dealer and eagerly bought uncooked by both whites and blacks. This trial run shows promise for monosex (all male) Tilapia farming and by increasing the stocking density and also fertilising heavily, profitable yields should be obtained.

Two mullet species, M. capensis and M. cephalus, were also stocked. M. cephalus showed a growth rate of up to one gram per fish per day in summer, and so this fish should be able to be brought to a marketable size in two years. M. capensis does not grow as fast, but is a good angling and table fish, suitable for stocking in farm dams. Twenty
thousand have been stocked into Zeekoevlei in the Cape. These fish are available on request from Amalinda.

**Ecology of a Mullet Species: M. capensis**
The adult breed at sea and the young then move into fresh water where they spend 3-5 years. Thus barriers built into rivers, for example weirs, can wipe out whole populations of this fish; hence the need for fish ladders. (A fish ladder is a series of gradually stepped pools which enable fish swimming upstream to bypass an obstruction in a river.)

The possibility of artificially spawning these fish is being investigated. Adult M. capensis transferred from fresh to salty water have shown increased gonad development.

**Fish production studies at Amalinda**
The basic aim of the fish production research at Amalinda is to accumulate the necessary knowledge about fish farming, under local conditions, and to be able to assist and give advice to the commercial fish farmer.

In the initial production experiments which started in January this year, the local mirror variety of the common carp (*Cyprinus carpio*) was used. The local strain of the mirror carp has been under selection pressures under local conditions for some eighty years, and the preliminary observations at Amalinda and elsewhere showed this variety to grow very much faster than its full-scaled counterpart. It was therefore considered worthwhile to study the growth of the local mirror carp, under local pond conditions, to assess its potential for use in fish farming. Comparative work using the well-known and fast growing Aischgrund carp variety from Marble Hall, Transvaal, is planned at a later date.

In order to estimate the production increase of fish ponds due to treatments such as fertilisation and feeding, it is first necessary to know the natural productivity of the ponds and the initial experiments concentrated on quantifying this for the area. Further experiments on mirror carp will be concerned with increasing fish production by treatments such as:

1. supplementary feeding without fertilisation
2. fertilisation
3. supplementary feeding plus fertilisation
Some factors influencing natural production

Feeding and Fertilisation

1. Natural production: surface area; water depth; temperature; amount of sunshine; chemical characteristics of water; nature of pond bottom.

2. Feeding: food composition (protein, vitamin, energy etc. content); form of feed (water stable pellets, crushed, finely ground); feeding method (demand feeders, automatic feeders, hand feeding).

3. Fertilisation: type of fertiliser (organic manures, inorganic phosphates, nitrates); amount and frequency of application.

Once the initial work is over and suitable results are obtained the next step will be polyculture.

There have been three separate experimental runs:

1. Establishment of natural productivity

2. As no carp fry were obtainable after this, the experimental ponds were used to determine growth rates of two mullet species and the west coast haarder, Liza richardsoni.

3. A second series of carp experiments is under way. Ponds are being fertilised and carp are being fed various types of maize. Prices in East London make it unfeasible to feed pellets at 20c/kg with a food conversion rate (f.c.r.) of 1:2.

The principle of feeding maize is to prevent the carp from using protein for their energy requirements. Experiments include feeding with a new type of maize called "opaque 2" which has shown improved growth in rats and chickens.

GRAHAMSTOWN

In Grahamstown Mr Derek Whitehead has recently established a fresh water fish shop which has sold 5 tonnes of fish in its first 6 weeks of operation. The fish sold are mainly Labeo umbratus which have been caught
in gill nets in Lake Mentz and parts of the Bushmans and Fish Rivers. There fish have been selling at 40c/kg.

In mid-March, Mr Whitehead had a surprise haul of almost 250 kg of mullet in an hour from a dam near the coast. The fish had probably entered the dam from a nearby river during a flood, and had attained an average weight of 2.5 kgs each.

At the time of writing Mr Whitehead was facing the agreeable task of deciding what price to charge for his unusual catch - probably somewhere between 70c and R1-00.
Indigenous and exotic fish species

In the Transkei the natural fish population of the rivers is rather poor. About ten fish species are found, four of which are Eels: Anguilla mossambica, Anguilla bicolor, Anguilla marmorata and Anguilla nebulosa labiata, while other fish found include Tilapia mossambica, Barbus natalensis, Barbus anoplus, Sandelia bainsii (canary kurper), Monodactylus falciformis (moonfish), and Glossogobius giurus (goby). With the exception of Eels, Tilapia (found in the warmer waters near the coast) and Barbus natalensis (found in the tributaries of Umzimkulu river) the other fish species are too small to provide angling sport or to serve as a food source.

Consequently some exotic fish species have been introduced to provide angling and food. The earliest introduction was the common carp (Cyprinus carpio) (1896), then introduced into farm dams in Matatiele and now spread into the Umzimvubu river system. The next introduction was trout which has spread to suitable waters.

The latest introduction includes Large mouth bass (Micropterus salmoides) between 1930-1954. This introduction has proved most successful. In 1953 ponds for breeding Large mouth bass were established at Bolo College of Agriculture. From this source Large mouth bass has been obtained for stocking virtually all suitable dams in the Transkei.

Other introductions include Blue gills (Lepomis microchirus), Small mouth bass (Micropterus punctatus). Also introduced into the Transkei from the Transvaal is the Barbus holubi and Tilapia sparrmanii.

As in many other African countries fish farming and fish culture in the Transkei is still a novelty and most of our work is still in the planning stage. However, there is already a trout hatchery at Mhlahlane about 27 km north west of Umtata, from which all trout suitable waters will be stocked. Also at this station trout production will be studied as well as the possibility of marketing this fish. For comparative purposes in these production studies silver carp and grass carp will be introduced at Tsolo. The fish will be obtained from Israel.

Also planned is a complete distribution survey of indigenous fish in the Transkei, their geographic variations, and relative abundance. This kind of survey is particularly opportune now that the Transkei stands at the
start of industrial development, which will be accompanied by water pollution.

It is therefore essential to be able to pinpoint the dangers and determine the effects of these changes on fish. This will affect the formulation of environmental impact statements.

The Transkei is also of particular scientific interest because it covers the transitional area between tropical Natal and the temperate to cold Cape rivers.

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**Madwelani: a Hospital garden fish farm**

In December 1977 EDA fieldworker Ross Duncan-Brown visited Madweleni Hospital near Elliotdale and assisted Dr Harry Kanis in setting up a small fish farm in the Hospital gardens.

There are three sewerage maturation ponds at Madweleni and also a fourth dam which has a built-in sluice. Tilapia were obtained from Amalinda in January 1978 and have been placed in one of the ponds, where their growth is being monitored. At the end of the year when the Tilapia have bred, Dr Kanis hopes to use the other ponds for monosex culture (all males) and conduct practical growth studies under Transkei conditions.

Supply of fingerlings is a great problem because of distances, and the fact that the Transkei Hatchery does not seem to have come into operation yet. Dr Kanis has offered to give his excess fingerlings away at the end of the year, provided they are fetched from Madwelani.

The EDA fieldworker spoke at a recent Conference of the Transkei/Ciskei Research Organisation in Umtata, and discovered that there was a keen interest in fish farming among those conducting development work. It seems likely therefore that there will be more fishing activity in that area in the future.
NOTES ON VARIOUS TYPES OF FISH

Indigenous fish - Barbel
One of our chief advantages of our barbel species for food production is their ability to survive in a small amount of water. The barbel, for instance Clarias gariepinus, has an accessory air-breathing organ.

The chief disadvantages of this fish are its predatory nature and its tendency towards cannibalism.

Tilapia
For the person interested in the culture of Tilapia, the booklet, "Fish farming with Tilapia in Natal" is available from the Natal Parks Game and Fish Preservation Board. Officers of the Natal Parks Board, in particular Mr Tom Pike, can be contacted for advice.

Probably the main disadvantage of Tilapia as a production fish is its low tolerance of cold water. Tilapia mossambica will die if the water temperature drops to 8°C. Moreover, it will not grow at temperatures below 20°C. This would tend to suggest that Tilapia are entirely unsuitable for culture in colder areas. However, this is not strictly true; since experiments at the Umgeni hatchery and at Grahamstown have shown that T. mossambica can be brought to a good marketable size during a limited summer growing period. The farm dam used at Grahamstown, incidentally, is in an area susceptible to frost. In this respect it will be interesting to note the behaviour of T. mossambica which have recently been discovered in Lake Mentz in the Eastern Cape.

Advantages of Tilapia are their omnivorous feeding habits and their good response to a diet of natural food.

The fecundity of Tilapia, which begin breeding at an age of 4 months, can be seen as both an advantage and a disadvantage. It is an advantage in that it cuts out the need for small fish farmers to rely on a central hatchery for fingerling supplies. It is a disadvantage in that it requires the relatively complicated management procedures of sorting or sexing the fish to avoid overpopulation.

One probably cannot expect from Tilapia the kinds of productivity one can get from carp, for instance, 4 tons/hectare under intensive culture in Lesotho. Thus Tilapia may not compare to carp in a purely economic...
sense. However, Tilapia farming does not require expensive direct feeding, nor are there transport costs related to fingerling supply. For the underdeveloped rural area, Tilapia culture, especially if integrated with other forms of agriculture could have tremendous potential.

**Moggel** *(Labeo umbratus)*

The moggel or mud mullet is endemic to many waters in South Africa, in particular the Karoo river systems. This fish has been successfully harvested by gill nets from Lake Mentz and sold at about 50c/kg at Uitenhage. However, competition with commercial sea fisheries appears to have put this particular operation out of business. Little is known, however, of this fish as a candidate for intensive culture in ponds.

**Mullet**

Mullet has been used as a component of polyculture in Israel. In South Africa, Anton Bok is doing research on the ecology and potential of two indigenous mullet species. The drawback of mullet is that they don't breed in fresh water and have a relatively slow growth rate. Their flesh however rates as excellent.

**Exotic fish - Trout**

Trout farming is the best-established form of fresh water fish farming in South Africa. However, this survey has not dealt with trout since it is tied to a luxury market and this, combined with its water requirements and high level of management make it unsuitable for underdeveloped areas.

**Carp**

The success of carp farming as a development project in Lesotho where conditions with regard to temperature are far from ideal, points to the tremendous potential of carp. The chief disadvantage of carp culture as practised in Lesotho is its dependence on direct feeding. In areas where families struggle to feed themselves, one can hardly expect them to use mealies or grain to feed the fish.

Carp do not need direct feeding to grow well, however, and it may well prove more economical to fertilise ponds than to feed. EDA's experiments in the Cape using small quantities of chicken manure have shown that growth rates of 3g/day in 250g carp can be obtained without direct feeding.
Although carp is considered a delicacy in Europe, Israel and the East, farmers in the Transvaal who have attempted to find a market amongst South African whites have been unsuccessful, perhaps due to competition from sea fish. However, results in Lesotho and at Hectorspruit suggest that there is a good market among blacks for carp.

**Silver carp and grass carp**

These are recent imports to Southern Africa. The silver carp has been shown to be a good component in polyculture. The grass carp is being cultured and bred at the Umgeni hatchery.
PROPOSED DEVELOPMENTS FOR THE FUTURE

Proposal: For the establishment of a training centre for Fisheries Science at Rhodes University, Grahamstown

The management and culture of marine and freshwater aquatic organisms, particularly fish, is becoming increasingly important to feed and provide employment for the world's very rapidly growing human population. South Africa has a large marine fishery and rapidly growing emphasis is being placed on freshwater potential, proved elsewhere in the world to be of such value in the feeding and employing of dense human populations. Such potential is particularly important in the development of African rural areas.

Considerable provision for the training of personnel for employment in research, development and management of the fisheries industry exists in most large countries of the world. The College of Fisheries at the University of Washington in Seattle, the Shimosenko College of Fisheries, Tokyo University and the large aquaculture training faculty at Auburn University, Alabama, are only a few examples out of many, and over a million graduates from them are currently employed. Nowhere in South Africa, however, is there yet any such graduate training offered. Any South African of whatever race who wishes to specialise in this growing and important profession must go overseas for training.

Rhodes University is by situation and existing infrastructure in an ideal position to offer such a course. It is 40km from the sea, midway between two important fishing ports, in the centre of a well-watered agricultural area ideally suited for aquaculture and adjacent to large African "home­lands" where aquaculture integrated with intensive agriculture would be of the greatest value.

At its JLB Smith Institute of Ichthyology the University currently accepts students of all races for higher degrees in the formal science of Ichthyology, ie. the study of classification, anatomy, relationships, etc., of fishes. It has a large building, one of the best libraries on general fisheries in the world and considerable expertise among the present staff. At Rhodes as well is the Institute for Freshwater Studies, again famous for its basic research and with an excellent library and staff.

Rhodes however, as is the case with other South African Universities, cannot as yet offer courses in the related science, internationally
known as Fisheries Science, which embraces the skills necessary for the development and management of fish as a natural resource, such as aquaculture, population dynamics, development, productivity, capture and management techniques etc.

That there is a demand for qualified Fisheries Scientists is revealed by the fact that there are over 100 professional posts established in this field in Government alone, with others in private enterprise, with current estimated vacancies of around 10 per annum. The potential for valuable development in South Africa in general and the African homelands in particular, of which we are on the threshold, is little short of enormous.

In view of this great need and potential, it is proposed that Rhodes University be funded to expand its Institute of Ichthyology into a Department of Ichthyology, offering specialised training in all branches of Fisheries to students of all races.
EDA AQUACULTURE PROJECT
by Ross Duncan Brown
March 1978

EDA has built up a resource centre in Cape Town containing information and articles on fish culture locally and abroad. There is a vast quantity of aquacultural literature available, so we have been selective to some extent, favouring practical information rather than scientific papers.

Much of the research work that is done tends to circulate primarily among research workers. We hope to aid the dissemination of such material into projects that can make practical use of past research work. At the same time through our workers and friends, and through "Link", the EDA magazine, we are spreading the idea of fish culture as a potential rural development.

Practical Experiments
Two projects are being undertaken at present in Cape Town. One is a viability study of fish culture in floating cages, and the other involves more or less conventional fish farming in some local dams. EDA's emphasis has been on fisheries development appropriate to the needs of areas experiencing protein shortages - the so-called underdeveloped areas. Bearing this in mind we have utilised existing dams for our projects rather than constructing made-to-order fish ponds. We believe that if fish farming catches on at a grassroots level it will bear little resemblance to the model rectangular pond with sloping bottom, monks weir, and demand feeder.

There are two aims to these experiments. Firstly, there is a shortage of people who know anything about fish farming. It's a mistake to assume that the personnel at the Government Harcheries are experts on fish farming. In fact it is generally not within their field at all. We've therefore aimed at interesting voluntary workers in our programmes and given them a chance to actually handle fish. This gives them some insight into the fish farming process so that they do not advertise fish culture as a rural development without understanding some of the practical problems themselves. It is important to realise that fish farming by itself is no panacea for nutrition problems. At best it is merely one element, albeit an important one, of our integrated development approach.

The second aim of EDA's experiments was to experience the practical
difficulties of starting up low budget fish culture without government aid or supervision. One comes across many ideas and suggested innovations in fish farming manuals, and we felt we needed somewhere to test them. We don't want to recommend anything that can't work in Southern Africa.

Practical difficulties
So far we have experienced a wealth of constructive failure: there seems no better way of learning. Perhaps the biggest difficulty has been with initial supply of fish. One assumes that this is a simple matter of approaching one's nearest hatchery. I was surprised to find that there is nowhere in the Cape where one can obtain carp commercially. As for Tilapia - I was told I could buy some fingerlings in Mid-October but as time passed this date stretched to early January, which is of course too late.

I got around the problem by netting wild carp and Tilapia with a throw net and breeding them myself. This leaves you with the problem of having quite a weight variation to start with. It also makes it difficult to claim scientific precision in ones growth rate figures. But the fact that one is using existing dams and not constructed ponds makes this a difficulty anyway. Next season I will have more than enough fish to start with. But how will the small farmer in an isolated area get his supply?

Another difficulty has been finding dams. At present I'm using seven dams and an eighth at the University of Cape Town. I have found that this number is really more than one individual can handle. The picture hasn't always been like this however. At one stage in late October 1977, I was down to one dam which was rapidly drying up. Fortunately that crisis passed, and I don't see any further problems in that area.

I've welcomed the fact that we've been restricted financially to the use of existing dams. I think the future of fish farming South Africa lies not so much in the constructed ponds, but in conservation dams and small dams that are fulfilling some other function primarily. At times I think we tend to lose sight of the fact that we are part of the Third World and must make use of what we've got.

Farm dams do however, create a number of problems. They are often too deep and irregular for the use of seine nets, and contain all sorts of submerged objects - from trees to motor cars - which damage one's equipment
After a lot of trial and error I've found that very good results can be achieved with a throw net for sampling, and a gill net for harvesting.

**Cage Culture Project**

This project is being run at University of Cape Town in conjunction with the Envirac Aquaculture Committee, which is a section of the student's environmental group. The cage (30m$^3$) consists of a frame 5m x 6m which floats on drums. The cage itself hangs in the water, suspended from the frame.

We got going too late for summer, but we have 100 Tilapia in the cage now and we'll see how they do through the winter. Before next summer we'll have to build another cage to act as a control. I'm very interested to hear from anyone who knows anything about cage culture.

**Future Plans**

At the end of the year we intend holding an Aquaculture Conference to discuss the fisheries potential of Southern African and work out a strategy for fisheries development in the future. One of the things that emerges from this survey is that people involved in the field need to get together on a person to person basis and swap information and skills. A conference of this nature is long overdue, and I think it could answer a lot of pressing questions and interchange of ideas.

For the scientist there will be the challenge of relating scientific research to practical goals. For the layman and the farmer there will be an opportunity to meet and discuss fish culture with experts. We expect this conference will be very fruitful.

The conference is still in the planning stages, venue and dates have yet to be finalised. We would welcome suggestions on any aspect. Interested parties should contact the EDA Cape Town Office.
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Introduction to Carp Farming: Dr E J Kruger, Nature Conservation Division, Transvaal Provincial Administration, Pretoria 1975.

Fish Culture (2nd ed): C.F. Hickling (Faber & Faber) 1971.


Fish Farming with Tilapia: Natal Parks, Game and Fish Preservation Board

Elementary guide to Fish Culture in Nepal: Dr E Woynarovich (FAO) Rome 1975


The Environmental and Development Agency (EDA) is a small group which facilitates work in the environmental and development field in Southern Africa. This is done by

- Running a resource centre which collects technical and developmental information from around the world and making it available to community groups in Southern Africa.

- Running a fish farming project to develop simplified aquaculture techniques and to test the economic viability of fish farming in Southern Africa.

- Researching and building appropriate technology equipment and testing these prototypes in communities with a view to eventual co-operative production.

- Editing a sourcebook of development information for the whole of Southern Africa. (Due to be published in mid 1979).

- Undertaking fieldwork to link up isolated development/community organisations and put them in touch with each other.

- Offering technical advice.

- Assisting with the organisation of seminars and conferences dealing with development, environmentally related matters and community work in Southern Africa.

- Publishing LINK, a two-monthly magazine, which carries news about EDA's work, technical information and articles of general interest to community workers.