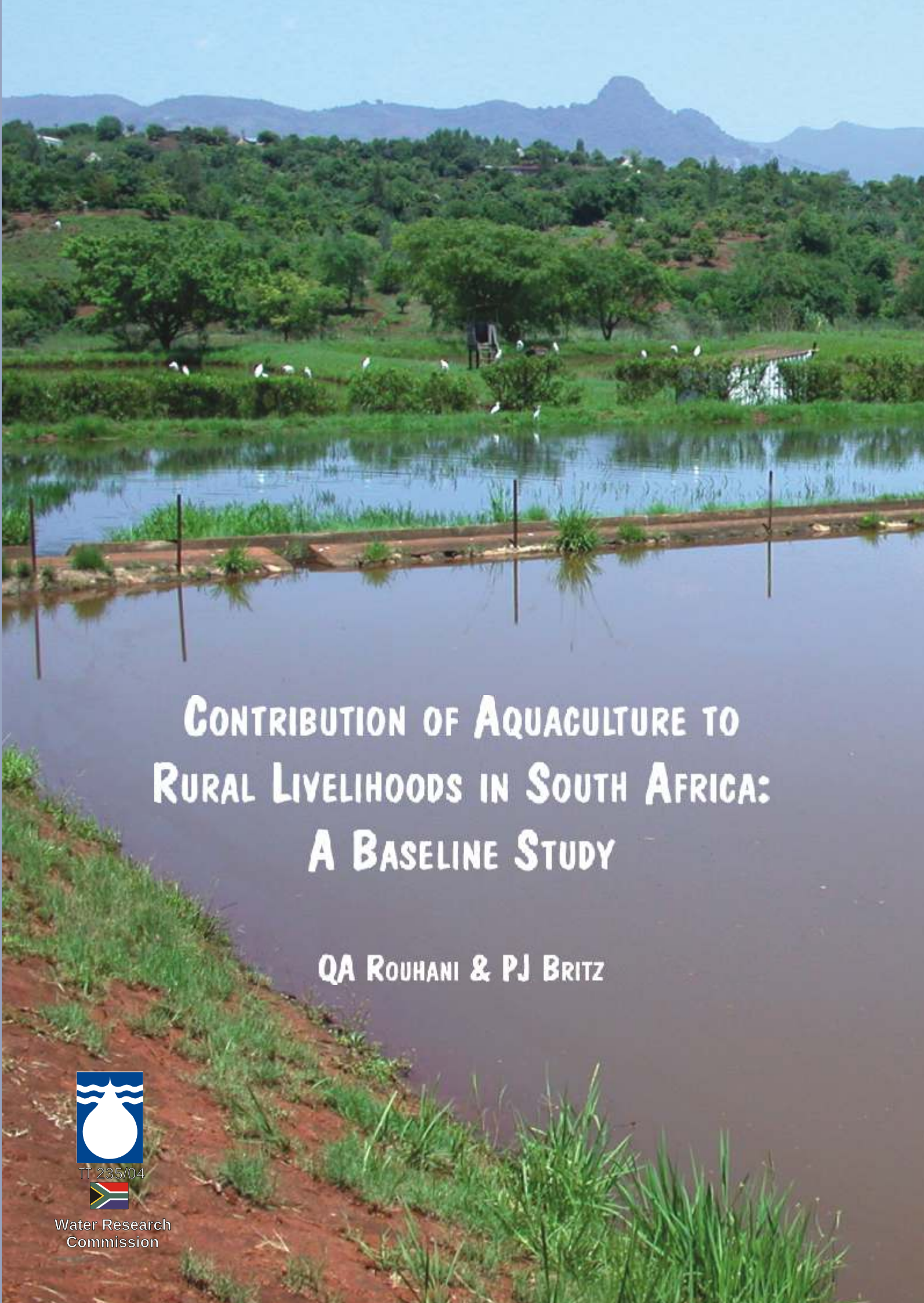


Contribution of Aquaculture to Rural Livelihoods in South Africa: A Baseline Study

QA Rouhani & PJ Britz

TT 235/04

Water Research Commission

CONTRIBUTION OF AQUACULTURE TO RURAL LIVELIHOODS IN SOUTH AFRICA: A BASELINE STUDY

by

Q.A. Rouhani & P.J. Britz

Department of Ichthyology and Fisheries Science
Rhodes University

Rural Fisheries Program
P.O. Box 94, Grahamstown, 6140, South Africa

Report to the Water Research Commission

March 2004

WRC Report No : TT 235/04

Obtainable from:

Water Research Commission
Private Bag X03
Gezina
0031

The publication of this report emanates from a project entitled: *Contribution of aquaculture to rural livelihoods: A baseline study* **(WRC Project No. 1466)**

ISBN No. 1-77005-186-4

Printed in the Republic of South Africa

ACKNOWLEDGEMENTS

The research in this report emanated from a project funded by the Water Research Commission and entitled:

Contribution of aquaculture to rural livelihoods: a baseline study

The Reference Group responsible for this project consisted of the following persons:

Dr G. R. Backeberg	Water Research Commission
Dr W Gertenbach	Dept of Agriculture (Western Cape Province)
Mr K. Ramsey	National Department of Agriculture
Mr J. Rossouw	Department of Water Affairs & Forestry
Dr H. Kaiser	Rhodes University
Mr D. Impson	Nature Conservation (Western Cape Province)
Prof P.J. Britz	Rhodes University
Mr. Q.A. Rouhani	Rhodes University

The financing of this project by the Water Research Commission and the contribution of the members of the Reference Group is gratefully acknowledged.

The authors wish to thank the following people for assisting in administering the questionnaires and for their local knowledge:

Western Cape
Dr Danie Brink and Mr Khalid Salie from Stellenbosch University.

Limpopo Province
Prof Eddie Meyer and Ms Kagiso Maponya from the Aquaculture Unit of the University of the North, and Mr Jacky Phosa of the Department of Agriculture.

Kwazulu Natal
Mr Stephen Goetze and Mr Mbongeni Khanyile of Makatini Research Centre.

Mpumalanga Province
Dr Johan Engelbrecht and Mr. Richard Siwelave of Mpumalanga Parks Board.

Thanks are offered to Dr CLW Jones for his contribution in writing this document.

Thanks are also offered to all of the fish farmers who were interviewed and who gave us their time and thoughts regarding the status and potential of aquaculture.

CONTENTS

EXECUTIVE SUMMARY

Introduction

Aquaculture is the beneficial and sustainable use of water as a medium in which to farm organisms, such as finfish, shellfish and aquatic plants, for example. The definition of aquaculture does not include fisheries, where surplus fish are harvested from populations in extensive water bodies. Fresh water aquaculture can contribute to economic development and food security in rural areas of South Africa. Policies that support aquaculture development in this country are being developed by the National Departments of Agriculture and Water Affairs and Forestry. However, the major constraint in formulating policy is the lack of information on the status and the potential contribution of aquaculture in rural areas. This was recognised during an aquaculture workshop organised by the Water Research Commission (WRC). Representatives of different stakeholders agreed that a baseline and scoping study was required to determine the contribution of aquaculture to rural livelihoods and to identify priorities for further research.

The specific objectives of the study were to:

- Establish the present and potential contribution of aquaculture and related activities to rural livelihoods;
- Investigate and provide reasons for disparities (if any) between the present and potential contribution of aquaculture to rural livelihoods;
- Identify problems that require attention for research and/or extension in order to provide practical useful solutions;
- Propose topics and terms of reference (objectives, rationale and deliverables) for priority water-related research projects in aquaculture.

During the survey stakeholders and participants in rural aquaculture projects were visited and interviewed in five provinces, namely the Limpopo, Mpumalanga, Kwazulu Natal, Eastern Cape and Western Cape Provinces.

Background to Aquaculture Development in South Africa

Aquaculture is globally growing faster than any other food production sector. This fact seen together with the pervasive poverty in rural areas creates a powerful policy incentive to promote rural aquaculture where suitable conditions exist. Aquaculture development in South Africa was initiated by the colonial authorities who established provincial hatcheries to stock angling waters with exotic species such as trout and bass. During the 1980's a series of hatcheries and production units were built in the former homelands (Venda, Lebowa, Gazankulu, Transkei) to promote aquaculture for food security. Commercial aquaculture also established itself around this time resulting in the production of trout, barbel, ornamental species and several marine

species. In the post-apartheid era a few small-scale commercial aquaculture projects have been initiated to promote emerging farmers and black economic empowerment. This survey provides an assessment of all previous initiatives and reports on their status.

Baseline Survey Results

Present Contribution of aquaculture to rural livelihoods

The contribution of aquaculture to the livelihoods of rural communities was found to be negligible. Of the five provinces surveyed, only two (the Western Cape and the Limpopo Province) had functioning projects. In the Limpopo Province, the 10 farms surveyed collectively produced between 5 and 10 tons of fish per year (Carp, tilapia and catfish). The estimated profit made was approximately R50000. Fifty farmers were associated with these 10 projects. Therefore, on average, each farmer made R1000 per year. In the Western Cape, the three trout cage-culture projects that were surveyed collectively produced a total of 16 to 18 tons of trout per year. The estimated profit that the farmers made per year was between R64000 and R68000. The total numbers of fish farmers associated with the three projects was 30; therefore, on average each farmer made about R2200 per year. Despite a fairly long history of public sector initiatives to establish rural aquaculture, no organic growth occurred in the sector.

The poor track record of aquaculture projects in rural areas points to a fundamental problem in the development approach that has been applied to date. Given that the state's emerging aquaculture policy places an emphasis on food security in impoverished rural communities, it is important to analyse why the projects failed, as there is a risk that the same mistakes would be made in a renewed round of public sector spending on rural aquaculture.

Why has rural aquaculture not realised its potential?

The survey revealed that rural aquaculture is not constrained by available land, water and infrastructure. Despite previous efforts to promote the rural aquaculture sector, no organic growth has occurred and those projects that had not been provided with ongoing technical support had failed. "Small scale commercial" aquaculture projects were found to be more viable than "food security" projects.

The survey results revealed that all "food security" type aquaculture projects identified were effectively dysfunctional or had failed. The products being produced were of low value, and no commercial aquaculture sector existed for these species. Participants possessed rudimentary education, little personal capital, and were poorly trained in aquaculture techniques. Simple problems often resulted in project dysfunction or failure. Most projects had too many participants and the level of income per participant was very low. The level of extension and technical support to these projects was low as a result of a decline in Government extension services. Most Government hatcheries have been privatised and training facilities are dysfunctional. This has had a negative effect on the development of new rural aquaculture projects. All "food

security" type aquaculture projects were found to be unsustainable without ongoing technical support, and probably some structured "low interest" loans for set-up and input costs.

The commercially orientated small-scale aquaculture projects (e.g. small scale trout farmers in the Western Cape Province and the Dakari Ornamental fish project) were intrinsically more viable than the "food security"type projects. . The technologies employed were more capital intensive and technically demanding than the food security projects. The availability of formal markets for their products and an existing private sector producing these species enhanced the financial viability of the projects. Participants were better educated and possessed some personal capital. The major weakness in all projects was a lack of training and experience in aquaculture and all projects required extension and technical support.

The results of the survey suggest that the establishment of a rural aquaculture sector, which can utilise the potential aquatic resources in a sustainable way for the benefit of rural communities, will be entirely dependent on sustained public sector led intervention. The failure of "food security" type aquaculture projects, initiated in the past by the public sector, and the decline of public aquaculture facilities should receive careful consideration in the drafting of new aquaculture policy and sector plans. Given the poor track record of the public sector in sustaining support to aquaculture projects, and the relative success of small-scale commercial projects, future policy should emphasise linkages to the existing private aquaculture sector by means of community-public-private partnerships.

Misguided development policies of the past and the lack of direction of many of the government facilities highlight the need for an aquaculture policy, appropriate sector plans and the allocation of appropriate resources.

Environmental potential for aquaculture in rural areas

In general, the environmental potential for developing rural aquaculture is good in certain areas of South Africa. However, factors such as land and water rights, land use patterns, economic viability the capacity of rural communities to undertake aquaculture, and environmental sensitivity, collectively determine which areas may be appropriate for rural aquaculture development. A need was identified to collect information in a GIS format to identify the potential for rural aquaculture at a higher level of resolution.

Potential of aquaculture for food security

Given the poor performance of "stand alone" food security aquaculture projects the question needs to be asked: "Can rural aquaculture projects be viable, and can they contribute towards food security in rural areas?" Given the circumstances of impoverished rural communities (Appendix II) who have suitable water resources for aquaculture, it was argued that aquaculture for food security can only be promoted in two ways: firstly, as an "on-farm diversification

strategy" for emerging farmers and secondly, in the form of "culture based fisheries" for subsistence farmers.

A "culture based fishery" is a form of extensive aquaculture that resembles a fishery where the volume of fish produced per unit area is low but input running costs are also very low. For example, fish will rely on natural production in a pond as their primary source of food (just as they would in a fishery); however, natural production in the pond may be enhanced by adding animal manure to the water, which increases carrying capacity of the pond. Such systems may not generate substantial financial returns to rural communities, but in rural parts of South Africa where unemployment is so high (Appendix II), a small increase in food security, particularly protein, will have a significant effect on the livelihoods of the people.

Potential for Small-Scale Commercial aquaculture

Commercial aquaculture requires a higher level of sophistication and organisation than aquaculture for food security. In commercial aquaculture, the product is usually intended for formal markets that demand consistency and reliability in production and quality. The experience of the small scale trout aquaculture projects in the Western Cape Province, the Dakari ornamental fish projects and the former Amatikulu satellite farmer project demonstrate that small scale commercial aquaculture in rural areas is possible, provided technical support is sustained, and there is an established link to an existing private sector. Community-public-private partnerships may be a suitable vehicle for promoting small-scale aquaculture projects.

The role of the public sector

Experience to date shows that a rural aquaculture sector will not develop organically, nor will the private aquaculture sector of its own accord assist resource poor rural farmers to any meaningful extent. Therefore, if the opportunity to promote rural livelihoods by means of aquaculture is to be realised a sustained public sector intervention is required. This includes training, assistance with start-up, provision of long term technical assistance through public sector extension services and community-public-private partnerships. A public sector commitment on this scale requires clear policy objectives, sectoral plans and institutional coordination. The role of the public sector was analysed in terms of emerging policy, the future of existing public sector aquaculture facilities, community public-private partnerships and inter-departmental coordination.

Proposed research topics

One of the objectives of the WRC Rural Aquaculture Baseline Study was to identify suitable research topics to promote the development of the sector. On the basis of the findings of the study, five possible research projects have been identified:

1. GIS Database of Suitable Areas for Rural Aquaculture including small water bodies and environmentally sensitive exclusion zones.

2. Supplementary species for cage culture for trout farmers in the Western Cape Province.
3. Culture Based Fisheries in small and large Dams
4. Recreational fishery development in rural areas
5. Evaluation of the role of provincial fish hatcheries and training facilities.

BACKGROUND TO THE WRC RURAL AQUACULTURE BASELINE STUDY

Rationale

Aquaculture is the beneficial and sustainable use of water as a medium in which to farm organisms, such as finfish, shellfish and aquatic plants, for example. The definition of aquaculture does not include fisheries, where surplus fish are harvested from populations in extensive water bodies. Policies to support aquaculture development are being developed by the national Department of Agriculture and the Department of Water Affairs and Forestry. The major constraint for developing a sustainable aquaculture policy is the lack of information on the status and the potential contribution of aquaculture in rural areas. This was recognised during an aquaculture workshop organised by the Water Research Commission (WRC), and representatives of different stakeholders. It was agreed that a baseline and scoping study was required, which would analyse the current situation and identify priorities for further research. This report is the product of the baseline study, which determined the actual and potential contribution of aquaculture to rural livelihoods in selected regions of the Limpopo, Mpumalanga, Kwazulu Natal, Eastern Cape and Western Cape Provinces.

The specific objectives were to:

- To establish the present and potential contribution of aquaculture and related activities to rural livelihoods;
- To investigate and provide reasons for disparities (if any) between the present and potential contribution of aquaculture to rural livelihoods;
- To identify problems that require attention for research and/or extension in order to provide practical useful solutions;
- To propose topics and terms of reference (objectives, rationale and deliverables) for priority water-related research projects in aquaculture.

Study design

The study was led by Rhodes University's Rural Fisheries Programme, in collaboration with aquaculture specialists from tertiary institutions and government departments in the five provinces. Each collaborator was visited to discuss the objectives of the project and to formulate strategies for implementation of the survey. At these meetings the design of the survey questionnaire was discussed and contributions were noted.

The survey questionnaire (see Appendix I) was circulated to the project collaborators and the Reference Group for comments, and tested in the field by interviewing the manager of the Eastern Cape government's Pirie hatchery. To ensure that the administration of the

questionnaire was standardised, a single researcher (Q. Rouhani) visited all project collaborators, fish farms and provincial facilities in all provinces.

Reference group

The preliminary results of the survey were discussed at a workshop where the project Reference Group and collaborators were present. The comments, suggestions and workshop outputs were incorporated into the analysis of the study and the subsequent report.

RURAL AQUACULTURE IN SOUTH AFRICA: CONTEXT AND HISTORY

Aquaculture in South Africa has a fairly long history of Government led interventions dating back to colonial times, which parallels aquaculture development initiatives in other countries. Aquaculture as a modern farming industry has boomed on a global scale since the 1980's but its growth in Africa, including South Africa, has been below expectation. In the section below we place South African aquaculture in an African and global context, and briefly sketch its history.

Aquaculture – A Global Perspective

On a global scale, aquaculture is growing more rapidly than any other food producing sector. World aquaculture production, including all aquatic animals and plants, totalled 45.7 million tons in 2000 and was valued at US$56.5 billion (FAO, 2002). In 1997, farmed fish, crustaceans and molluscs contributed 3.9% of total world fish supplies, and this figure had increased to 27.3% by 2000 (FAO, 2002). The global aquaculture industry is a heterogeneous sector with more than 210 registered farmed aquatic animals and plants. Finfish made up just over 50% of global aquaculture production in 2000 (FAO, 2002). On average, global aquaculture has experienced a compounded growth rate of 9.2% per year since 1970 (FAO, 2002). This is considerably greater than that of fisheries and the terrestrial agriculture sector, which experienced an average compounded growth of only 1.4% and 2.8%, respectively for the same period (FAO, 2002). This trend is set to continue as world fishery production has effectively levelled off, the demand for fish is increasing due to population growth, and the shortfall in supply will have to come from aquaculture if per capita consumption is to be maintained. The imperativeness for Governments to develop policies to support the growth of aquaculture is therefore very compelling.

Seventy-one percent of the fish produced from aquaculture in 2000 (i.e. 63 million tons) was used directly for human consumption, and most of the balance was reduced to meal and oil (FAO, 2002). Sixty one percent of world aquaculture production that was consumed by humans underwent some form of processing before market, and of that, 53.7% was consumed fresh, 25.7% was frozen before consumption, 11.0% was canned and 9.6% was cured (FAO, 2002). The per capita supply of food fish from aquaculture globally (excluding China) has increased four-fold in the past three decades, from 0.6 kg in 1970 to 2.3 kg in 2000 (FAO, 2002). This

suggests that the contribution made by aquaculture to global protein security has continued to increase per capita, in spite of global human population growth.

Aquaculture – An African Perspective

Africa's contribution to global aquaculture production is extremely low relative to the contributions made by other continents. Africa contributed only 0.4% of global production in 1995, compared to 87.7% from Asia and Oceania, 6.7% from Europe, 1.6% from South America, and 0.7% from the former USSR during the same year (Hecht and De Moor, 1997).

However, in line with global trends, the aquaculture industry in Africa has also experienced considerable growth over the past few decades. For example, African aquaculture production, including finfish, shellfish, molluscs and aquatic plants, increased from 11,800 to 82,014 tons between 1985 and 1995; that is an eight-fold increase in only 10 years (FAO, 1997; Hecht and De Moor, 1997).

The production of fish and shellfish from the African continent totalled approximately 79,500 metric tons in 1998; 57% of this was produced by three countries bordering the Mediterranean, with Egypt producing most (i.e. 43,000 tons) (Hecht, 2001). Thirty-tree sub-Saharan countries produced the remaining 34,000 metric tons, of which 93% can be attributed to 6 countries, viz. Nigeria (16700 tons), South Africa (4500 tons), Zambia (4100 tons), Zimbabwe (3800 tons), Namibia (1300 metric tons) and Kenya (1100 tons) (Hecht, 2001). The other 27 countries for which statistics are available produced a total of only 2500 tons (Hecht, 2001). Most of the product in the six major producing countries originated from relatively large and capital intensive private operations or joint ventures between the private and the public sector, whereas by contrast, the farms in the 27 minor producer countries are small-scale or subsistence operations (Hecht, 2001). Hecht (2001) concluded from this summary that national aquaculture development programs for rural areas in most sub Saharan countries have not been sustainable, despite substantial international donor funding and despite a highly suitable environment for the extensive culture of tropical and subtropical species.

Since the 1950's aquaculture has been regarded as a potential source of cheap protein for rural subsistence communities. Most development efforts by the former colonial administrations, and subsequently by independent Governments backed by donor aid, have been directed at introducing aquaculture into the small-scale farming sector which constitutes the backbone of Africa's rural economy. These efforts spanning half a century have largely failed and in recent times a number of analysts have tried to explain the reasons for this. They include the following:

- There is a "… lack of appreciation of the basic requirements [for small-scale aquaculture in Africa] at all levels, from central government to the individual farm household…"

(ICLARM & GTZ, 1991; Hecht and De Moor, 1997), and furthermore, "…nowhere in Africa is there an awareness that the development of aquaculture must be firmly integrated within overall and comprehensive rural development programmes…" (ICLARM & GTZ, 1991; Hecht and De Moor, 1997); to summarise, the direct transfer of northern hemisphere technology is not possible without taking local social, cultural, and economic conditions into account;

- In some instances, aquaculture has been promoted in regions that are unsuitable in terms of climate, infrastructure and market (Hecht and De Moor, 1997);

- Major technological constraints include inadequate supply of fish feed ingredients, prohibitive transport costs and a lack of juveniles for stocking ponds (Hecht and De Moor, 1997);

- Administrative constraints include a lack of coordination between development and research, limited availability of finances, inadequate collaboration within and between administrative departments, a lack of stability of institutional frameworks and inefficient rural extension system (Hecht and De Moor, 1997);

- Social constraints include an absence of a traditional culture of fish farming in sub-Saharan Africa, limited availability of well-trained senior personnel, security issues such as theft of equipment and poaching of stock, and poorly trained extension officers (Hecht and De Moor, 1997);

Notwithstanding the above constraints, the following text from Hecht and De Moor (1997) appropriately directs the way forward for small scale aquaculture in sub-Saharan Africa:

> Aquaculture…definitely has a place in Africa… However, we must always be mindful of the fact that aquaculture is an economic activity no matter how small the scale of the enterprise. And herein lies the crux of the matter. Aquaculture must be promoted and developed as an enterprise and not as a means to simply enhance nutrition. This may sound harsh and hard, but it is a reality, and it is only on this reality that small and large-scale aquaculture in Africa can attain the potential that the continent offers - and that potential is enormous…

This being said, in his report to the FAO in Rome (2001), Prof. Thomas Hecht also emphasises the point of "economic reality" when promoting and developing commercial aquaculture in rural Africa. The low price of fish as a food source together with relatively high production costs for

intensive farming systems and financially poor rural communities can, in many cases, reduce viability of commercial aquaculture programs in parts of Africa. For a more detailed review of aquaculture in Africa, and particularly the shortfalls facing aquaculture on the continent, see Hecht (2001).

Aquaculture – A South African Perspective

The modern aquaculture industry in South Africa was effectively initiated in the 1980's with the establishment of trout, oyster, mussel, ornamental fish and catfish farming (Hecht and Britz, 1990). In 1988, the sectors produced a total of 3094 tons, valued at R45.8 million (Hecht and Britz, 1990). Ten years later, in 1998, this figure had increased to 5208 tons (FAO, 1998). This translates to an average increase per annum of 6.8% between 1988 and 1998, which is considerably lower than that for the rest of Africa over a similar time period (i.e. an average annual increase of 10.5% between 1989 and 1998: FAO, 1998). During this period a number of state led projects were initiated to stimulate the growth of rural aquaculture, largely with the objective of enhancing food security and income in rural households situated areas with traditional communal land tenure systems.

The potential for fresh water aquaculture in South Africa is however significantly constrained by the natural environment. The first major constraint is a scarcity of water and the second the extreme seasonal temperature fluctuations over much of the interior (Britz and Hecht, 1990). For example, the winters over large areas of the interior are too cold for economically viable production of many warm-water aquaculture species, yet the summers in the same areas are too warm for cold-water fishes such as the salmonids. Thus, salmonid aquaculture is limited to higher altitudes where summer temperatures do not get too high, and for warm water species, such as ornamental fish, greenhouse tunnel systems with that sustain warm-water aquaculture during winter are employed. Water is often recirculated in such systems which partly addresses the problem of water scarcity. Successful aquaculture enterprises are thus likely to employ more capital and skills intensive methods of production to overcome the temperature and water limitations in most areas of the country. This poses a problem for the development of rural aquaculture in South Africa as skilled expertise, capital and efficient extension service are required if programs are to be successfully sustained.

A third constraint, also related to the environment, is the choice of species available for production. With the exception of trout and ornamental fish, which have a high market value, most indigenous and introduced fresh water fish species have historically yielded prices too low to justify the costs of intensive aquaculture production.

A Brief History of Aquaculture in South Africa[1]

The development of aquaculture in South Africa can be divided into several epochs or categories. Firstly, the colonial era during which exotic species were introduced and produced, mainly for angling purposes. The apartheid era saw the development of private sector commercial aquaculture (particularly trout and oysters) and government led "homeland" aquaculture initiatives to address food security issues. Thirdly, the post-1994 democratic era, which has witnessed the development of a large scale commercial aquaculture (in particular abalone) and a trend towards more entrepreneurial rural aquaculture. Our study revealed that the legacy of each era is still evident today in the form of various facilities and projects. In order to appraise existing projects, many of which are dysfunctional, and to develop recommendations for the growth of the sector based on existing policy imperatives, it is important to understand the original motivation and history behind what we see today.

Exotic angling fishes dominated aquaculture before the 1950's

Aquaculture in South Africa has its roots in the provincial state hatcheries, which produced exotic species of fish for angling purposes. The successful production of trout was made possible with the establishment of the Jonkershoek Hatchery in Stellenbosch and the Pirie Hatchery near King Williamstown in the 1890's (Hecht and Britz, 1990). It was from these facilities that most of the suitable waters in the Cape Colony were stocked with trout, and this continued for the following hundred years.

It was Government policy at the time to develop inland sport angling. The focus of aquaculture during this period was on the production of exotic salmonid fishes, since these were the most favoured species. In addition to rainbow and brown trout, fish such as large and small mouth bass and carp were also produced and stocked into inland waters. Other provincial hatcheries were built and exotic fishes were stocked in most of the country's water bodies. This infrastructure and the skills that were created laid the foundation for later attempts to promote food fish farming.

Development of aquaculture for food production and subsistence during Apartheid era

In the 1980's a policy was developed and implemented to develop aquaculture in the ethnically based rural "homeland" areas of South Africa. The then Department of Development Aid, tasked with promoting projects which would enhance the viability of the nascent homeland "states", set up a committee (Kommittee Insake Visserye) to promote aquaculture projects in the former Transkei, Venda, Gazankulu and Lebowa, primarily for food security of the impoverished communities subsisting under traditional land tenure systems. Aquaculture programmes at the University of the North (in the former Lebowa homeland), University of Venda (former Venda

[1] A more detailed history of aquaculture in South Africa is presented by Hecht and Britz (1990).

homeland), University of Zululand (former Kwazulu homeland) and University of Transkei (former Transkei homeland) were established to support these initiatives. The projects focused largely on the development integrated, polyculture systems. Species used included common carp, Chinese carps (bighead, silver and grass carps), tilapia and catfish, with ducks or chickens supplying nutrient input into the pond. By and large these projects failed to yield the expected outcomes. It would be an oversimplification to blame “Apartheid” policies as many of the projects have continued to the present day with similar objectives. In this study we visited all the projects and facilities we could identify, and appraised their current status with a view to formulating recommendations on appropriate directions for the development of rural aquaculture.

Some attempts were also made to promote the commercial aquaculture of carp, trout and catfish in the 1980’s and 1990’s. Carp farming was promoted by the former Transvaal Nature Conservation Department as a culture species in the early 1980’s at the Marble Hall fish hatchery. Many commercial farmers built ponds and began growing the species, but the boom was short lived and production crashed from 30.3 metric tons in 1975 to only 1.2 metric tons three years later (Hecht and Britz, 1990) mainly due to the low demand and market price for carp. Trout farming in the Lydenburg area was more successful as commercial farmers developed innovative products and marketing strategies. Government hatcheries that were built specifically to support trout farming and angling included the de Kuilen and Lydenburg hatcheries. In the late 1980’s the Foundation for Research Development supported the research into catfish farming at Rhodes University, which led to the establishment of commercial farming of the species in the Lowveld region. Production rapidly grew to 1000 ton per annum but as with carp farming, low market demand and concomitant low prices resulted in production effectively ceasing by 1992.

Despite the efforts described above, the objective of successful production of fish as a cheap protein source either from the small scale rural or commercial farming sectors in South Africa did not materialise. “Production driven” aquaculture technologies were a global phenomenon in the 1980’s resulting in many failures. In the nineties there was a trend towards market driven aquaculture, focusing on high value species that could sustain the high running costs typical of intensive aquaculture.

One commercial sector that developed independently of any government support in the early 1990’s was ornamental fish farming. Approximately 60% of ornamental fish sold in South Africa are imported. This provided the incentive for local producers to supply the market. The industry began largely as a backyard hobby, but larger scale producers emerged over the last 15 years who produce over 80 different varieties of aquarium fish (Hecht and Britz, 1990; Britz and de Kock, 1994).

During the late 1980's and early 1990's the provincial nature conservation departments changed their policy and stopped promoting the production and stocking of exotic fishes into indigenous waters. This constituted an effective withdrawal of Government support for the freshwater aquaculture industry, and resulted in the closure, mothballing or privatisation of many Government aquaculture facilities. The period of political transition in the early 1990's resulted in a lack of policy or funding to support aquaculture research and development, and without government support, the aquaculture industry in South Africa effectively developed at a much slower rate than in other parts of the world.

Development of small-scale commercial aquaculture in the post-Apartheid era

Despite the lack of a national aquaculture policy since 1994, there have been attempts to develop small-scale commercial aquaculture in rural contexts on the back of larger commercial enterprises. These initiatives have been motivated by Governments policy of promoting black economic empowerment and supporting emerging farmers.

A significant initiative was the training and setting up of 48 small-scale "satellite" fish farmers linked to the Amatikulu Hatchery in Kwazulu Natal. Amatikulu Hatchery was a successful commercial enterprise, exporting approximately 1 million ornamental fish per year. The production side of the farm was sold off as units of two fish production tunnels each to experienced workers from the farm and was financed by loans from the Small Business Development Corporation. Initially production went well while a contracted farm manager was supervising the farmers. However, when the farmers elected to dispense with the cost of the managers salary, profits and production declined, revealing a lack of basic business and farm management skills. The Amatikulu small-scale satellite farming businesses eventually failed and Amatikulu Hatchery turned its focus to prawn farming. However, despite the fact that the "satellite" farming scheme failed (due to poor management capacity), it is a model worth pursuing.A similar model, with modifications, has been suggested to promote small scale abalone farmers in rural coastal areas. An existing small-scale ornamental fish farming project in Limpopo Province is described in our report below (see Dakari Holiday Resort and Fish Venture, Results section 20).

In the Western Cape Province, small scale growout of trout has been successfully implemented at a number of sites. This initiative is supported by Stellenbosch University (in association with the British Department for International Development), and the Western Cape Department of Agriculture at Elsenburg. An inventory detailing the status of these projects is provided in this report (Results sections 4-7).

To summarise, the history of aquaculture in South Africa has shown that the production of low value species as an inexpensive alternative protein source has been unsuccessful. All successful aquaculture enterprises in South Africa are engaged in the production of high value fin or shell-fish. Successful aquaculture has and continues to be driven by the market and entrepreneurial creativity and drive.

Definition of Terms

Within the context of this study, it is important to define the terms *commercial aquaculture* and *aquaculture for food security*.

The term *commercial aquaculture* includes the following:

- The majority of fish that is farmed is sold and is not consumed by the farmer;
- The projects tend to be intensive where, for example, fish are produced at high stocking densities and the main source of feed is a fishmeal based pellet;
- The farms operate on strict business principles;
- The product is usually a high value species.

Aquaculture for food security is described as follows:

- Fish is farmed primarily for home consumption and excess produce is sold locally; the sale of excess product usually does not involve value-adding;
- The projects are extensive where, for example, fish are raised at low densities in earthen ponds and feed primarily on natural pond production; however, this diet may occasionally be supplemented with a formulated feed;
- The project usually depends on donor or government funding for its implementation and to some extent for its operation;
- Low value species such as carp, catfish and tilapia are usually produced.

The rural small-scale cage-culture of trout in the Western Cape, as discussed later in the report, typifies the term *commercial aquaculture* as defined above, while *aquaculture for food security* is typified by rural aquaculture in the Limpopo Province, as described in the results of this report.

BASELINE SURVEY RESULTS

The survey results are presented by province and divided into Government Support Facilities and Rural Aquaculture Projects. The figures listed in this report should be viewed as estimates as it was not always possible to obtain accurate data from rural fish farmers.

Western Cape - Government Support Facilities

1. Jonkershoek Hatchery and Stellenbosch University

1.1 Brief history and current status

Jonkershoek Hatchery near Stellenbosch is the oldest and one of the most successful hatcheries in South Africa. It was established in 1894 to breed trout for stocking local dams and rivers. Control of the facility was handed over to Stellenbosch University in 1989 when Nature Conservation adopted a policy that no longer supported the production and stocking of exotic species into natural water bodies. Stellenbosch University is actively involved in trout aquaculture and use the revenue from the sale of trout fingerlings from Jonkershoek Hatchery to support its research. The facility provides fingerlings to the small scale aquaculture projects in the area. The Jonkershoek facility provides a good example of how a semi-privatised government facility can benefit and promote both small scale and commercial aquaculture.

Apart from the Jonkershoek facility, the University of Stellenbosch possesses extensive aquaculture facilities, laboratories and support services.

1.2 Infrastructure

The Jonkershoek facilities include a well equipped hatchery, a number of small earthen and cement ponds, and a cage culture facility in a nearby dam.

1.3 Production

The Jonkershoek Hatchery is currently committed to assist the development of small-scale trout farmers in rural Western Cape. The hatchery annually produces and sells 120 000 trout fingerlings to small-scale farmers.

1.4 Human resources

The farm manager has a tertiary level education in aquaculture.

Top. Fish farmers in Worcester weighing trout for sale from the cages in dams.

Bottom. Outflow from a commercial trout farm in Ceres. This development project was funded by government.

Top. A typical trout cage culture set up at Cape Olive Farm.

Bottom. Processing trout from the cage culture projects. There is a high market demand for trout.

Rural aquaculture and support facilities in the Western Cape Province: 1 = Institute of Animal Production, Department of Agriculture Western Cape (Elsenburg); 2 = Jonkershoek Hatchery; 3 = University of Stellenbosch; 4 = Ceres Aquaculture Project; 5 = Rustenburg wine farm; 6 = Worcester Project; 7 = Cape Oliver Farm.

2. Institute of Animal Production, Department of Agriculture Western Cape (Elsenburg)

2.1 History and current status of project

In 1997, the Institute of Animal Production in the Western Cape (Elsenburg) started offering extensions services for an aquaculture program that was initiated by the University of Stellenbosch. The program was aimed at the upliftment of previously disadvantaged communities in the rural parts of the Western Cape Province. Collaborative research with University of Stellenbosch and extension services offered by the institute are ongoing.

2.2 Infrastructure

Research facilities for aquaculture research include a re-circulation unit with 20 fish-ponds housed in a greenhouse tunnel and 15 earthen dams, five of which are under plastic. In addition, its aquaculture facilities include a raft with cages for trout/tilapia research, which is situated on an irrigation dams at Elsenburg.

2.3 Production

Research at Elsenburg is directed at basic, applied aspects of aquaculture farming, the principles of which apply to small-scale fish farming and commercial aquaculture. In addition to research and extension services offered by the facility, Elsenburg Agricultural Research Institute also offers courses in aquaculture for farmers and extension officers.

2.4 Human resources

The research and extension facility is managed by staff with relevant tertiary educations.
Students are also involved in the program.

Western Cape - Rural Aquaculture Programs

3. Rustenburg Wine Farm

3.1 History and current status of project

The Rustenburg Wine Farm is situated approximately 10 km from Stellenbosch. The project started in 1996 when farm workers approached management, and with assistance from Stellenbosch University, started a cage culture project in the irrigation dams on the wine estate. The primary motivation behind the project was to create additional income for the farm workers.

3.2 Infrastructure

The facility includes floating cages that were purchased with a R70000 loan (10% interest) secured by the workers from the farm owners. The cages are in good condition and are situated in an existing dam that is used to irrigate vineyards.

3.3 Human resources

Seven farm workers (two women and five men) are involved in the project. They have all received onsite training and attended workshops organised by Stellenbosch University. Furthermore, they have access to expertise from Stellenbosch University to assist them at any time. However, the fish farmers would like further training. Apart from services received from Stellenbosch University, they do not receive any other assistance. This highlights the need for the training of government agriculture extension officers in aquaculture technologies.

3.4 Production

Production is restricted to the winter period, due to temperature and water availability. The farmers buy juvenile trout (300g) from Jonkershoek Hatchery and produce 1.1 – 1.2 kg fish by the end of winter. The farmers sell unprocessed fresh fish to commercial processors, and keep accurate records of fish sales. The farmers buy approximately 4000 to 5000 juvenile trout fingerlings per season. The fish are fed a fishmeal based pellet that is supplement with a carotenoid (*Carophyll Pink* from Roche Products) towards the end of the production cycle to improve flesh pigmentation. In addition, they are size graded during the season, although this does not always take place.

Average harvest per year is approximately 5 tons. However, most of the fish harvested in 2002 were condemned due to the presence of an alga that taints the taste of the fish. Fish processors will not buy fish that has been exposed to the algae.

Fish diseases and parasites have not been a problem. However, the availability of water is of concern, since the supply to the dam is not permanent. Furthermore, water quality during periods of low flow is a concern to the farmers, since this can negatively affect production and organoleptic properties. A support team from Stellenbosch University regularly monitors water quality in the dam. Farmers experience fish losses due to predators, such as cormorants.

Box 1 Rustenburg Wine Farm profile.

Project inception	1996
Status of project	Operational
Species of fish being farmed	Trout (cage culture)
Number of beneficiaries	7 farm workers
Constraints	Limited supply of water Limited technical support to assist in production and management of the cages
Current production	3-4 tons of fish per season at a profit of R4 per kg. Project potentially makes R12000 to R16000 per season.
Potential of project	Due to the limited water supply production cannot be increased. Ongoing technical support will assist farmers to produce better quality fish, which in turn would improve profit margins.

3.5 Finances and marketing

Juvenile trout are purchased at a price of R19.50 per kg. The major expense is the fishmeal based trout diet. Cost of feed (with carotenoids) is R6400 per ton (R160 per 25 kg bag) and without pigment R5200 per ton (R130.00 per 25 kg bag). The fish is sold between R19.50 and R22.00 per kg, depending on size and quality of the flesh. Gross income varies between R98000 and R110000 per annum). Farmers do not have a contract with any of the processors, so can therefore sell to different processors each year. The small-scale trout farmers in the Boland region have formed a co-operative to collectively market the fish to ensure the best possible price.

The farmers have a bank account for the project, which is managed by a committee comprised of the farm workers. The income of the fish sales is used to service the loan, which they plan to pay off completely next season (2003). The income is also used to buy fingerlings for the following season. The remaining profits are shared equally among all workers involved, and are used mainly to pay school fees for their children. There is concern that some workers invest less time and effort in the project than others, yet they all draw equally on its profits; this concern has not yet been resolved and is possibly why this project is the least successful of all of the projects visited in the Western Cape.

4. Cape Olive Project

4.1 History and current status of project

The farm workers of Cape Olive approached Stellenbosch University to assist them in developing a trout cage-culture project in the farm's irrigation dams. Negotiations were initiated during 1999 and the first two cages were built by 2001. Expansion took place during 2003 when an additional two cages were built. The project is currently in operation.

4.2 Infrastructure

The facilities include four cages that are situated in an existing irrigation dam. The project was initially funded by the Unlimited Oliver People Trust (R49000). The expansion was funded by the same workers fund (33%) and the balance was funded by Land Care, a government funding organisation. There is sufficient runoff so water supply in the dam is not a problem. The facilities are new and in good condition.

4.3 Human resources

The project and its facilities belong to the 21 farm workers of Cape Olive (11 men and 10 women). They received onsite training and continued support from Stellenbosch University. However, the fish farmers feel that they require additional training. Since they all have full time jobs with Cape Oliver, they have to employ a labourer to feed the fish and maintain the cages on a daily basis.

4.4 Production

The group purchase juvenile trout from Jonkershoek Hatchery, and stock the cages at the beginning of winter. The animals are fed trout pellets, and are size grading regularly during the season. A support team from Stellenbosch University regularly monitors water quality in the dam.

The project produced 5 tons of trout during 2002, and this was increased to 7 tons in 2003. They have not yet had a problem with the alga that taints the taste of the trout. The intention is to increase production to between 10 and 20 tons per year. However, the supply of juvenile fish has been identified as a concern, since it is the farmer's opinion that supply from Jonkershoek Hatchery is not always reliable and consistent.

The group feels that the purchase of a freezer will improve overall production since this facility would eliminate the need to sell their produce fresh.

4.5 Finances and marketing

The farmers keep a good record of fish sales and the operation is run on sound business principles. The trout are sold fresh to a fish processor. However, the group is considering adding value to their product by smoking the fish. They currently sell the fresh trout at

approximately R20.00/kg (i.e. an annual gross income of R100000 in 2002 and R140000 in 2003). The group has a bank account and this is governed by a formal structure (the workers have a forum). The workers share the profits equally among themselves.

Box 2 Cape Olive project profile.

Project inception	1999
Status of project	Current
Species of fish being farmed	Trout (cage culture)
Number of beneficiaries	21 farm workers
Constraints	Limited supply of juvenile trout to stock cages. Limited technical support to assist in production and management of the cages.
Current production	7 tons of fish per season at a margin of R4 per kg. R 28 000 profit per season.
Potential of project	With improved access to juvenile trout production could be increased to about 10 tons per season. Technical support on an ongoing basis would assist the farmers to produce better quality fish, which in turn would result in better prices on the market. The group also has the potential to value add the trout (e.g. smoking).

5. Worcester Project

5.1 History and current status of project

The Worcester Project was initiated in 1999. The project belongs to two retired teachers. It was funded personally by the owners, and involves the cage-culture of trout in a dam on the outskirts of Worcester. The purpose of the project was to produce trout for commercial sales, and it is currently in full operation.

5.2 Infrastructure

The project facilities include two cages, which are in good condition, and are situated in an existing balancing dam.

5.3 Human resources

The owners of the cages feed the fish on a daily basis. They employ local labour to assist with the harvesting of fish.

The owners have received training and continue to receive ongoing support from Stellenbosch University; however, they feel they require further skills and training, and additional financial assistance from government to aid the expansion of the project.

5.4 Production

The farm produces 5 to 6 tons of trout a year during winter, even though they have had problems with an alga tainting the taste of the fish. Water quality in the dam is regularly monitored by a support team from Stellenbosch University.

Box 3 Worcester project profile.

Project inception	1999
Status of project	Operational
Species of fish being farmed	Trout (cage culture)
Number of beneficiaries	Two
Constraints	Limited technical support to assist with production and management.
Current production	5 – 6 tons a year at a margin of R 4 per kg. Profit[2] per season varies between R 20 000 and R 24 000 per season. The farmers however do not always make this amount of money as the producers pay less for the fish if the size and quality of the fish is below standard.
Potential of project	If the farmers had better technical support they would be able not to necessarily produce more fish (as that is limited by the size of the cages), but rather better quality fish, which in turn would command higher prices.

[2] "Profit" here, and elsewhere in the report, is defined as total income less total running expenditure; it does not take expenditure related to financial loans, land and infrastructure, for example, into account.

Table 1 Profile of Government facilities that support aquaculture in the Western Cape. Criteria are ranked on a scale where 1 = non-existent, 2 = poor, 3 = average, 4 = good, and 5 = excellent.

Government facility	Number of employees	Species	Clarity of purpose	Current Status	Potential	Technical skills	Comments
Elsenburg	Elsenburg has an aquaculture section but only conducts research; it does not supply fingerlings or technical support to the small scale trout farmers.						
Jonkershoek Trout Hatchery	N/A	Trout	5	5	5	5	Research facility of SU, however it also provides fingerlings to small scale commercial farmers

Table 2 Profile of the rural aquaculture projects in the Western Cape. Criteria are ranked on a scale where 1= non-existent, 2 = poor, 3 = average, 4 = good, and 5 = excellent.

Project	Purpose	Species	Technical support	Group technical skills	Project Status	Project Potential	Motivation of group
Ceres Aquaculture project	Commercial	Trout	2	2	3	5	5
Rustenburg Wine Farm	Commercial	Trout	2	2	3	3	3
Worcester	Commercial	Trout	2	2	3	4	3
Cape Olive	Commercial	Trout	2	3	4	5	5

5.5 Finances and marketing

The farmers stock the cages with juvenile trout bought from Jonkershoek Hatchery. Stocking takes place at the beginning of winter and fish are harvested before water temperatures increase at the beginning of summer. The cost of production, including fish feed, transport, mortality and other overheads is between R15.00 and R16.00 per kg. Farmers sell their trout fresh to local fish wholesalers. They keep good records of sales, and sell the fish between R19.50 and R22.00 per kg, depending on the quality of the product.

6. Ceres Aquaculture Enterprise

6.1 History and current status of project

The Ceres Aquaculture Enterprise was initiated by the local municipality's Local Economic Development project (LED). The aim of the project was to grow trout for commercial sales using water from a nearby stream. The project was initiated in June 2003 and was subsequently handed over to a private individual.

6.2 Infrastructure

The facility consists of four porta-pools, each with a diameter of 6 m and a water supply from a nearby stream. The facility also includes a brick structure that is used as an office and a store room. The infrastructure is new and in good condition.

The owner requires further funding as he is planning to increase the size of the current operation. In addition, he intends to develop a sports fishery on the property since his facility includes two dams.

6.3 Human resources

In addition to the farm owner, the farm employs six full time employees. Neither the farmer nor the employees have received any formal training in aquaculture. However, the farm owner is planning to attend an aquaculture course at Stellenbosch University.

6.4 Production

The farm currently buys fingerlings from Jonkershoek Hatchery, but plans to breed trout on site in the future. The farm has not yet produced any fish since juvenile fish were only stocked a few months previously. A production record keeping system is in place, and a support team from Stellenbosch University monitors water quality and offer ongoing support on a regular basis. The farmer initially intends to sell the trout as a fresh product, but will consider processing the fish further in future so as to add value to the product before sale.

6.5 Finances and marketing

The owner is confident that he will be able to market all of the fish he produces. Although the farm employs a formal accounting system, no financial statements were available since

production has not yet begun. The farmer foresees that the main expenses will be salaries and fish feed.

Box 4 Ceres project profile.

Project inception	June 2003
Status of project	Operational
Species of fish being farmed	Trout (porta pools)
Number of beneficiaries	One owner, six workers (Government funding),
Constraints	Limited technical skills of operators
Current production	None, however if all of the 1 400 fingerlings stocked in the porta-pools reach market size (approximately 1 kg each), then they would produce 1.4 tons of trout per season.
Potential of project	The approximate carrying capacity of this system is between 5 – 10 kg / m3 (this is however dependent on a number of factors, such as experience of the fish farmers, summer temperature, water exchange rates and quality of feed). Therefore the farmers should expect to harvest between 845 kg and 1.7 tons of trout per season. The profit margin of this operation would be approximately R 4 per kg, therefore the profits would be between R 3 380 and R 6 800. If project plans to expand (build more porta – pools, spawn trout for fingerling production and start a recreational fishery) materialize, then further profits could be expected.

Eastern Cape - Government Support Facilities

7. Amalinda Hatchery

7.1 Brief history and current status

Amalinda Hatchery was established in 1967 by the Department of Nature Conservation to conduct research and to breed exotic fishes such as bass and carp to stock dams in the Province. Nature Conservations subsequently changed its policy regarding the breeding and stocking of exotic fishes, and the facility changed focus and began research into the breeding of indigenous fishes, such as fresh water mullet, yellowfish species and Eastern Cape Rocky *(Sandelia)*.

In the mid 1990's this facility was closed due to lack of funds and a lack of policy regarding freshwater research and development. The facility was subsequently leased to a private company in 2000, with the aim of producing Koi-carp for the ornamental fish trade.

7.2 Infrastructure

The facility has 41 earthen ponds of various sizes and a hatchery, with a number of permanent structures such as offices, storerooms, laboratories and ablution facilities. The condition of the facility is good, with water supply that is pumped from a nearby dam.

7.3 Production

The fish are bred at the facility and the larval and juvenile fish rely primarily on natural pond production. Pond productivity is increased by aerating the ponds. As the fish grow they are weaned onto commercially available fishmeal based koi-carp diets. The facility produces approximately 50000 koi-carp per annum. These fish are sold live to wholesalers and retails, both locally and in other parts of the country. The private venture has proved to be financially successful. Financial details were not disclosed.

7.4 Human resources

The facility currently employs four workers and a farm manager. The farm manager has a tertiary qualification in aquaculture and business management.

7.5 Recommendation

Recommendations are not applicable since the operation is private.

8. Umtata Dam Hatchery

8.1 Brief history and current status

The University of Transkei (UNITRA) motivated for this facility in 1980. Its purpose was to conduct research and to produce Chinese carps[3] for stocking into local dams, and to develop an integrated polyculture system appropriate to local conditions (see Prinsloo and Schoonbee articles in Water SA). The last aquaculture scientist from UNITRA left the University in 1987, and since then, it has not been used to produce fish on a meaningful scale. The facility still carries a large service staff complement, reflecting a lack of policy after the re-incorporation of the Transkei into the Eastern Cape Government in 1994. It now falls under the jurisdiction of the Provincial Agriculture Department.

8.2 Infrastructure

The infrastructure is in poor condition. There are 37 earthen ponds, many of which require repair. In addition, most of the equipment and machinery is either missing, stolen or broken.

[3] The species produced included the silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*) common carp (*Cyprinus carpio*), and grass carp (*Ctenopharyngodon idella*).

8.3 Production

The facility has not produced any fish for many years.

8.4 Human resources

The facility employed 33 staff members in 2001. This figure has since been reduced to 20 full time employees. Most have no technical skills.

8.5 Recommendation

The absence of an aquaculture policy at provincial government level, and poor administration, are the most plausible reasons for the poor state of this facility. Since an aquaculture policy has recently been presented to government, a starting point would be the acceptance and implementation of the policy by national and local government, followed by a study to determine the potential role (if any) of the Umtata Dam Hatchery in the greater framework of aquaculture development and research in South Africa.

9. Tsolo College of Agriculture

9.1 Brief history and current status

The aquaculture section of Tsolo College of Agriculture was motivated by UNITRA in 1982 and 1983. The primary purpose of the facility was to teach students, conduct research, and to stock local dams with carp to promote the development of aquaculture in the Eastern Cape. The facility no longer teaches students, but focuses on training local farmers in agriculture. The aquaculture facilities are currently not utilised as the Tsolo College has no staff skilled in aquaculture.

9.2 Infrastructure

The aquaculture section includes 16 earthen ponds of various sizes. The pond's water source is a river that flows through the College property.

9.3 Production

The facility is not producing fish.

9.4 Human resources

None.

9.5 Recommendation

The geographical position of this facility is not conducive to aquaculture, due to cold winter temperatures. Furthermore, its close proximity to Umtata Dam Hatchery may negate the

Table 3 Profile of government facilities in the Eastern Cape that support aquaculture. Criteria are ranked on a scale where 1= non-existent, 2 = poor, 3 = average, 4 = good, and 5 = excellent.

Government facilities	No. of employs	Species	Clarity of purpose	Current Status	Potential	Technical skills	Comments
Umtata Dam Hatchery	20	Carp	1	2	1	1	
Tsolo College of Agriculture	N/A	Carp	1	2	1	1	
Amalinda Hatchery	4	Koi-carp	5	4	5	5	Private venture between EC Gov & commercial operator
Pirie Hatchery	N/A	Eels	5	4	4	5	Leased to commercial operator for research in eel aquaculture and fisheries
Rhodes University	N/A	N/A	N/A	N/A	N/A	5	The University functions as a high-level teaching and research facility only, with no extension services and no commercial production

Box 5 Mabeleni Trout Hatchery profile.

Mabeleni trout hatchery is a small facility that was built by the Transkei Department of Agriculture to supply fingerlings for Mabaleni Dam, which is 48 hectares in size and approximately 30km from Umtata. The hatchery and nearby Mabeleni Dam is situated within a forest that used to be administered by DWAF, but was recently privatised. The current owners of the forest are Singise Forest. For a long period of time the hatchery was not functional and some of its structures were vandalized. Approximately three years ago the Transkei Piscatorial Society applied to Singise to lease the hatchery and were granted a 77 year lease. In 2003 the club spawned their first batch of trout and produced approximately 50000 fingerlings, which they stocked into the dam. The Transkei Piscatorial Society is made up of 25 members who volunteer their time to look after the hatchery. The Society employs a lady to care for the fingerlings in the hatchery. An agreement between the society and Singise Forests is that the club would not produce fingerlings commercially, but only for the clubs needs.

Top. Mr Rory Haschick feeding koi at Amalinda Hatchery in East London. This government facility has been partially privatised and is being used to grow koi for the ornamental market.

Right. Pirie Hatchery (Near King Williams Town) was used to produce trout to stock local dams and rivers; however, after years of disrepair, it is now rented to an eel research group.

Rural aquaculture and support facilities in the Eastern Cape Province: 1 = Amalinda Hatchery; 2 = Umtata Dam Hatchery; 3 = Tsolo College of Agriculture; 4 = Pirie Hatchery; 5 = Rhodes University; 6 = Mabeleni.

need resuscitate this facility. However, the Department of Agriculture should conduct a feasibility study to determine the potential utilisation of the facilities at Tsolo College of Agriculture for training.

10. Pirie Hatchery

10.1 Brief history and current status

The Pirie Trout Hatchery was established in 1897, and continued to stock the rivers and dams of South Africa with trout for approximately 100 years. The hatchery fell under the directorate of Nature Conservation, and with the change in policy regarding the stocking of exotic fishes such as trout, the function of this facility came into question. The facility stopped producing trout in 2001 and was leased to a private company that now uses the facility for research into the development of a local eel fishery and the use of local eel as a potential aquaculture species.

10.2 Infrastructure

The facility includes 16 cement ponds, each approximately 50 X 25 m, an indoor hatchery, and various offices and storerooms. The facilities are all in a fair state of repair.

10.3 Production

This information was not available.

10.4 Human resources

This information was not available.

11. Rhodes University

11.1 Brief history and current status

The Department of Ichthyology and Fisheries Science (DIFS) at Rhodes University was established in the early 1980's. The DIFS has established strong working relationships with marine fisheries, mariculture and freshwater aquaculture industries in South Africa and throughout Africa and continues to promote and support these sectors through the training of high level manpower, research and consultancy services.

11.2 Infrastructure

This includes teaching and research facilities in ichthyology, fisheries science and aquaculture, including a marine hatchery, a freshwater hatchery and growout facilities and ornamental fish aquaculture tunnels.

11.3 Production

The DIFS is a primarily a research facility, but also produce trout fingerlings for stocking private trout angling waters in the Eastern Cape Province.

11.4 Human resources

Six professional staff are involved in aquaculture related teaching, research and consultancy services. Four service staff are employed to run the aquaculture facilities.

Eastern Cape - Rural Aquaculture Programs

There were no rural aquaculture programs in the Eastern Cape Province at the time the study was conducted.

Kwazulu-Natal - Government Support Facilities

12. Makatini Research Centre

12.1 Brief history and current status

Makatini Research Centre is currently the only operational provincial aquaculture facility in Kwazulu-Natal Province. The Makatini Research Centre started operating in 1985 as an agriculture and aquaculture research facility under the direction of the then Department of Development Aid. The facility falls under the control of the provincial Department of Agriculture.

12.2 Infrastructure

The facility has a hatchery and four 40 X 40 m earthen ponds. The aquaculture facilities are presently in good condition due to the recent availability of funding. The Makatini Research Centre is currently involved in a joint research program with the University of Stellenbosch, investigating the effects of cage-culture on water quality of irrigation dams and the production of tilapia.

12.3 Production

Production at this facility is entirely research orientated.

12.4Human resources

The facility is managed by skilled aquaculture personnel.

12.5 Recommendation

The Makatini Research Centre is in an ideal location to promote and develop rural aquaculture: the climate is conducive to year-round production of fish and water is readily available. However, national and local policy for rural aquaculture development would need to be adopted to determine the facility's role in the greater framework of aquaculture development.

Table 4 Profile of the government facilities that support aquaculture in Kwazulu-Natal Province. Criteria are ranked on a scale where 1 is non-existent, 2 is poor, 3 is average, 4 is good, and 5 is excellent.

Government facility	Number of employees	Species	Clarity of purpose	Current Status	Potential	Technical skills	Comments
Makatini Research Center	2	Tilapia and catfish	4	4	4	4	This is a research center and does not conduct extension services to local aquaculture farmers

Table 5 Profile of the rural aquaculture projects in the Kwazulu-Natal Province. Criteria are ranked on a scale where 1 is non-existent, 2 is poor, 3 is average, 4 is good, and 5 is excellent.

Project	Purpose	Species	Technical support	Group technical skills	Project Status	Project Potential	Motivation of group
Mpontshini Primary School	Food security	Tilapia	1	1	0	0	3
Mboza Aquaculture	Food security & commercial	Tilapia	Unknown	Unknown	0	0	Unknown

Box 6 Profile of the Kwazulu-Natal Wildlife Hatcheries.

KZN Wildlife has four facilities, none of which are presently operational due to change in policy with regards to breeding and stocking of exotic fishes. Three of the hatcheries, including Kamberg, Underberg and the Royal Natal National Park Hatchery, produced trout for stocking dams under the management of KZN Wildlife. The fish in these waters were made available to the public for angling. Underberg and Royal Natal National Park Hatchery were closed approximately 20 years ago, while Kamberg Hatchery was closed in 2003. Kamberg Trout Hatchery still has fish in it, though the decision to lease this facility to the private sector or to destroy the facility has still not been made.

Nagel Dam Hatchery is a warm water facility that was used by KZN Wildlife to breed carp, and tilapia, to stock local dams for angling and for local sale, and goldfish for the pet-shop trade. In addition to the hatchery, this facility also included earthen ponds. It has not been operational since 2001 and is not under the management of DWAF. The environmental/community component of Umgeni Water has subsequently taken over operation of the facility and is planning to start a community aquaculture project.

Kwazulu-Natal – Rural Aquaculture Programs

13. Mpontshini Primary School

13.1 History and current status of project

There is an orphanage at the Mpontshini Primary School. The aim of the project was to provide food for the children in the orphanage, by initiating a polyculture project that included the production of chickens and fish, similar to that at the Makatini Research Centre. The principal of the school, who had no prior aquaculture experience, designed and built the system. The project was initiated in January 2003 and by September that same year, the fish had died, and the project came to an end.

13.2 Infrastructure

The fish tank (5 X 5 m) was made out of cement blocks, and was situated under a wooden/wire chicken enclosure. The wire mesh at the bottom of the chicken enclosure allowed chicken waste to enter the fish tank.

The chickens did well (as they are still alive). However, the construction of a concrete tank was a mistake. Fish cum poultry farming can only be undertaken in earthern ponds.

13.3 Human resources

The head master (project leader) had no knowledge of aquaculture procedures, and had no technical support. It is largely for this reason that the project failed.

13.4 Production

A total of 80 tilapia fingerlings were stocked, all of which died.

13.5 Finances and marketing

There were no records of the development costs.

Top. Facilities at the Makatini Research Centre, which is ideally situated as a training and extension facility for local fish farmers

Bottom. Vandalised facilities at the Mboza fish farming project. A fish pond can be seen in the background.

Top. An attempt at polyculture at Mpontshini Primary School. The facility was badly designed and the fish died due to limited technical support.

Bottom. The abundance of water and suitable climate in the Makatini flats, makes this area suitable for aquaculture.

Rural aquaculture and support facilities in the Kwazulu Natal Province: 1 = Makatini Research Centre; 2 = Mpontshini Primary School; Mboza Aquaculture Project; Kamberg; 5 = Underberg Trout Hatchery; 6 = Royal Natal National Park Hatchery; 7 = Nagel Dam Hatchery.

Box 7 Mpontshini Primary School Profile

Project inception	June 2003
Status of project	No longer operational
Species of fish being farmed	Tilapia
Number of beneficiaries	Unknown number of orphans at school
Constraints of project	Poor design and location of system, limited water supply, headmistress had no technical skills and limited support from agriculture extension officers
Current production	None
Potential of project	None

14. Mboza Aquaculture Project

14.1 History and current status of project

The project was initiated in 1998 and formed part of larger integrated agriculture project that included, in addition to aquaculture, a dairy and a vegetable production unit. The project came to an end in 2001 due to management difficulties.

14.2 Infrastructure

The aquaculture facilities included an earthen pond (60 X 60 m) with water pumped from a nearby river. Other infrastructure included offices and storerooms, however, they were in poor repair since they had been vandalised.

14.3 Human resources

Three beneficiaries operated the fish farm and the dairy, and one beneficiary operated the vegetable section. There was no record of the type of training received by the beneficiaries.

Although the project had input from the Department of Agriculture, it was thought to have failed due to poor project management. No precise information could be obtained.

14.4 Production

There were no records of fish production, other than that the fish ponds were fertilised with chicken manure and were stocked with tilapia.

15.5 Finances and marketing

The intention was to sell the fish locally. However, there is no record of any revenue generated from the program, and beneficiaries of this project received limited to no financial and business guidance. Project beneficiaries were paid a subsidy of R350.00 per month.

Box 8 Mboza aquaculture project profile.

Project inception	1998
Status of project	No longer operational
Species of fish being farmed	Tilapia
Number of beneficiaries	Unknown
Constraints of project	Poor management of project
Current production	None
Potential of project	None

Limpopo Province – Government Support Facilities

15. Dzindi Fish Project

15.1 Brief history and current status

The Dzindi Fish Project was built in the 1960's by the Transvaal Provincial Administration (Nature Conservation Division). Its primary purpose was to breed tilapia and carp for stocking local dams. In 1994, it was handed over to the provincial Nature Conservation Department. With the change in policy by Nature Conservation regarding the production of exotic species the facility fell under the Directorate of Economic Affairs. Subsequently, the facility has stopped producing fish. However, negotiations are currently underway that will see the facility fall within the domain of The Department of Agriculture.

15.2 Infrastructure

Infrastructure at this facility includes eight 50 X 20 m earthen ponds that receive ample water from a canal, offices and store rooms. The facilities are in good condition.

15.3 Production

The facility has not been productive for a number of years.

15.4 Human resources

The facility currently employs a total of 20 staff members, none of whom have any skills in aquaculture. The employment of this staff is a contentious issue in current negotiations with The Department of Agriculture.

15.5 Recommendation

This facility has excellent potential to produce fish and to serve as a demonstration unit in the province. A detailed study needs to be undertaken to determine the facility's role in the greater framework of aquaculture in the Province and in South Africa, taking any future local and national aquaculture policies into consideration.

16. Tompi Seleka College of Agriculture

16.1 Brief history and current status

The facility began operating in the early 1960's, with the purpose of training students in fisheries and aquaculture. Aquaculture no longer forms part of the curriculum, the primary reasons being that graduates could not find placement after Nature Conservation reduced its activity in local aquaculture.

16.2 Production

No current production.

16.3 Human resources

Currently, there is no staff with technical skills in aquaculture at the College. However, Mr Jacky Phosa of the Department of Agriculture uses the College facilities to give the occasional course in aquaculture to rural farmers.

16.4 Infrastructure

Initially the facility had 12 earthen ponds. There are now seven ponds, all of which are in poor condition and require maintenance.

16.5 Recommendation

The role that Tompi Seleka College of Agriculture could play in the development of aquaculture in South Africa will be determined once local and national government have adopted an official aquaculture policy. It is recommended that this facility could be developed in conjunction with planned developments of the Marble Hall Fishery Station, 20 km away from the Tompi Seleka College of Agriculture (see the recommendations for the Marble Hall Fishery Station for details).

17. Turfloop Breeding Station

17.1 Brief history and current status

This facility was motivated for by the University of the North and built for the former Lebowa government by the Department of Agriculture in 1982. The intention was to breed catfish and carp to stock local dams. The University of the North had close ties with this facility. However, production has declined over the years, and in 2003 no fish were produced.

17.2 Infrastructure

The facility includes 20 earthen ponds and a large well-equipped hatchery. The facility is in a very good state of repair.

17.3 Production

Although the facility has the capacity to produce large numbers of fish, production has declined over the years in response to a decreased demand for fingerlings. No fish are currently produced.

17.4 Human resources

The facility employs 11 full time staff members, with various levels of technical skills in aquaculture.

17.5 Recommendation

The Department of Agriculture is considering handing this facility over to the local community as a development project to breed fish for local sale. However, it is foreseen that the development of aquaculture will, in the near future, require hatchery facilities, such as those currently available at the Turfloop Breeding Station, to effectively supply fingerlings to the greater Limpopo Province. Therefore, it is recommended that the facility remain under the full directorate of The Department of Agriculture until the completion of a needs assessment and the adoption of a national aquaculture policy. It is further recommended that the stations maintains its strong links with the University of the North. Given the changes in the tertiary education sector in South Africa the facility could serve as the centre of technical aquaculture training in the northern regions of the country.

Limpopo Province – Rural Aquaculture Programs

18. Batlhabine Itireleng Fish Project

18.1 History and current status of project

The project was initiated in 1992. However, soon after the ponds were stocked with fingerlings, the project was brought to a halt. This was due to conflict between two local chiefs over land that was not related to the project in any way. The Lebowa government initially financed the project.

The motivation for the project was food security for the farmers and to generate revenue through the sale of fish to the local community. Neither a feasibility study nor a business plan was conducted prior to commencement of the project.

The conflict between the local chiefs has recently been resolved, and a new group has approached the Department of Agriculture for funding and assistance to restart the project.

Members of the new group have received training in aquaculture at Tompi Seleka Agriculture College, and the Department of Agriculture is willing to provide ongoing technical support. A request for financial assistance to restart the project has been made to government. However, a marketing study has still not been undertaken to determine if there is sufficient local demand for the fish.

18.2 Infrastructure

Infrastructure at the Batlhanbine Itireleng Fish Project includes six earthen flow-through ponds (75 X 50m) and a brick building with a fish processing area, a storeroom, an office and ablution facilities. All the facilities are in fairly good condition, particularly considering that they have not been used for 12 years. Water enters the ponds via a 4 km canal from Tlhabine Dam. Sections of the canal are currently blocked by debris.

18.3 Human resources

The local tribal authority nominated a group of seven project beneficiaries in 1992; however, these people are no longer involved in the project. The new group, also nominated by the local tribal authority, includes three men and eight women. Their only exposure to aquaculture was a three month training course at the Tompi Seleka Aquaculture College. The Department of Agriculture will provide additional ongoing technical support.

Since the project has not yet received start-up funding, the beneficiaries' main concern is to receive these funds so that they can begin utilising their facilities to produce fish. Given the non-existent skills level of the applicants the demand for funds to restart the project is a major concern. Funds should initially be made available to properly train the group.

18.4 Production

In 1992, each pond was stocked with 20000 catfish and 20000 tilapia fingerlings. However, due to the above mentioned conflict, no fish were harvested. The ponds are currently not in production and are entirely dry.

The group intends to feed the fish with commercially available fish food, and to sell their product fresh, gutted and cleaned. However, no proper market survey has been undertaken.

18.5 Finances and marketing

The project beneficiaries have not yet attempted to develop a market for future produce. The intention is to sell fish to the local community.

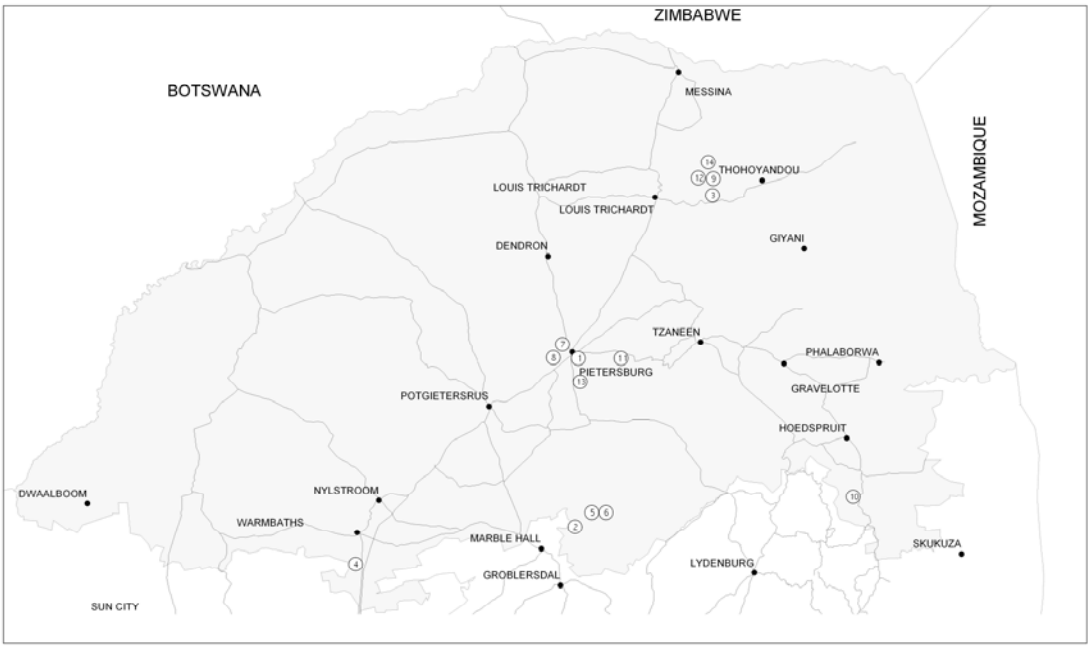
No financial statements were kept for the initial phase of this project, and the lack of production and funds does not yet necessitate financial record keeping of the current phase.

Top. Dzindi Fish Farm is a government facility that is currently unutilised, situated near Thohoyando. This facility has an abundant supply of water as seen by the canal.

Left. Ndo Reineth of Dakari Holiday Resort and Fish Venture project showing mollies reared in concrete tanks. This commercial project has potential to grow into a larger operation. It is situated near Thohoyandou.

Top. Batlhabine Itireleng Fish Project was built in 1992. This project has facilities that include ponds, a building to process fish, office and storeroom, and a canal that supplies the facility with water from a nearby dam. However, due to disagreements in the local community the project never produced fish.

Below. There is demand for fish locally. This is evident by this sale taking place next to the road near Tompi Seleka College of Agriculture.



Rural aquaculture and support facilities in the Limpopo Province: 1 = Turfloop Breeding Station; 2 = Tompi Seleka College of Agriculture; 3 = Dzindi Fish Project; 4 = David Pholosi; 5 = Boreadi-A-Ngoaketsi; 6 = Uncle James; 7 = Ipopeng Fishery Project; 8 = Itereleng Fishery Project; 9 = Deena Govender; 10 = Clare Village Project; 11 = Batlhabire Itireleng Fish Project; 12 = Dakari Fish Venture; 14 = Venda University.

Box 9 Batlhabine Ittereleng profile.

Project inception	1992
Status of project	No longer operational
Species of fish being farmed	Catfish and tilapia
Number of beneficiaries	Seven
Constraints of project	Conflict caused the project to shut down, however it has been resolved. The site and infrastructure (provided some repairs are undertaken) is good.
Current production	None
Potential of project	The ponds could produce approximately 22 tons of fish per year. A market survey would need to be conducted to determine the size of the local market, and precise production costs and potential profits.

19. Dakari Holiday Resort and Fish Venture

19.1 History and current status of project

In 2001, members of the local community approached The Department of Agriculture for assistance in starting this aquaculture project. They subsequently received funding from various donors, which totalled approximately R150000. Their first greenhouse tunnel was built in 2002, and was designed to produce ornamental fish for the aquarium fish trade. The group produced a business plan before the project began, and the University of Venda provided technical assistance. The project is still operational and appears to be successful.

19.2 Infrastructure

The facility consists of one green-house tunnel that houses 60 concrete tanks, each of which holds 1 m^3 of water. In addition, there are 40 concrete tanks outside the tunnel that are not yet in use. The facility has access to Eskom power, and an electric blower (compressor) delivers air to each of the tanks. Water is pumped from a borehole to each tank using an electric pump; the water is not recirculated.

19.3 Human resources

The beneficiaries of this programme included a core group of five individuals, who in turn recruited additional members. The group currently includes thirteen members: two men and eleven women.

They have received technical training in fish husbandry from Venda University of Technology and Tompi Seleka College of Agriculture. However, they feel that they require further training, particularly in business skills and in the technical aspects of ornamental fish farming. Furthermore, it became apparent that additional training is required when it was found that the members had no idea of the importance of basics, such as the effect of water quality (e.g. pH and ammonia), on fish health and production.

19.4 Production

Detailed production figures were not available, although the group does keep a record of fish sales. The group estimates that it produces approximately 12000 live-bearing ornamental fish per year (Table 9). Production in winter is low due to reduced water temperatures; production estimates for the winter months were not available. The group believes that winter production could be increased considerably if the facilities included water heaters. The group keeps a record of water temperature.

Adult fish are fed commercially available fish flakes and are conditioned for breeding on brine shrimp. Juvenile fish are fed a standard fish flake diet, which is supplemented with live *Daphnia*.

Although fish disease is a problem in the ornamental fish industry, the operation has not experience serious problems with fish diseases.

The live fish are harvested and packaged for transport, by members of the group, using conventional methods (i.e. fish are placed into plastic bags containing water and pure oxygen). The product is shipped to market by courier service.

19.5 Finances and marketing

The group market their fish in Gauteng at a wholesale price of R2.00 per unit. Although they have opened an account at a local bank, the group does not keep detailed financial records. The group mentioned that they make approximately R15,000 per month. However, given the low monthly production of fish it is doubtful whether their estimate is realistic.

The group's intention is to increase the wholesale price to R8.20 per fish, since they believe that they are not making sufficient profit. This increase is unrealistic. In addition, they plan to expand the operation and to export their product directly. However, this would require considerable expansion and the group would require further training and additional technical support before this step can be considered.

Box 10 Dakari profile.

Project inception	2001
Status of project	Functioning
Species of fish being farmed	Mollies – various types (ornamental species)
Number of beneficiaries	13
Constraints of project	Due to limited technical skills of the project beneficiaries production is not yet optimum. Furthermore there is limited technical support for the project. Winter production is low due low water temperature (the water needs to be heated however the project beneficiaries do no know how to install a heater)
Current production	The current production is approximately 1000 fish per month (but probably lower).
Potential of project	At an exchange rate of 1m3 of water every four hours, fish could be stocked to approximately 5 fish per 10 litre, therefore 500 fish per 1m3 tank. The project has 60 tanks, therefore they would be able to harvest every month (taking into consideration that mollies reach market size in approximately 3 months) 10 000 fish. At R 1 profit per fish, the group could expect to make R 10 000 per month (note winter production would be lower)

20. Dzindi Fish Project

20.1 History and current status of project

The Venda Department of Agriculture and Forestry initiated the Dzindi Fish Project in 1973. The objective of the project was to breed tilapia and carp for stocking local dams and. It was subsequently handed over to the Department of Nature Conservation in 1994. At this time, Nature Conservation fell under the directorate of Economic Affairs. The Dzindi Fish Project facility remained under the control of Economic Affairs after Nature Conservation was moved from the directorate of Economic Affairs. The facilities have not produced fish for a number of years. However, the Department of Agriculture is in the process of negotiating with the Department of Economic Affairs to take over this facility (excluding current staff who have no aquaculture technical skills).

20.2 Infrastructure

The facility includes eight earthen ponds (approximately 50 X 20 m). These ponds are in good condition and are fed by a canal from the Dzindi River. The canal has a strong flow of water, even during the dry season. Although electricity is available, there is no machinery on the farm.

20.3 Human resources

The project employs a staff of 20 individuals, all of whom are employees of the Department of Economic Affairs, and none of whom have any training or experience in aquaculture. The staffs believe that the facility is likely to have a positive impact on them directly when the facility is placed under the control of the Department of Agriculture.

20.4 Production

There are some tilapia, carp and catfish in the ponds. However, nobody knows how many fish were stocked or when stocking took place, since no records were kept. Although fish are not being produced, the staff feed them a fishmeal based diet on occasion.

20.5 Finances and Marketing

This is not applicable since fish are not being produced.

21. Ipopeng Fishery Project

21.1 History and current status of project

This Ipopeng Fishery Project was first initiated in 1997, and included 28 farmers. The initial phase proved to be unsuccessful (it was not possible to determine the reasons). The project was restarted in 2003 and currently supports a group of 13 farmers. The second phase was funded by the Department of Agriculture, with the primary motivation being food security for the farmers and the generation of revenue from fish sales to the local community.

21.2 Infrastructure

The facility consists of three earthen ponds (90 X 54 meters), a fish processing building, containers which are used as storerooms, and a brick structure, which is used as an office and a guard house. All the facilities are in a good state of repair, and the farmers have adequate gear such as nets, freezers and waders.

Formerly, the ponds served as maturation ponds of a sewerage works. In addition to the six ponds currently in use, the group has access to another 16 ponds on the property. The facility has an adequate supply of water that originates from the local sewage works.

21.3 Human resources

The current group of 13 farmers was recruited by the Department of Labour after its members made an application to the Department for employment. In 2003, three members of the group attended an eight week course at Marble Hall Fishery Station. Although having received technical training, the group felt they require further skills in project management, fish breeding, broodstock management, business management and marketing.

The project is steered by a board composed of a member from University of the North, a member from Eskom, a member from NTK (a local feed company), a member from the Department of Agriculture, a member from the local municipality and 2 of the farmers.

21.4 Production

The local climate allows for the production of fish throughout the year. Until recently, they bought catfish and carp fingerlings from Turfloop Hatchery, and allowed the tilapia to breed in the ponds. However, because of the closure of Turfloop Hatchery the farmers will have to find a new source of carp and catfish fingerlings.
The fish feed is supplemented with chicken pellets, which they obtain from Polokwane. They do not feed the fish as much as they would like to due to the high cost of the feed.

Although they keep records of fish sales, exact production figures were not available. Each week one pond is netted and approximately 150 kg of fish is harvested. The fish is sold locally for R 10/kg. The group also consumes some of the fish.

Although the group has had no problems with fish diseases, production is severely hampered by theft. Armed gangs from the nearby informal settlement openly steel fish from the ponds using nets. The group is powerless and rely on local police to curb the theft of their produce. The local municipality has undertaken to erect a fence around the ponds, but this has not yet materialised. A combination of low moral and low production, both due to theft, has resulted in some of the group members finding additional employment to supplement their income.

21.5 Finances and marketing

Fish is sold at R10.00/kg directly to the consumer, though they would prefer to sell to local shops and to supply an export market. The former option would require substantial expansion and the desire to supply an export market is unrealistic. Although the group maintains records of fish sales, financial statements were not available. The group claim to have made R6000.00 profit during 2002. They expected to make no profit in 2003 due an increase in the level of theft. The group has a bank account, which they do not appear to use since it has no money in it.

Box 11 Ipopeng profile.

Project inception	1997
Status of project	Operational
Species of fish being farmed	Catfish, carp and tilapia
Number of beneficiaries	13
Constraints of project	Heavy losses from theft are a major problem. The group do not have enough technical support to assist them to increase production and to market the product.
Current production	Approximately 360 kg of fish per pond per year (they are currently using only six ponds but could have access to 16 ponds)
Potential of project	The project could potentially produce approximately 28.8 tons of fish using the current six pond and 76.8 tons if all 16 ponds were used. An approximate cost of producing the fish would be in the region of R 5 – R 10 per kg. A market survey would need to be conducted to determine the size of the local market.

22. Itereleng Fishery project

22.1 History and current status of project

The Itereleng Fishery Project was initiated by the Department of Agriculture in 2001, and was funded by the Department of Health and Welfare. The motivation behind the project was to generate revenue by selling fish locally. The ponds were only stocked once before the project collapsed due to limited training and skills.

22.2 Infrastructure

The group has access to nine earthen ponds (90 X 40 m), but they only made use of two. The facility was previously used for water maturation and formed part of a waste-water treatment plant. The facility also includes a brick building, which houses a fish processing area, a storeroom, an office and ablution facilities. These facilities are in good condition since they have never been used.

22.3 Human resources

The project included 15 volunteer farmers when it was first initiated (9 men and 6 women). Currently, the project is defunct, yet four members remain: two men and two woman. Only one of the members who attended a two month training course at the University of the North has any skills in aquaculture. .

The remaining members would like to revive the project. The group would also like to integrate the project with poultry and a vegetable project.

22.4 Production

8000 tilapia and 2000 catfish fingerlings were stocked into the ponds. However, only 20 catfish and seven tilapia were harvested. The fish were never fed, and harvest never took place due to a lack of skills, training, and support.

22.5 Finances and marketing

This is not applicable since insufficient fish have been produced to warrant marketing and financial record keeping.

Box 12 Itelereg profile.

Project inception	2001
Status of project	No longer operational
Species of fish being farmed	Catfish and tilapia
Number of beneficiaries	Four
Constraints of project	Limited technical support for the project and poor motivating by the project beneficiaries
Current production	None
Potential of project	Have potential to produce 32.4 tons of fish per year. The cost of would probably in the region between 5 –10 R kg to produce the fish. A market survey would need to be conducted to determine the size of the local market.

23. Mr David Pholosi Commercial Farm

23.1 History and current status of project

Mr David Pholosi is an emerging commercial vegetable farmer who has an interest in aquaculture. After stocking his water reservoir with tilapia, he independently built an earthen pond to start producing fish, at an approximate cost of R16000.

23.2 Infrastructure

The facility includes a water reservoir that is 15 m in diameter and a 30 X 10m earthen pond. The primary use of the reservoir is for holding borehole water before being used to irrigate vegetables gardens. The earthen pond was built specifically for the culture of fish, but will also serve to irrigate vegetable when this is necessary.

23.3 Human resources

The operation is run by Mr Pholosi. His son was recently sent on a three month aquaculture training course at Tompi Seleka College of Agriculture. The Department of Agriculture has undertaken to assist Mr Pholosi with technical skills.

23.4 Production

Since the farm has not yet started producing fish and since Mr Pholosi has no experience in fish farming, he was not sure as to the number of fish his pond would be able to produce. Mr Pholosi wishes to obtain funding to develop and increase the production of fish.

23.5 Finances and marketing

Mr Pholosi intends to sell fresh fish to the local community, and then to expand and supply larger centres. His intention is to supply fresh or frozen fish to the market in Pretoria where he currently markets his vegetable produce on a daily basis.

Box 13 David Pholosi profile.

Project inception	Project still being developed
Status of project	Project still being developed
Species of fish being farmed	Plans to grow tilapia
Number of beneficiaries	Private concern
Constraints of project	Needs technical support
Current production	None
Potential of project	300 kg per year, however if successful he plans to expand.

24. Boreadi-A- Ngoaketsi

24.1 History and current status of project

Mr Fannie Masha, a farmer and businessman, built a cement pond in his back yard in 1992. His intention was to grow and sell fish locally. Mr Masha undertook this project independently and still has fish in his tank.

24.2 Infrastructure of facility

The cement block tank is approximately 7 X 7 meters, with a depth of approximately 3 m. The bottom of the tank is not level and has 2 or 3 separating walls. These walls tend to limit the netting of fish. Water is obtained from a borehole.

24.3 Human resources

This is a family project. Mr Masha has visited the University of the North on three occasions to learn about aquaculture, and would like to receive further training in fish production and tank design and building.

24.4 Production

Mr Masha keeps tilapia and catfish in the tank. They are harvested as fingerlings from a nearby river before being stocked in the tank. The fish are fed kitchen waste, and his children harvest approximately 50 fish a year from the tank. These fish are used for personal household consumption only.

24.5 Finances and marketing

The small size and subsistence nature of the operation does not warrant the keeping of financial records.

Box 14 Boreadi A Ngoaketsi profile.

Project inception	1992
Status of project	Functioning (but at a minimum level)
Species of fish being farmed	Catfish and carp
Number of beneficiaries	Private concern
Constraints of project	Limited technical skills and limited support from agriculture extension officers
Current production	50 fish per year (approximately 20 kg per year)
Potential of project	49 kg per year

25. Uncle James' Project

25.1 History and current status of project

Uncle James, a local businessman and farmer, built a water reservoir at a personal cost of R30000. The reservoir was built in 2002 for the purpose of holding borehole water intended for citrus orchard irrigation and to enable him to produce fish to be sold at his butchery.

25.2 Infrastructure

The facility includes one cement lined reservoir (70 X 10 m) with a borehole water source. In addition, Uncle James has several businesses, which give him access to transport, freezers and a market outlet.

25.3 Human resources

Uncle James has not yet received any training in aquaculture, and is not certain how many fish he will be able to produce. He would like to receive some formal training in aquaculture since he is not sure of current production methods such as what to feed the fish and how to harvest them.

25.4 Production

The pond was stocked with tilapia and "yellow fish" from the nearby Mogwetsi River. A record of the number of fish that were stocked was not kept, and the pond has not yet been netted to determine the current number of fish. Numerous juvenile tilapia were observed in the shallow areas of the pond, indicating that this fish has been reproducing successfully. They were fed on kitchen waste only.

25.5 Finances and marketing

Since no fish have yet been harvested or marketed, financial records have not been kept. It is Uncle James' intention to market the fish from his local butchery.

Box 15 Uncle James' profile.

Project inception	2002
Status of project	Functional
Species of fish being farmed	Tilapia
Number of beneficiaries	Private concern
Constraints of project	Owner has no aquaculture skills and he has limited support from agriculture extension officers
Current production	None yet
Potential of project	Approximately 700 kg per year. The owner of the project would be able to sell that amount of fish at his butchery

Table 6 Profile of the government facilities that support aquaculture in Limpopo Province. Criteria are ranked on a scale where 1 is non-existent, 2 is poor, 3 is average, 4 is good, and 5 is excellent.

Government facility	Number of employees	Species	Clarity of purpose	Current Status	Potential	Technical skills	Comments
Turfloop Breeding Station	11	Carp	1	3	4	3	This facility is well equipped but lacks direction
Tompi Seleka College of Agric	N/A	Carp	1	2	3*	1	Due to shortage of funds and policy this facility has declined in standards
Dzindi Fish Project	20	Tilapia, carp & catfish	1	0	4	0	Negotiations are underway to transfer this facility from Economic affairs to Agriculture

* The amalgamation of Tompi Seleka and Marble Hall Fisheries would potentially see this as high as 4 or 5.

Table 7 Profile of the rural aquaculture projects in the Limpopo Province. Criteria are ranked on a scale where 1 is non-existent, 2 is poor, 3 is average, 4 is good, and 5 is excellent.

Project	Purpose	Species	Technical support	Group technical skills	Project Status	Project Potential	Motivation of group
David Pholosi	Commercial	Tilapia	2	1	In progress	3	4
Boreadi-A-Ngoaketsi	Food security	Tilapia & catfish	2	1	2	2	4
Uncle James	Commercial	Tilapia	2	1	2	3	4
Ipopeng Fishery Project	Food security & Commercial	Carp & tilapia	2	2	2	4	4
Itereleng Fishery Project	Food security & Commercial	Catfish & tilapia	2	2	0	3	1
Deena Govender	Commercial	Carp & tilapia	2	4	0*	5	5
Clare Village	Food security	Tilapia & Carp	Unknown	Unknown	0	0	Unknown
Batlhabine Itireleng Fish Project	Food security & Commercial	Catfish & tilapia	2	2	0	3	N/A
Dakari Fish Venture	Commercial	Mollies (ornamental)	2	3	3	4	4

*This project was successful but a bill for R100000 for the use of effluent water from the sewerage works forced the facility to close.

26. Mr Deena Govender Crocodile Farm

26.1 History and current status of project

Mr Deena Govender operated a private tilapia and carp production unit between 1994 and 1997. He subsequently changed the operation and is currently producing crocodiles. The crocodile operation is also a private concern.

26.2 Infrastructure

Mr Govender had access to 24 earthen ponds (40 X 60m). These ponds were originally maturation ponds that formed part of a sewage effluent treatment plant. They are currently in a fair state of repair. Farm infrastructure also includes blowers that are used to aerate the ponds.

26.3 Human resources

The operation employed 6 to 8 workers. Mr Govender acquired skills in aquaculture by visited the aquaculture unit at University of the North and by reading aquaculture literature.

26.4 Production

The tilapia and carp were allowed to breed in the production ponds, and the operation produced approximately one ton of fish per pond per year. Fish were produced year-round, over two production cycles, and temperature records were maintained. Mr Govender experienced no disease problems. The fish production unit appeared to be highly successful, but was closed down after a misunderstanding regarding a water pumping bill that had accumulated to over R100000.

The operation was subsequently changed to crocodile breeding, where production costs were said to be lower and the revenue generated considerably higher. Production figures for the crocodile operation were not available.

26.5 Finances and marketing

All of the fish were sold fresh from the farm gate. Tilapia was favoured by the local rural community and was sold at R15.00/kg. Carp was favoured by the local Indian community and was sold at R18.00/kg. The farm regularly ran out of fish since local demand exceeded the very limited availability. Fish were not fed, and relied on natural production of the highly fertile water for nutrition and growth. The main costs of the operation were labour and electricity,

Financial records were maintained for both crocodile and fish production operations, however, the details of these records were not made available.

Box 16 Deena Govendeer profile.

Project inception	1994
Status of project	No longer operational
Species of fish being farmed	Carp and tilapia
Number of beneficiaries	Private concern
Constraints of project	Project was successful, however a R 100 000 bill for water use forces the business to close
Current production	None
Potential of project	If the outstanding amount for the use of water is resolved, the project could again produce 24 tons of fish per year and employ 6 – 8 workers

27. Clare Village project

27.1 History and current status of project

The Clare Village Project was initiated by the Gazankulu government for the local tribal authority in 1976. It was primarily built for food security and to generate revenue through the sale of fish to the local community. The project collapsed in 1994, and details of the project are scant since the people involved are no longer available.

27.2 Infrastructure

The facility includes six earthen ponds (40 X 70m). These ponds were supplied with water from a dam situated below the ponds, using a solar powered pump. The dams are currently empty and an office and storeroom belonging to the project have been vandalised. The facility is in poor condition.

27.3 Human resources

The project involved members of the local community. However, the number of people involved and their skills and views were not available.

27.4 Production

A record of production success and details were not available.

27.5 Finances and marketing

A record of financial success and marketing details were not available, other than the fish that were produced were consumed locally.

Box 17 Clare project profile.

Project inception	1976
Status of project	No longer operational
Species of fish being farmed	Unknown (but probably tilapia and carp)
Number of beneficiaries	Unknown
Constraints of project	Poor management and design
Current production	None
Potential of project	None, the location of the ponds is poor.

Mpumalanga Province – Government Support Facilities

28. Lydenburg Hatchery and Fish Production Unit

28.1 Brief history and current status

The Lydenburg Fish Production Unit falls under the directorate of Mpumalanga Parks Board. The station (one of the largest in the country) was commissioned in 1948 to produce trout and bass. Conservation policy changes saw the unit change to the production of indigenous yellowfish, for recreational angling. The facility has been partially privatised and currently produces trout for human consumption. In addition, a section of this facility will, in the future, be leased to a private concern to develop a fly fishing park.

28.2 Infrastructure

This is a large facility, including 126 ponds of various sizes, a hatchery, a cold room, storerooms and offices.

28.3 Production

The change in policy over the years has disrupted production. However, the major problem facing the station at the moment is the availability of water. Its water quota is insufficient and many of the ponds are empty and not in use. Exact production figures were not available.

28.4 Human resources

The facility is managed by skilled aquaculture personnel, together with 15 to 16 semi skilled employees.

28.5 Recommendation

Many towns in the Highveld region of Mpumalanga Province, such as Lydenburg and Dullstroom, depend largely on the trout fly fishing industry to draw tourists to the area. Trout

fishing is a major source of income for the region and has had a profound effect on land use and property values. Although it is current policy not to use government facilities to stock natural water bodies with exotic fish, such as trout, trout are clearly here to stay and are economically very important. No facilities exist in this province to train staff in aspects of fish husbandry, river management, fishing techniques, guiding, and hospitality. Furthermore, there appear to be no strategies from the trout industry to promote black economic empowerment and socio-economic benefits to local communities. It would therefore seem logical to evaluate whether the Lydenburg Fish Production Unit, and perhaps the adjacent de Kuilen hatchery, could be used as training and service facilities for the trout fishing and farming industry. A first step would be to do a needs assessment by consulting the trout industry, local and provincial authorities and other stakeholders on the matter.

29. Marble Hall Fisheries

29.1 Brief history and current status

Marble Hall Fisheries (formerly known as the Lowveld Fisheries Research Station) began operating in 1951 as a research facility that promoted the aquaculture and angling of carp. At that time, it fell under the directorate of Nature Conservation. It is currently under the directorate of The Department of Agriculture.

29.2 Infrastructure

The facility is large and includes 55 earthen ponds of various sizes, a hatchery, a laboratory, offices and storerooms. However, a third of the facility will be flooded by the Arabie Dam, since the height of the dam wall is currently being increased.

29.3 Production

Marble Hall Fisheries is run as a commercial facility that produces and sells tilapia, bass, yellowfish *(Labeobarbus marequensis)* and catfish fingerlings. Production is relatively low, since only 20000 fingerlings were sold in 2002.

Table 8 Profile of government facilities in the Mpumalanga Province that support aquaculture. Criteria are ranked on a scale where 1 is non-existent, 2 is poor, 3 is average, 4 is good, and 5 is excellent.

Government facilities	No. of employs	Species	Clarity of purpose	Current Status	Potential	Technical skills	Comments
Lydenburg Fish Production Center	16	Trout	1	2	3	4	Reduction in water quota and no clear direction has size of opperation
Marble Hall	15	Carp, tilapia, yellowfish & catfish	1	3	5	4	Relocation due to Arabie Dam; recommended link with Tompi Seleka

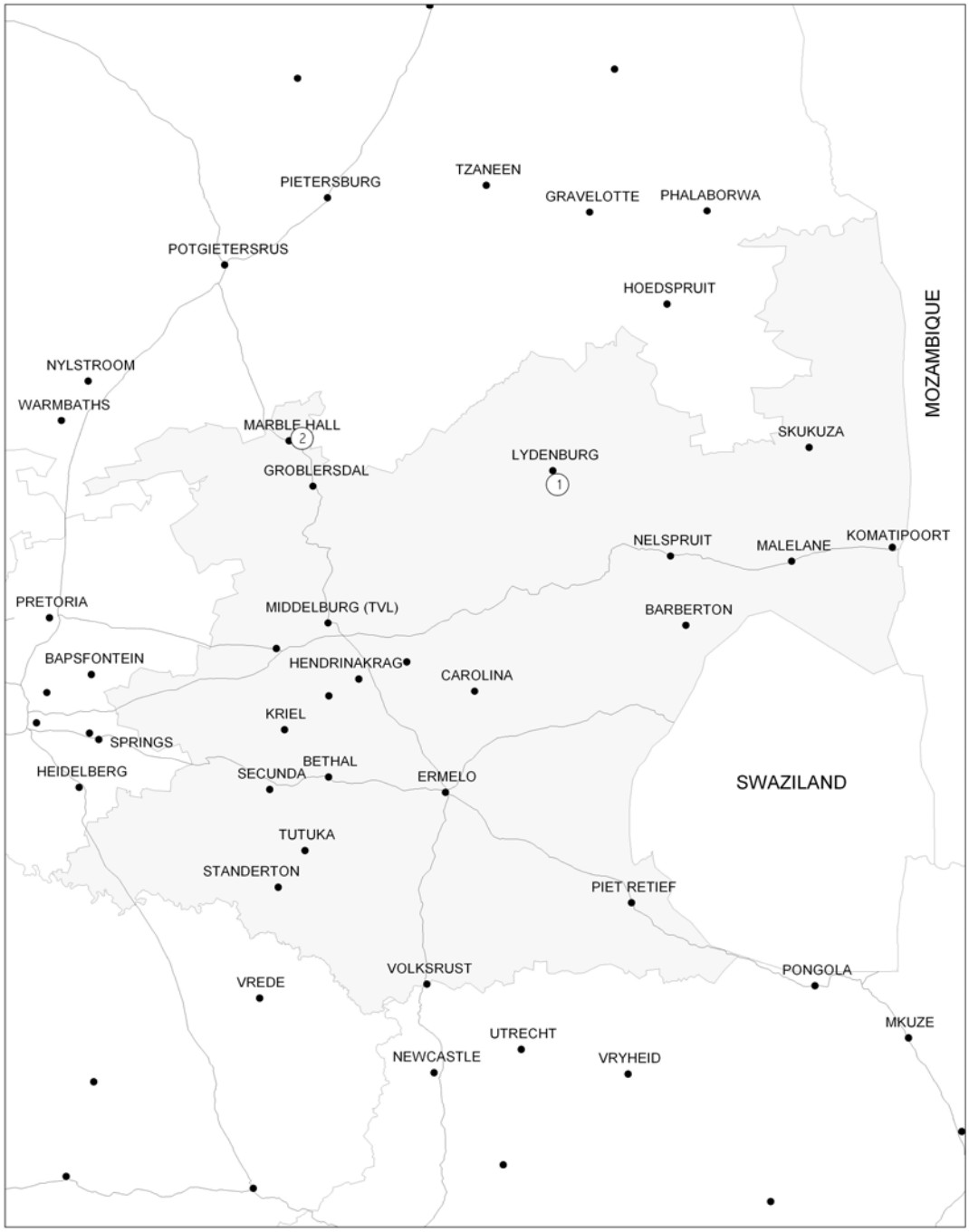
Box 18 De Kuilen Hatchery profile.

De Kuilen Trout Hatchery is owned by the Mpumalanga Parks Board; however it was leased to a private company that successfully produced between 25 and 30 million trout ova annually. The ova were of good quality and were sold on the export market. In August 2003, a competing American firm bought them out on the understanding that they would no longer produce ova. The facility is now unused, and the Mpumalanga Parks Board has not yet decided to re-lease it or not.

Marbe Hall Fish Centre is a government facility that is well equipped (**top**) and has many ponds (**bottom**). This center has potential as a training facility for local farmers.

Top. The manager of the government trout farm at Lydenburg, Mr De Beer, standing next to a trout pond.

Left. De Kuilen hatchery is a government facility near Lydenburg and has potential to produce between 25 to 30 million trout ova per year, but is currently not in use.



Aquaculture facilities in the Mpumalanga Province: 1 = Lydengurg Fish Production Centre; 2 = Marble Hall.

29.4 Human resources

The facility employs 16 permanent staff. The farm manager is experienced in aquaculture. It is the manager's intention to run aquaculture training courses for rural communities. However, an extension service is not part of its current mandate.

29.5 Recommendation

There are plans to relocate the entire facility since about a third of the property will soon be flooded by the Arabie Dam. However, since Marble Hall Fishery requires facilities and Tompi Seleka Agriculture College requires skilled staff and improved facilities, resources may be better spent by combining both operations and further developing the facilities at the Tompi Seleka Agriculture College. This requires a feasibility study and should be considered in conjunction the future local and national aquaculture policy. The possibility then exists to completely privatise the remainder of the facilities.

Mpumalanga Province – Rural Aquaculture Programs

There were no rural aquaculture community projects in Mpumalanga Province.

Orange Free State – Government Support Facilities

30. Gariep Dam Hatchery

30.1 Brief history and current status

The Gariep Dam Hatchery was built as a research and fingerling supply station, and continues with this original purpose.

30.2 Infrastructure

The facility includes 12 hectares of earthen ponds, an indoor hatchery, and various other facilities, all of which are currently in use and are in a good state of repair.

30.3 Production

Research at Gariep Dam focuses on developing culture protocols for indigenous species. In addition to this, the facility currently produces indigenous fishes for stocking of private waters; stocking is carried out by permit only. Although it has the capacity to produce in excess of 150,000 fingerlings per year, the facility is not operating optimally due to the current lack of a skilled fulltime manager and assistant; it currently markets about 10,000 fingerlings per year.

30.4 Human resources

This hatchery employs 10 labourers that are either unskilled or have limited skills. The facility also has a position for a manager and research assistant, both of which require a tertiary education; however, these posts are not currently filled.

30.5 Recommendation

Status quo, until such time as the national aquaculture policy has been accepted by government and a decision can be made as to the contribution that Gariep Dam Hatchery will make to the development of aquaculture in the country.

Orange Free State – Rural Aquaculture Programs

There were no rural aquaculture community projects in the Orange Free State.

PRESENT CONTRIBUTION OF AQUACULTURE TO RURAL LIVELIHOODS

The rural aquaculture baseline survey conducted in 2003 revealed that despite a relatively long history of public sector support to establish small scale aquaculture, the contribution of aquaculture to the livelihoods of rural communities was negligible. Of the five provinces surveyed, only two provinces – the Western Cape and the Limpopo Province – had functioning projects. In the Limpopo Province, the 10 farms surveyed collectively produced well below 10 tons of fish per year. The total numbers of fish farmers associated with these 10 projects was 50, and on average each farmer generated an extremely low income from aquaculture; i.e. well below R1000 per year. Despite public sector initiatives to establish "food security" type rural aquaculture projects in Kwazulu-Natal, Eastern Cape Province and Mpumalanga, dating back to the 1980's, none are currently in operation.

The survey results showed that the majority of rural aquaculture projects were public sector or donor initiated "food security" type enterprises. Almost all of them have been a failure (with the exception of those in the Western Cape Province), and those that are still operational were performing below their potential (Table 9). It also became clear that the growth of the sector was not limited by available land and water. Furthermore, there has been no organic growth in the sector. The only two entrepreneurial projects, which belonged to black emerging farmers, were under performing due to a lack of knowledge of aquaculture techniques and technical support, though these projects were not the sole sources of income for the owners and formed part of integrated farming and trading businesses.

The potential of aquaculture programs is influenced by, not only biological and physical environmental conditions, but social conditions too. Therefore, it is not always possible accurately calculate the potential of rural aquaculture projects. However, it is estimated that the ten projects surveyed in the Limpopo Province have an estimated production potential up to ten times current production; current production is well below 10 tons per year. Similarly, the Dakari ornamental fish farm was producing an estimated 1000 fish a month, which is approximately 10% of its potential.

The small-scale trout farmers in the Western Cape, who receive technical support from the University of Stellenbosch, were performing somewhat better. The three cage projects that were surveyed produced 16 to 18 tons of trout per year, with an estimated profit of between R64000 and R68000 per annum. The total numbers of fish farmers associated with the three projects was 30, therefore on average each farmer made about R2200 per year (Table 9). The quality of the fish was an issue of concern as the colour and the taste of the trout were often below standard and this could be directly attributed to poor management and to limited technical support and extension services.

Table 9 Current and potential fish production by weight and value using current facilities in the rural aquaculture programs in the different provinces of South Africa, together with the investment in the program and the current and potential number of people directly involved in the program.

Province and Program	Number of Employees		Annual Production (tons)		Annual Profit (xR1000)		Annual Production (xR1000)	Capital Invested (xR1000)
	Current	Potential	Current	Potential	Current	Potential	Current	
Western Cape Province								
Rustenburg Wind Farm	7	7	3 to 4	3 to 4	12 to 16	12 to 16	64 to 84	74
Cape Oliver	21	21	7	10	28	40	210	100
Worcester	2	2	5 to 6	5 to 6	20 to 24	20 to 40	105 to 126	30
Ceres	7	7	1.4	1.7	4 to 7	4 to 7	29.4	485
Total	**37**	**37**	**16 to 18**	**20 to 22**	**64 to 75**	**76 to 103**	**336 to 378**	**-**
Percentage of potential	**100**	**-**	**80 to 82**	**-**	**73 to 84**	**-**	**-**	**-**
Kwazulu-Natal Province								
Mpontshini Primary School	0	0	0	0	0	0	0	Unknown
Mboza Aquaculture	0	0	0	0	0	0	0	Unknown
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-**
Percentage of potential	**0**	**-**	**0**	**-**	**-**	**0**	**-**	**-**
Limpopo Province								
Batlhabine Ittereleng	7	4 or 5	0	22 to 25	0	112	-	Unknown
Dakari Holiday Resort	13	4 or 5	12,000*	100,000*	10	100	24	145
Ipopeng Fishery	13	4 or 5	7.8	77	39	385	78	Unknown
Itereleng Fishery	4	4	0	32	0	160	-	Unknown
David Pholosi	Private	N/A	0	0.3	1.5	1.5	-	15
Boreadi-A-Ngoaketsi	0	0	0.02	0.02	0.2	0.2	0	Unknown
Uncle James'	Private	1	0	0.7	0	3.5	-	30
Deena Govender	6 - 8	6 - 8	0	24	0	12	-	Unknown
Clare Village	0	0	0	0	0	0	-	Unknown
Total	**43 to 45**	**22 to 28**	**8**	**159**	**51**	**785**	**102**	**-**
Percentage of potential	**160 to 195****	**-**	**5**	**-**	**8**	**-**	**-**	**-**

*Number of ornamental fish produced per month and not weight.
**These facilities are over staffed by the percentage indicated.

Table 10 Current and potential production of fingerlings produced in provincial/government aquaculture facilities, together with the investment in the facilities and the current and potential number of people employed by the facility.

Government Facility	Status	Purpose		Number of Employees		Number of fingerlings/year	
	1=operational; 2=dysfunctional	Original	Current	Current	Potential	Current	Potential
Western Cape Province							
Jonkershoek Hatchery[4]	1	fingerling	fingerling	4	4	120,000	
Eastern Cape Province							
Amalinda Hatchery[5]	1	fingerling	private	5	5	50,000 koi	Unknown
Umtata Hatchery	2	research & fingerling	no function	20	0[6]	0	0
Tsolo College of Agriculture	2	research & fingerling	no function	N/A	0	0	0
Pirie Hatchery[7]	2	fingerling	private	N/A	-	-	-
Mabeleni	1	fingerlings	private	-	-	50,000	-
Kwazulu-Natal Province							
Makatini Research Centre[8]	1	research	research	2	2	N/A	N/A
Nagle Dam Hatchery	2	fingerling	no function	-	-	-	-
Cambrey Trout Hatchery	2	fingerling	no function	-	-	-	-
Royal Natal Parks Hatchery	2	fingerling	no function	-	-	-	-
Underberg Trout Hatchery	2	fingerling	no function	-	-	-	80,000
Limpopo Province							
Dzindi Fish[9]	2	fingerling	no function	20	4 or 5	0	N/A
Tompi Seleka College[10]	1	training	training	N/A	N/A	N/A	N/A
Turfloop Breeding Station	2	fingerling	no function	11	5 to 7	0	300,000
Mpumalanga Province							
Lydenburg Fish Production	1	fingerling	table fish	16	16	15-20,000 trout	150-200,000[11]
Marble Hall[12]	1	fingerling	fingerling	16	16	100,000 tilapia	500,000
De Kuilen	2	fingerling	no function	-	-	-	25-30 mil. ova
Orange Free State							
Gariep Dam Hatchery[13]	1	research & fingerling	research & fingerling	10	12	10,000	150,000+

[4] Jonkerhoek Hatchery is currently leased to Stellenbosch University. It's function is research, however, it sells fingerlings to rural fish farmers; production is limited by water supply.
[5] Amalinda is currently leased to a private company that produces koi-carp; these fingerlings are not available for stocking rural fish ponds.
[6] Umtata Hatchery stopped operations in 1987; its future is undecided since its geographic position may not be suitable for aquaculture.
[7] Pirie Hatchery has been leased to the Anguiliid Research Institute; this is a private research and development facility only.
[8] Makatini Research Centre is a government research centre that offers no extension facility and is not designed to provide fingerlings to rural farmers.
[9] Dzindi Fishery Station was a designed as a grow-out facility and not as a hatchery to produce fingerlings; it has not produced fish for a number of years.
[10] Tompi Seleka is a teaching facility and does not have a dedicated hatchery; the ponds at this facility are used as a teaching aid.
[11] The potential production at Lydenburg is limited by water quota and the quality of the water due to effluent of upstream trout farms.
[12] Marble Hall produces fingerlings for commercial farms/anglers only; only 20 to 30% of its production is sold due to no market; the rest are fed to bass; no rural aquaculture.
[13] Gariep Dam Hatchery and Fishery currently has no manager or assistant manager; all current employees are unskilled which accounts for low current production.

Table 11 Role of South African universities in rural aquaculture.

	Research	Training	Extension Services	Fingerling Production
Stellenbosch University	Yes	Yes	Yes	Yes*
Rhodes University	Yes	No	Yes	No**
University of the North	Yes	Yes	No	No
Institute of Animal Production (Elsenburg)	Yes	Yes	Yes	No

* Trout fingerlings are produced for rural aquaculture from Jonkershoek, which is run by Stellenbosch University

** Trout fingerlings are produced for the sport fishery, and not for rural aquaculture

The poor track record of aquaculture projects in rural areas points to fundamental problems in the development approach that has been applied to date. Given that the state's emerging aquaculture policy places an emphasis on food security in impoverished rural communities, it is important to analyse why the projects failed, as there is a risk that the same mistakes will be made in a renewed round of public sector spending on rural aquaculture.

WHY HAS RURAL AQUACULTURE NOT REALISED ITS POTENTIAL?

The potential contribution of aquaculture to rural livelihoods needs to be assessed in terms of 1) the environmental and infrastructure potential for production of various fish species and 2) the capacity of rural communities to undertake a new and relatively technically demanding enterprise requiring some capital. Evidence from this study, and the experience of small-scale fish farming in the rest of Africa, suggests that the potential for economically viable rural fish production is not primarily constrained by the environment or available infrastructure. Therefore, before considering the environmental potential for aquaculture, it is appropriate first to examine whether aquaculture has potential as a significant economic activity in rural areas, and if so;- under what circumstances? The survey results provide some valuable insights into why rural aquaculture initiatives in South Africa have largely failed or underperformed, and point to strategies that could be employed to promote economically viable aquaculture.

A trend that is immediately evident was that all the aquaculture projects surveyed which had a "food security" objective had failed or were dysfunctional, whereas the commercially orientated small-scale trout culture projects were operating at more than 80% of production capacity.

Reasons for this are discussed under the headings below.

1. Lack of policy

There is currently no policy in South Africa for the development of aquaculture, which is probably the single biggest constraint to the development of aquaculture in rural areas. Without policy, there is no sector planning. Without sector planning, development is uncoordinated and disjointed at best. Most existing food security aquaculture projects are an inheritance of apartheid era homeland development policies, and typical of the donor driven approach to aquaculture development in Africa of the last forty years (Hecht 2000). To our knowledge there has been no critique of the pervasive failure of rural aquaculture projects in South Africa, and there is thus an inherent danger that the policy failures of the past will be repeated. Certainly there is evidence that failed polices and projects have been continued for many years without review. For example, the dysfunctional Umtata Dam Hatchery which still employs 20 staff, and the substantial Turfloop, Lydenburg and Marble Hall Fish Breeding facilities, which have been maintained for years with no clear operational policy or plan.

In the Western Cape Province, there is support at a provincial level for rural aquaculture development through Stellenbosch University and the Institute of Animal Production (Elsenburg), and these efforts have borne fruit in the form of small-scale trout farmers. However, even here coherent policy and support framework appears to be lacking.

Fortunately, the National Department of Agriculture commissioned the Aquaculture Association of Southern Africa to produce a national aquaculture policy in 2003. It should be noted that the proposed policy is not regulatory in nature, nor is it a detailed sector plan. Implementation plans would have to be developed by each province and the policy "is intended as a common base from which to build regulation and sector plans in the future facilitation of the industry" (draft aquaculture policy prepared by AASA for the National Department of Agriculture, 2003)

2. Marketing and feasibility studies

All of the currently successful projects, i.e. the commercial operations, included a feasibility study to determine the viability of the project before the project was implemented. Conversely, almost all of the other projects had failed to follow this procedure indicating the importance of market analysis before project implementation. Almost all of the farmers of the failed projects had unrealistic marketing expectations. For example, some of the food security farmers who farmed in the treated sewage effluent ponds planned to export their fish internationally. Such unrealistic expectations reflect the lack of training and the absence of prior feasibility studies.

3. Number of project beneficiaries

All of the projects that were run as a collective-group project had too many beneficiaries within the group in terms of the project's economic capacity. This is an outcome of democratically implemented projects using land or facilities that are located in communal land and further highlights the complete absence of prior market analysis by the funders. Large groups complicate project governance and the greater the number in a group, the less each member stands to make, thus diluting the entrepreneurial incentive of project members.

The problem is well illustrated by comparing the entrepreneurially motivated Worcester trout project with the collective-group based Cape Olive trout project, both in the Western Cape. The beneficiaries of the Worcester trout project funded the operation with personal capital, the partnership was made up of only two people and each earns 50% of the profits generated from the sale of 5 to 6 tons of trout per season. By contrast, the Cape Olive project produced a similar volume of fish per season, however,

the profits were divided between 21 beneficiaries. In addition, disputes between the beneficiaries of some of the larger trout projects in the Western Cape were reported due to their unequal labour inputs.

As government funders or donor agencies take the number of beneficiaries into account when allocating funds to projects, there is an inbuilt incentive to support projects which support more people. However, experience has shown that the larger the group of beneficiaries, the less manageable the program and the smaller the profits per beneficiary, to the point that the project fails due to a lack of interest due to poor financial returns. A future challenge is the identification of incentives and mechanism that promote individual entrepreneurship in an equitable way within resource poor rural communities.

4. Education level of the farmers

In the survey, the level of formal education of project participants, particularly the project leaders, was informally assessed (since this topic was not covered in the questionnaire) by the project researcher (Q. Rouhani) who personally met all of the farmers, and was able to form an impression of their abilities based on the interviews conducted. In general, the level of education of the farmers could be related to the success of the project. All of the Western Cape farmers interviewed were articulate, and the leader of the Dakari ornamental fish project in the Limpopo Province stood out due to her high level of articulation and general business awareness. All these projects were successful, whereas those that were not successful were run by people with little or no formal education. In the failed projects the less educated participants were incapable of solving relatively simple technical problems, such as a net snagging on the pond bottom, were highly dependent on outside assistance and through the lack of education and knowledge had unrealistic expectations. Aquaculture in South African rural areas is a novel and, in relative terms, technically demanding enterprise requiring some capital and creative solutions to daily problems. It is therefore unrealistic to expect largish groups of uneducated, resource poor, rural people to sustain aquaculture projects on their own. In the section below we consider alternative models such as community-public-private partnerships which could be employed to provide the requisite skills for successful aquaculture in rural areas.

5. Inadequate training

Inadequate training was identified as a major weakness in most of the operations, including the commercially orientated projects. All the farmers that were interviewed agreed that they required further training. For example, farmers were unaware of the

effects of basic factors, such as the influence of water quality on the health of their fish, and feed requirements for optimal growth.

6. Lack of extension services

Training alone is not sufficient as experience, throughout Africa, shows that long term on-going technical support is required if rural aquaculture projects are to be successful. All the farmers that were interviewed expressed the need for technical support. The high level of support and the technical service offered by Stellenbosch University to the trout farmers in the Western Cape was identified as a key factor to the continued success of these programs.

It became evident during the course of the survey that simple technical problems were often the cause of project failure or, at least, the reason for poor performance. Training, no matter how well it is done, cannot prepare the prospective fish farmers for all of problems they will encounter once the project has started. It is therefore unrealistic to expect rural aquaculture projects to succeed without ongoing technical support from skilled government extension officers, or through some form of community-public-private partnership. In all projects visited the ongoing technical support requirement had been underestimated, and the emerging farmers were expected to sustain the projects independently too soon after inception. A further reason why extension services for rural fish farmers are now virtually non-existent is the lack of policy for aquaculture, both at the provincial and national level.

If a new policy for rural aquaculture development is to be implemented, the means of provision of extension and technical support will be critical. However, as local governments need to create jobs and improve livelihoods there is a danger that projects will be started that reflect positively on performance criteria of the respective government departments, rather than project sustainability; and project sustainability is dependent on the provision of on-going extension services. In order to achieve long term sustainability it is furthermore critical to invest in the training of agricultural extension officers.

7. Lack of functional government hatcheries

Government hatcheries no longer produce fingerlings for rural aquaculture projects, which has impacted directly on some of the projects. With the adoption of the proposed aquaculture policy, the role of existing hatcheries in terms of fingerling supply, extension and training will have to be re-assessed.

Summary and Conclusions

Rural aquaculture is not currently constrained by available land, water and infrastructure. Despite previous efforts to promote the rural aquaculture sector, no organic growth has occurred and projects that are not provided with ongoing technical support have failed. “Small scale commercial” aquaculture projects were found to be more viable than “food security” projects. The key characteristics of the two types of rural aquaculture enterprise are compared in Table 12.

The survey results revealed that all “food security” type aquaculture projects identified were effectively dysfunctional or had failed. The products being produced were of low value, and no commercial aquaculture sector existed for these species. Participants possessed rudimentary education, little personal capital, and were poorly trained in aquaculture techniques. Simple problems often resulted in project dysfunction or failure. Most projects had too many participants and the level of income per participant was very low. The level of extension and technical support to these projects was low as a result of a decline in Government extension services. A lack of aquaculture policy has resulted in most Government hatcheries and training facilities becoming privatised or dysfunctional which has effectively halted the development of new rural aquaculture projects. It was clear that “food security” type aquaculture projects cannot be sustainable without ongoing technical support, and probably some initial subsidy of input costs. Moreover, it is our contention that food security type aquaculture projects should only be promoted where these form part of a farm / agricultural diversification strategy. The chances for success of “food security” type projects as stand-alone enterprises are extremely remote.

The commercial or entrepreneurial small scale aquaculture projects surveyed were intrinsically more viable as evidenced by the small scale trout farmers in the Western Cape Province and the Dakari Ornamental fish project. The technologies employed were more capital intensive and technically demanding than the food security projects. The availability of formal markets for their products and an existing private sector producing these species enhanced the financial viability of the projects. Participants were better educated and possessed some personal capital. The major weakness in all projects was a lack of training and experience in aquaculture and all projects required extension and technical support.

The results of the survey demonstrate that the establishment of a rural aquaculture sector which can utilise the potential aquatic resources in a sustainable way for the benefit of rural communities will be entirely dependent on a sustained public sector led intervention. The failure of “food security” type aquaculture projects initiated in the past by the public sector, and the decline of public aquaculture facilities should receive careful consideration in the drafting of new aquaculture policy and sector plans. Given the poor track record of the public sector in sustaining support to aquaculture projects, and the relative success of the small-scale commercial projects, future policy should emphasise linkages to the existing private aquaculture sector by means of community-public-private partnerships.

Table 12 Comparison of the characteristics of “small scale commercial” and “food security” type aquaculture projects. Not all projects surveyed possess all characteristics listed, and often they possess some characteristics of both,

Small-scale commercial aquaculture	**Food security aquaculture projects**
Fewer participants per project	Larger number of participants
Entrepreneurially motivated individuals with some private capital	Impoverished individuals with few or no other economic alternatives
Owner/ manager accountable to a small group of shareholders	Individuals equal members of a democratically constituted committee or group
Managers possess some formal education	Leaders/ managers possess a lower level of formal education
“Intensive” aquaculture techniques	“Extensive” aquaculture technology
High value products for formal market eg. trout, ornamental fish	Low value products for the local informal market e.g. tilapia, carp, barbel
Linkages to an established private farming sector	No linkages to the private farming sector
Dependence on public sector technical support	Dependence on public sector technical support
Business feasibility studies prior to project inception	Rudimentary to no economic analysis prior to project inception

POTENTIAL FOR AQUACULTURE IN RURAL AREAS

In the light of the poor performance of past “food security” type aquaculture projects, and the decline in public sector capacity to support rural aquaculture, careful attention needs to be paid to the types of rural aquaculture projects which are promoted in the future. In this section we consider the potential for rural aquaculture in South Africa in the light of past experience, and suggest fresh approaches to future development.

Environmental Potential: Land, water and infrastructure

In general terms the environmental potential for rural aquaculture is good in certain areas of South Africa, but other factors such as land and water rights, land use patterns, economic viability, the capacity of rural communities to undertake aquaculture and environmental sensitivity, collectively determine which areas may be appropriate for rural aquaculture development.

Warm water aquaculture

Suitable temperature conditions for the culture of warm water species such as carp, tilapia, barbel and ornamental fish exist in the following areas:

- North West Province.
- The Lowveld areas of Limpopo and Mpumalanga Provinces.
- The low-lying areas of Kwazulu Natal, primarily due to the sub-tropical climates in these regions.
- The lower Orange River in the Northern Cape Province.

Cold water aquaculture

Trout culture can be undertaken in or below high-lying catchment areas such as:

- The Hottentots Holland Mountains of the Western Cape Province.
- The Drakensberg Mountains in Kwazulu Natal and the Eastern Cape Province.
- Mpumalanga in the Dullstoom/Lydenburg area.

Culture based fisheries

Throughout most of South Africa winter temperatures are too low for the intensive culture of warm-water fish species. However, if hatchery reared fish are stocked into small and large dams for growout with no additional input costs, economically viable, extensive fish production is possible, despite the low winter growth rates. This style of extensive aquaculture for food security could thus be feasible over much of rural South Africa wherever small impoundments occur.

The need for a GIS database

It was beyond the scope of the project to develop a detailed database on specific areas suitable for environmentally sustainable rural aquaculture in South Africa and this should be a topic for further research. Such an undertaking is a fairly complex task, which would have to be GIS based, and take into account factors such as:

- The biophysical characteristics of various regions and which species could be cultured there.
- Available land resources in suitable regions, particularly land ownership issues. For example is the land private, communal or state-owned.
- Available water resources. For example, what water resources are available, and who possesses the rights to the water.
- Infrastructure. Depending on the level of intensity, rural aquaculture projects will have certain infrastructure requirements.
- Proximity of dams to human settlements and markets.

Potential of Aquaculture for Food Security

Given the poor performance of aquaculture projects with a food security objective, as documented in the present survey, the question needs to be asked: "Can rural aquaculture projects be viable, and can they contribute to food security and rural livelihoods?" We have suggested that greater emphasis needs to be placed on the promotion of small-scale commercial aquaculture projects, but this style of aquaculture may be beyond the reach of many rural farmers due to the higher educational, training and capital requirements of such projects. If we consider the circumstances of impoverished rural communities who have suitable water resources for aquaculture, we suggest that aquaculture for food security could be promoted as 1) an "on-farm diversification strategy" for emerging farmers or 2) as "culture based fisheries" for subsistence farmers.

It must be borne in mind that rural subsistence or emerging farmers usually cannot afford the most basic input costs. Emerging farmers can be described as financially poor and have small volumes of ready cash (Simmonds, 1985). They have limited access to loans and are aware that their financial environment is uncertain since they regularly experience shortages of cash. In addition, they usually have families to support, and are subsequently, averse to taking risk. Furthermore, they tend to live in communities that have limited infrastructure for good marketing, communication and transport. The "food security" projects surveyed were in general "stand alone" ventures requiring significant inputs to become viable, for example, the purchase of feed, fingerlings and capital for the construction of ponds and buildings (although in all instances capital costs were donated by the public sector). Experience in promoting rural aquaculture among small-scale farmers in Malawi has shown that fish production can be viable

where the activity forms part of an on-farm “diversification strategy” (Prof T. Hecht, personal communication, March 2004). The projects of emerging farmers, Uncle James and Mr Pholosi, described in the survey results (Section 24 and 26) typify this approach, but were unproductive because they were lacking the requisite technical support and guidance.

Rural “food security” type aquaculture projects should thus be extensive and designed to reduce input costs and to operate using the most basic technology. Fish should be sold locally, as transport is almost always a problem in rural areas and getting fish to markets far from the production ponds can cripple the project. Furthermore most rural areas have no access to electricity, and if they do, frequent cash shortages mean that the farmers do not always have sufficient money to pay for the costs associated with running freezers and other electrical equipment.

Culture based fisheries require almost no input costs from the beneficiaries and would be suitable in impoverished areas where communities live by subsistence farming. The main input cost is the fish stocking, but there is a case for this cost being covered by the state, or at least heavily subsidised, as these target communities are heavily dependent on State grants for their basic livelihood in the form of pensions, child subsidies and school feeding schemes. The stocking of dams with fish could be viewed as a form of subsidy to enhance basic nutrition and would fall within the mandate of the Department of Water Affairs and Forestry to maximise the use of inland waters of the Republic. The experience of Rhodes University’s rural fisheries programme shows that with minimal assistance, impoverished rural communities can be taught to fish small dams on a sustainable basis without ongoing technical assistance.

If aquaculture is employed as an on-farm diversification strategy among emerging farmers with more personal resources, the farmer already possesses certain resources and has an entrepreneurial motivation. He is thus not entirely dependent on the new enterprise for his livelihood, and the governance problems and dependence on capital from the public sector, which typify the stand-alone aquaculture projects, are avoided. Such farmers are keen to learn new farming techniques, for example, in Malawi an “innovative farmers” scheme is being supported to bring farmers together to share experiences, solve problems and learn new techniques (Prof T. Hecht, personal communication, March 2004).

In conclusion potential exists to develop sustainable aquaculture and culture based fisheries for food security in the rural areas of South Africa, provided that:

1. Projects are correctly designed taking all socio-economic and cultural factors into account.
2. Local market share exists and is secure.

3. The farmers are provided with regular technical support and extension.
4. The have access to fingerlings at affordable rates for on farm stocking of ponds and that appropriate small and large impoundments are stocked at the expense of the state.
5. The environmental and climatic conditions are suited for the extensive production of the target aquaculture species.

However, it should be recognised from the onset that these projects will have low yields due to the extensive nature of the aquaculture systems (i.e. low input equals low output). Furthermore, in many parts of the country even where climate is conducive to extensive production, these extensive systems will experience reduced production in winter when ambient temperatures are low. Nonetheless, the development of rural aquaculture is required since most of the rural population live below the poverty line (Appendix II); therefore, the importance of developing and promoting sustainable food security cannot be under emphasised.

Potential for Small-Scale Commercial aquaculture

Commercial aquaculture requires a higher level of sophistication and organisation than aquaculture for food security. In commercial aquaculture, the product is usually intended for formal markets that demand consistency and reliability in production and quality. The experience of the small scale trout aquaculture projects in the Western Cape Province, the Dakari ornamental fish projects and the former Amatikulu satellite farmer project demonstrates that small scale commercial aquaculture in rural areas is possible, provided technical support is provided, and there is an established link to an existing private sector. Community-public-private partnerships are a suitable vehicle for promoting small scale aquaculture projects.

The following factors should be considered for successful small-scale commercial aquaculture in South Africa:

- The location of the fish farm is critical. If the farm is far from market, particularly if farm is producing table fish where large volumes of fish need to be transported, then transport costs can erode profits. Also, the climatic zone in which the farm is located will influence the success of small-scale commercial aquaculture;

- Species selection. High value species for which a local market and commercial production sector exists must be selected

- Technical support. Operating a fish farm that can consistently produce good quality fish requires substantial effort and skill and for this, emerging small scale commercial farmers require the assistance of qualified technical extension officers on an ongoing basis.

- Markets and financial viability. A market survey and financial feasibility study is essential before the farm is built and put into operation. There are many cases where large scale commercial farms have failed due to inadequate market surveys. Emerging small-scale farmers require specialist assistance to undertake such studies.

- Target group. Government has undertaken to assist black emerging commercial farmers. These farmers typically have transport, farm machinery that could be used to dig ponds, labour and an understanding of the market. Therefore, commercial aquaculture should be targeted at black emerging commercial farmers as an on-farm diversification strategy and not at rural subsistence farmers.

The Role of the Public Sector

Experience to date shows that a rural aquaculture sector will not develop organically, nor will the private aquaculture sector of its own accord assist resource poor rural farmers to any meaningful extent. Therefore, if the opportunity to promote rural livelihoods by means of aquaculture is to be realised a sustained public sector intervention is required. This means not only starting projects and training farmers, but providing long term technical assistance by means of public sector extension services and community-public-private partnerships. A public sector commitment on this scale requires clear policy objectives, sectoral plans and institutional coordination. In this section the role of the public sector in promoting rural aquaculture development is discussed.

Policy and sector planning

Currently South Africa has no coherent policy for rural aquaculture development. The lack of policy has resulted in the closure and privatisation of many state hatcheries and a decline in extension and training capacity for rural aquaculture. In 2003 the National Department of Agriculture (NDA) commissioned the Aquaculture Association of Southern Africa (AASA) to develop a draft national aquaculture policy entitled *Industry contribution to a South African national aquaculture policy; towards sustainable aquaculture development for all*.

The policy is intended to "…facilitate sustainable and responsible aquaculture development for the social and economic benefit of all South Africans…" Furthermore, the policy aims to limit fragmentation between authorities and government departments in growing the economic, social and participatory benefits of aquaculture.

The principles by which the policy proposes to promote sustainable rural aquaculture are:

- Government should take the necessary steps to optimise the economic contribution of aquaculture to the country.
- Government should review policies, legislation, plans and institutions to address the characteristics and needs of aquaculture in recognition of the fact that aquaculture is a distinct enterprise.
- Government should promote on-farm research, demonstrations and increased practitioner-to-practitioner extension as ways to increase economic and social benefits from aquaculture.
- Government should promote private sector participation through access arrangements to areas specifically designated for aquaculture and through the provision or facilitation of the necessary support services and access to finance.
- Government should co-operate, where necessary, in the promotion of inland and marine ranching and stock enhancement.
- Government should undertake research and technological development in all aspects of aquaculture production. One focal area must be the identification of new sources of locally available raw materials for fish feed.
- Government should not allow the introduction of exotic species or genetically modified species to aquatic eco-systems unless the impact has been fully investigated.
- Government should establish standard guidelines and regulations for the application of environmental impact assessments related to aquaculture, where these are necessary.
- Government should monitor diseases and the spread of diseases of relevance to aquatic species (feral and cultured).
- Government should regulate quality of effluent water.
- Government should promote sustainable aquaculture development from a social, economic and environmental perspective. This includes the provision of extension services to cater for needs such as statutory assistance to industry participants.
- Government should promote that preference be given to South African citizens and to ventures beneficially controlled by South African citizens who can benefit from the utilization of South Africa's natural resources for aquaculture development.
- Previously disadvantages individuals, communities and demographic entities should be fully integrated into the aquaculture development process. For this Government shall establish and promote an industry entrance development strategy or plan.

Completion of the policy is currently constrained by a lack of information on the potential contribution of aquaculture to rural livelihoods and the present study is seen as a valuable contribution to addressing this need (K. Ramsay, National Dept. Agriculture, personal communication, February 2004)

The Department of Water Affairs and Forestry (DWAF) has recently (January, 2004) put out a tender to develop aquaculture policy to inform its areas of jurisdiction. Clear policy from DWAF regarding access to water for aquaculture, particularly by rural communities, and the management water quality standards for aquaculture will assist in the implementation of sectoral development.

Synopsis of Government Facilities and Their Potential Role in Rural Aquaculture Development

As outlined in the survey results Government aquaculture facilities fall into two classes:

1) The Nature Conservation hatcheries formerly used for producing exotic species for angling.
2) Aquaculture facilities to support rural aquaculture in the former homelands.

Government hatcheries that have not yet been privatised are not functioning (Table 10), and no Government hatchery currently produces fingerlings intended for stocking rural aquaculture projects or water bodies(Table 10). The inadequate supply of fingerlings to farmers was a concern in both the Western Cape and in the Limpopo Province, and was beginning to negatively affect the further development of existing projects. Fingerling provision could become a bottleneck if the development of rural aquaculture is supported under a new aquaculture policy. Government should therefore re-assess the role of its aquaculture facilities, particularly the hatcheries in terms of its emerging policy objectives. This will require inter-departmental coordination and negotiation, particularly with respect to the Nature Conservation hatcheries. The emerging national aquaculture policy being formulated by the Department of Agriculture will help to inform such a process. In this section we briefly profile the existing facilities and suggest possible future roles for them.

Western Cape Province

Stellenbosch University is the driving force in rural aquaculture in the Western Cape. The university has committed its staff and facilities (including Jonkershoek Hatchery) to promoting this sector. Another facility that should be playing a more direct and active role in aquaculture is the Institute of Animal Production (Elsengurg). Post-1994 Elsenburg included aquaculture as a research and development activity and was involved in various projects including the establishment of small scale cage culture of trout in irrigation dams. The departure of key staff has curtailed Elsenburg's aquaculture activities; however, with its facilities and staffing, the institute is well positioned to play both a research and extension support to small scale fish farmers.

The facilities at Stellenbosch University, Elsenburg and Jonkershoek are in a good state of repair.

Eastern Cape Province

Government facilities in the Eastern Cape that are available for aquaculture development are Umtata Dam Hatchery, Tsolo College of Agriculture and Amalinda Fish Station. The facilities at Umtata Dam Hatchery and Tsolo College of Agriculture are run down, the staff lack technical skills and geographically they are not well positioned for aquaculture. These facilities do not hold much potential and it is recommended that after a provincial aquaculture sector plan has been formulated, a more detailed study be taken to determine the future of these two facilities. However, Amalinda is ideally situated, both from a climatic and human resource perspective, and could play a major role in the development of aquaculture in the Province.

The old Mabeleni trout hatchery has been leased to the Transkei Piscatorial Society, which uses the facility to produce small numbers of fingerlings for club use. The Pirie Hatchery is leased to a private enterprise attempting eel culture. There could possibly be a future role for these facilities in supporting trout sport fishery development and the stocking of dams in rural areas with fingerlings.

Rhodes University's Department of Ichthyology and Fisheries Science (DIFS) undertakes high level marine and inland aquaculture research, possesses a trout hatchery, which supplies fingerlings for stocking private trout angling waters and has the physical and human capacity to produce any freshwater species for aquaculture in South Africa. It also possesses technical support capacity for rural aquaculture development through its Rural Fisheries Programme and could potentially train rural fish farmers and guides for sport fisheries.

Kwazulu Natal (KZN)

The Aquaculture unit at Makatini Research Centre is the only government facility in KZN that is currently involved in aquaculture. The unit is small; however, it has relatively good facilities and staff with good technical skills. This facility is research orientated, and does not directly promote aquaculture or provide extension services. It is recommended that this facility be provided the funds to expand its service as a base for rural aquaculture development and extension services in the region. The areas around Makatini are ideal for aquaculture due to the abundant supply of water and high winter temperatures.

Ezemvehlo KZN Wildlife previously operated trout hatcheries at Kamberg, Royal Natal National Parks Hatchery and Underberg, and a warm water fish hatchery at Nagle Dam. With the change in policy to cease producing exotic species all facilities were closed or privatised. At the time of writing it was not known which of these facilities was still controlled by Ezemvehlo KZN Wildlife,

and what their policy was regarding their future existence. If rural communities are to be empowered to play a greater role in the trout angling industry, the possible role of the Kamberg hatchery as a training and fingerling supply centre could be evaluated.

Mpumalanga Province

The only two government facilities in Mpumalanga Province that were involved in aquaculture were the Lydenburg Fish Production Centre and Marble Hall Fisheries Unit. The de Kuilen trout hatchery close to Lydenburg was not operational but was in good repair and had capacity to produce over 25 million trout ova. Mpumalanga Parks Board have adopted a conservative policy that does not include production or stocking of trout and thus both de Kuilen Hatchery and Lydenburg Fish Production Centre are currently underutilised

Lydenburg is located in the centre of the very lucrative trout fishing industry, which generates substantial regional income and employment. The Lydenburg Fish Production Centre has substantial infrastructure and could be a suitable facility to provide training and services to the trout fishing industry. At the time of writing we were not aware of any strategies for black economic empowerment or training of members of local communities in the trout industry. It would therefore seem logical to explore the possibilities for utilising these facilities with the Mpumpalanga Parks Board, representatives of the trout industry, local authorities and communities near trout farming or angling waters.

Marble Hall is perhaps the most suitable facility to train potential warm water fish farmers and to provide extension services in the Province. It has all the necessary infrastructure (including accommodation for visiting farmers) and a skilled technical staff. Although the current facility will be flooded, due to an increase in height of the nearby dam wall, the facility will be relocated.

Limpopo Province

Turfloop Hatchery is a well equipped facility that could provide the entire fingerling requirement for Limpopo Province, provided a suitable sectoral plan was developed. The staff has the necessary aquaculture skills, however they would need further training, which could be provided by the Aquaculture Unit of the University of the North.

The aquaculture section of Tompi Seleka Agriculture College is poorly equipped to adequately provide any form of training. It has no permanent staff with technical skills and its infrastructure is run down. Juxtaposed to the poorly equipped Tompi Seleka is the future flooding of a large section of the Marble Hall station. It is recommended that consideration be given to amalgamating the staff and the infratsurcture of Marble Hall with Tompi Seleka and to provide training for fish farmers. Alternatively, this function could be undertaken by by the Aquaculture Unit of the University of the North.

The facilities at Dzindzi Aquaculture Project are of no benefit to the Department of Agriculture, since the area is remote, and any services that could be offered there would be duplication. While the facility has adequate water supply and sufficient ponds, none of the staff have any aquaculture skills. Therefore, it is recommended that the feasibility of handing this facility to the local community to farm fish for food security be considered.

Community Public Private Partnerships (CPPP's)

The development of commercial aquaculture in the rural areas can be catalysed by the involvement of the private sector through Community Public Private Partnership's (CPPP). These have proved to be successful in other sectors of agriculture (such as paprika farming in the Northern Cape). The advantages of a CPPP model is that by combining assets unique to each sector (Table 13), all of the requirements for a successful commercial aquaculture project could be met. Using this model, government facilities, such as the Lydenburg Hatchery, which are currently either underutilized or close to being closed down, could be revitalized with the involvement of the private sector. However a framework for achieving this would need to be developed. Support for CPPP's has been provided by the Department of Trade and Industry through the Development Bank of South Africa. Public-private partnerships (PPP) can also be established under the auspices of the treasury, which has a PPP manual and will register PPP's that meet certain criteria.

Table 13 Contributions of the various partners in a community-public-private partnership (CPPP) model.

Sector	Funding	Resources	Infrastructure	Manpower	Markets
Communities (Rural)	Through government	Access to Land & Water		Labour, security	
Public (Government)	Grants, cheap loans	Access to Land & Water	Yes (e.g. Turfloop and Marble Hall facilities)	Technical skills, training	
Private sector	Loan finance	Equipment		Management, Technical, business skills	Yes

Differences in opinion between the Department of Agriculture and Nature Conservation with regards to the use of exotic species in aquaculture

Many candidate aquaculture species are exotic. The Provincial Nature Conservation Departments have, therefore, on occasion been unsupportive of aquaculture. This has caused friction with the developmentally orientated departments such as agriculture and economic affairs. Some of these exotic species (e.g rainbow trout) have now been in South Africa for over a hundred years, and in certain catchments these species are now resident and can provide economic benefit. While it is important to conserve biological diversity in pristine areas, it is also important to develop sustainable industries in impoverished parts of the country where the impact of exotics is low. The lack of clear guidelines as to which species can be grown in which catchments and sub-catchments has in certain instances retarded aquaculture development. This constraint to aquaculture development requires clear policies on the use of exotic species and coordination between the respective Departments of Agriculture and Nature Conservation.

PROPOSED TOPICS OF RESEARCH

One of the objectives of the WRC Rural Aquaculture Baseline Study was the identification of suitable topics of research to promote the development of the sector. On the basis of the findings of the study, five possible research projects were proposed.

1. GIS Database of Suitable Areas for Rural Aquaculture including Small dams

Knowledge of potentially suitable areas for rural aquaculture is limited to a broad geographical basis. A high resolution database which integrates key bio-physical and socio-economic information is required to identify suitable areas for the culture of various species. The database should include the following information:

- The biophysical characteristics of various regions, including water temperature, water quality, rainfall and geological data.
- The environmental requirements of candidate species.
- Aquatic biodiversity data and the distribution of exotic fish species.
- Environmentally sensitive and conservation zones.
- Land zonation and ownership.
- Available water resources and uses including rivers, irrigation schemes, small and large dams.
- Water rights.
- Socio-economic and demographic information.
- Electricity, road and communication networks.

By integration of the above information a synoptic analysis of suitable areas, species and available water for rural aquaculture could be generated. This would help to inform policy and planning decisions regarding the level of public support appropriate for rural aquaculture. The Department of Water Affairs and Forestry possesses extensive databases on water resources and could be approached to assist with this undertaking.

2. Supplementary species for cage culture for trout farmers in the Western Cape Province

Trout production is seasonal (May-November) in the Western Cape Province dams, as summer temperatures are too high to support cage culture in irrigation dams. For five months of the year the cages are empty and do not generate income for the farmers.

Research should be aimed at identifying aquaculture species that could replace trout making the program operational all year round. However, such a species would required similar production conditions to trout and would require similar marketability. Alternatively, research could focus on finding a species that could be stocked into the cages and grown to market size during the period that the cages are empty, i.e. during the five summer months of the year. Stellenbosch University has undertaken some research along these lines and has stocked the cages during the summer period with tilapia, but the project was met with limited success only.

3. Culture Based Fisheries in Small and Large Dams

Small dams

There are an estimated 50,000 to 100,000 small water bodies (i.e. less than 1,000 ha each) in South Africa (Potts, 2003). Rose *et al* (1987) identified 8469 dams that are less than one hectare and 676 dams between one and ten hectares in the former Ciskei; that is a total of 9136 dams that are equal to or less than 10 hectares, in the Ciskei alone. Small dams are particularly productive from a biological point of view, and often do not contain fish. They are therefore a potentially large source of fish production with minimal input cost, provided they are stocked with fish and managed appropriately. Research to determine the potential of these dams for culture based fisheries to produce fish for food security in the rural areas is therefore required.

Specific areas of research that would need to be addressed included:

- The number, distribution and size of the dams;
- Water permanency of the dams; since some of the smaller dams dry up seasonally, this needs to be considered when determining the feasibility of stocking such dams.
- The potential, and in particular the cost of Government hatcheries providing fingerlings to rural communities as part of Government subsidy to these communities.
- The choice of fish species that would be environmentally most appropriate to stock into such dams.

Large Dams

There are many large dams located in the rural areas South Africa, however few are effectively utilised for fish production. If these dams were to be effectively managed they could provide rural communities with significant volumes of fish. Although most of these dams have been stocked with fish in the past, the stocks have not been managed to maximise the production capacity of the dam. For example, previous work has shown that mullet (*Mugil cephalus*)

stocked into large freshwater impoundments (e.g. Lake Mentz near Port Elizabeth) could sustain a commercial scale fishery (Anton Bok, *pers. com*.).

Research covering the following aspects would be required:

- Develop an effective management plan for fish production in dams, in relation to the needs of the fishers and other stakeholders (e.g. farmers, municipalities).
- Biological production potential of large dams;
- Determine appropriate species and develop appropriate stocking and harvesting strategies.

4. Development of recreational fisheries

Aquaculture can contribute significantly to establish and develop recreational fisheries in rural areas. A good example is the multi-million rand trout sport fishery in the Eastern Cape. This sector has grown rapidly in South Africa over the past two decades and requires new fishing waters to sustain its growth. The fly-fishing industry is extremely lucrative, and could attract local and foreign tourists into rural areas that they otherwise would not have visited and lead to the creation of infra-structure and jobs in the hospitality industry in economically marginalized rural areas. There is enormous potential to expand the fly fishing sector into rural areas, many of which are extremely scenic and remote. Rural communities are largely unaware of this potential, and are also not aware of how to develop and attract the industry to its waters. Research into the development of this industry in rural parts of South Africa by means of community-public-private partnerships requires further attention.

Preliminary research into the develop of a trout fly fishing industry in rural Eastern Cape (greater Umzimvubu Municipality) has recently been completed by The Rural Fisheries Programme of the Department of Ichthyology and Fisheries Science, Rhodes University. The area is located in the north east of the Eastern Cape adjacent to the southern border of Lesotho and close to the well-developed trout fly fishing area in the eastern area of the Eastern Cape. Areas at >1000m ASL in the Umzimvubu municipality have many dams and streams with ideal habitat ideal for trout. Many of these streams and dams were stocked with trout decades ago, but limited access, a lack of tourism, generally undeveloped infrastructure, and a lack of local awareness of the potential the area has for trout fly fishing, have prevented the development of this industry in the area.

To develop the sport fishery, the following is required:

- Identification of appropriate species of fish that could be stocked in selected rivers and dams in each rural area, so as to enhance the sport fishery, without negatively effecting existing biodiversity in the systems;
- Determination of the role that Government hatcheries, such as the Pirie Hatchery (King Williams Town) and the old Mabeleni hatchery near Umtata, could play in supplying rural communities with trout fingerlings.
- Developing integrated management plans for the promotion, development and sustainability of sport fisheries in the rural areas.

The Lydenburg Hatchery is well placed to play an analogous role to Jonkershoek Hatchery in terms of supporting black economic empowerment both in aquaculture and trout fishing sectors.

5. Participatory Action Research to Evaluate the Role of State Hatcheries

Based on the results of the survey and following the discussions at the WRC Project Reference Group meeting in January 2004, at Rhodes University, it was agreed that the present factors constraining aquaculture in rural areas were mainly a consequence of a lack of policy and institutional capacity and that the development of rural aquaculture will depend principally on a public sector led intervention, inclusive of technical support and fingerling supply. The study revealed that there are many state owned hatcheries and training facilities falling under various Government Departments that are either unproductive, privatised, or defunct. Though not assessed these assets are worth millions of Rands. Based on the survey results it was further agreed that the involvement of the private sector in rural aquaculture would be essential for sustainable growth (see section above on CPPP's). As policy issues were being addressed by the National Department of Agriculture, it was suggested that the WRC should support the undertaking of workshops in preparation for Participatory Action Research (PAR) with the various public and private sector stakeholders to appraise the potential role of these hatcheries in the light of emerging policy, and where applicable to develop a framework for a Community Private Public Partnerships (CPPP's) to revitalise government hatcheries that are currently under- utilised.

It was proposed that the PAR project should be undertaken in one year and funded by the WRC. Furthermore, the terms of reference would be determined by the WRC, with input from Rhodes University.

REFERENCES

Britz, P.J. and S. De Kock (1994) *Proceedings of the Aquaculture Association of Southern Africa*, Number 3, 1994.

FAO 1998: *Fisheries Statistics Year Book, 1998*.

FAO 2002: *The Status of World Fisheries and Aquaculture Report, 2002*. http://www.fao.org/docrep/005/y7300e/y7300e00.htm

Hecht, T and P.J. Britz (1990) *Aquaculture in South Africa*: *History, Status and Prospects*. NMB Printers (Pty) Ltd.

Hecht T. and I. De Moor (1997) *Small Scale Aquaculture in Sub-Saharan Africa*. http://www.ru.ac.za/academic/departments/difs/

Hecht T. 2000. Considerations on African aquaculture. World Aquaculture Vol. 31(1): 12 – 19.

Potts, M.W. 2003. *Toward the development of species-specific fish production models for small reservoirs in southern Africa*. PhD Thesis, Rhodes University, Grahamstown.

Rose, A.J., D.R. Tapson & B.D. Jordan (1987) *Report on the potential for the development of freshwater aquaculture in the Republic of Ciskei.* Agricultural and Rural Development Research Institute (ADRI).

Simmonds (1985). *Farming system research: A review*. The International Bank for Reconstruction and Development, World Bank Technical Paper Number 43. 97 pp.

APPENDIX I. QUESTIONNAIRE FOR THE RURAL AQUACULTURE BASELINE SURVEY [14]

1. Background

Name of Aquaculture facility
Date

Contact details for Aquaculture facility. (name of manager and contact details)

Location of Aquaculture facility (e.g. distance from closest large town)

2. History of aquaculture facility

When did this facility start (provide details of its history)?

What was its motivation (food security / commercial)?

Who funded the project?

Approximate cost of setting up project?

Was a feasibility study + business plan initially undertaken (if possible provide details)?

Who motivated for the fish farm (community / NGO / Gov / other)

Is this facility still running?

If not….why?

3. Infrastructure

How many ponds (and size) are present (describe the system –e.g. intensive / extensive, flow through / recirculating).

What condition is the facility in?

Are the ponds earthen or concrete?

[14] Completed questionnaires are held by the Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown.

Comment on the machinery at the facility (e.g. pumps, blowers, generators – make list of machinery and comment on status).

Source of water (municipal, borehole, river) / Have there been any problems with water availability (and if so, for how long)?

Does the farm use electricity, (source, Eskom / generator)

Is the water treated before it is released (describe process)

4. Human Resources

How many people work at or are associated with the facility?

What are the technical skills qualification of the staff?

Is their salary covered by the profits from the farm or is it supplemented from another source. (details)

5. Biological

If the present species of fish being grown at the facility is different to the one originally grown (when the farm was built), determine why there was a change.

List the species of fish being grown at the fish farm (and also the species of fish that was previously being grown)?

Provide production values (numbers of fish or tonnage)?

Have there been any problems with fish diseases and how was it treated (and by who)?

6. Financial aspects / Marketing

Selling price of product?

Who buys / uses the product?

Is the fish processed in any way….Describe?

Are there other markets that could be tapped into?

What can be done to tap into these markets.

What are the monthly running expenses of the fish farm (list during growing season and out of season – if applicable)?

Does the fish farm have a formal accounting system (e.g. bank account).

Is there a formal structure that governs the project (e.g. board / committee)?

Describe the marketing strategies of the fish farm (if any)?

Are there any links with tertiary institutions / private companies (with regards to marketing)?

7. Beneficiaries

Who are the beneficiaries of the project?

How were they (beneficiaries) nominated (elected / appointed)?

How many of the original beneficiaries are still with the project (details as to why they left-if any)?

How many males / females are associated with the project

8. Technical skills

What kind of training have the beneficiaries received (from where and when)?

Do the beneficiaries feel they need further training?

Does any government department provide technical services to the project?

Are there any links with tertiary institutions / private companies (with regards to technical skills)?

9. Record keeping

Do the staff keep records of fish sales, production e.t.c?

Do the staff keep records of water quality and other biological variables?

10. Production

Is there a nursery at the facility (describe if there is one)

Describe any breeding program

How many months of the year is the fish farm able to produce fish (details)

11. Feeds and feeding

What are the fish being fed (details –where are they buying the feed from, , type of feed, cost, how often do they feed, how do they transport the feed).

12. Processing

How is the fish sold (e.g. whole, filleted, fried).

Have they tried processing the fish to add value?.

Do they have any value adding equipment (e.g. smoker, vacuum sealer).

13. Questions for the manager

List the constraints that the fish farm faces (e.g. Human resources, Production, Marketing, funding)

What do you think can be done to improve this facility?

APPENDIX II. SOCIO-ECONOMIC DATA FOR FIVE PROVINCES IN SOUTH AFRICA AND FOR SELECTED LOCAL MUNICIPALITIES[15]

Table 1 – Selected socio-economic indicators for Eastern Cape Province, Western Cape Province, Mpumalanga,Kwazulu-Natal and Limpopo.

	Eastern Cape	Western Cape	Mpumalanga	Kwazulu-Natal	Limpopo
Population (2003 estimate)	6 496 916	4 736 399	3 243 591	9 751 598	5 408 354
Population density (2003)	38.3/km^2	36.6/km^2	40.8/km^2	105.9/km^2	43.6/km^2
Projected population growth rate (2001-2006)	1.04%	1.19%	1.51%	1.12%	1.24%
GGP per head (2001)	R8 917	R34 986	R21 331	R11 924	R6 869
Unemployment rate (2002)[a]	47.4%	25.1%	42.7%	44.1%	58.5%
Average annual household income (2001)	R43 097	R87 896	R50 115	R57 538	R39 520
Adult lilteracy (1996)	76.5%	95.8%	79.4%	89.2%	77.7%
Infant mortality rate (1998)	61.2	8.4	47.3	52.1	37.2
No schooling (people aged >20)	22.8%	5.7%	27.5%	21.9%	33.4%
Households living in traditional dwellings (2001)	38.1%	2.2%	12.9%	27.9%	19.7%
Households using wood for cooking	35.9%	2.9%	23.3%	27.0%	59.9%
Unprotected water source	31.7%	0.3%	4.9%	18.4%	10.5%
Households with no toilet	30.8%	7.7%	10.3%	16.2%	23.3%
People living in poverty (2001)	67.4%	21.2%	53.8%	53.6%	63.5%
Average household size	4.1	3.6	4.0	4.2	4.3

a. Expanded definition

[15] Reference: Stats SA

Table 2 – Selected socio-economic indicators for Eastern Cape Province

	Eastern Cape Province	King Sabata Dalindyebo Municipality (EC 157)
Population (2001)	6 436 763	415 229
Unemployment rate (2001)[b]	24.6%	57.1%
Households living in traditional dwellings (2001)	38.1%	49.0%
Households with no toilet	30.8%	44.4%
No schooling	22.8%	17.8%
Unprotected water source	31.7%	46.6%

b. Strict definition

Table 3 – Selected socio-economic indicators for Western Cape Province

	Western Cape Province	Witzenberg Municipality (WC022)
Population (2001)	4 524 335	83 567
Unemployment rate (2001)	17.1%	14.6%
Households living in traditional dwellings (2001)	2.2%	2.0%
Households with no toilet	7.7%	9.2%
No schooling	5.7%	11.5%
Unprotected water source	0.3%	0.3%

Table 4 – Selected socio-economic indicators for Mpumalanga Province

	Mpumulanga Province	Greater Marble Hall Municipality (CBLC3)
Population (2001)	3 122 990	121 327
Unemployment rate (2001)	23.0%	44.8%
Households living in traditional dwellings (2001)	12.9%	15.8%
Households with no toilet	10.3%	13.0%
No schooling	27.5%	37.7%
Unprotected water source	4.9%	18.7%

Table 5 – Selected socio-economic indicators for Kwazulu-Natal Province

	Kwazulu-Natal Province	Jozini Municipality (KZ272)
Population (2001)	9 426 017	184 090
Unemployment rate (2001)	21.6%	60.2%
Households living in traditional dwellings (2001)	27.9%	55.6%
Households with no toilet	16.2%	63.6%
No schooling	21.9%	50.8%
Unprotected water source	18.4%	38.7%

Table 6 – Selected socio-economic indicators for Limpopo Province

	Limpopo Province	Thulamela Municipality (NP 343)
Population (2001)	5 273 642	584 563
Unemployment rate (2001)	21.6%	59.6%
Households living in traditional dwellings (2001)	19.7%	40.8%
Households with no toilet	23.3%	31.2%
No schooling	33.4%	30.0%
Unprotected water source	10.5%	7.3%

APPENDIX III. CONTACT DETAILS

CONTACT LIST
ASSOCIATIONS, INDUSTRY SECTOR HEADS AND INDIVIDUALS

SURNAME	NAME		E-MAIL	ADDRESS	TELEPHONE
ASSOCIATIONS:					
LOUBSER	NICK	ABALONE FARMERS ASSOCIATION	nickl@ij.co.za	PO BOX 22428, FISH HOEK, 7974	(028) 384-1371
BECKERT	INGO	CATFISH SA	ingo@cybertrade.co.za	PO BOX 648, SUIDER PAARL, 7624	082 569-8906
UYS	HANNES	SOUTH AFRICAN KOI TRADE ASSOCIATION	hannesu@iafrica.com		(021) 988 9724
STUBBS	GREG	WESTERN CAPE TROUT FARMER'S ASSOCIATION	info@three-streams.co.za	PO BOX 107, PAARL, 7622	(021) 876 2485
VAN DER MERWE	RENIER	MPUMULANGA TROUT FORUM		PO BOX 309, LYDENBURG, 1120	(013) 235 1248
SECTOR HEADS:					
EEL					
MATHEWS	JON	SA EELS	jmathews@saeels.co.za	Postnet Suite 230, Private Bag X 16, Constantia, 7848	(021) 794 4795
GRASS CARP					
HINRICHSEN	ETTIENNE	AQUAECO	aquaeco@telkomsa.net		(021) 856 5277
MARRON					
VISSER	JAMES	JD MARRON	jdmarron@mweb.co.za		(021) 875-5565
MUSSELS AND OYSTERS					
PIENAAR	VOSSIE	BLUE BAY MUSSELS	bbmussel@mweb.co.za	PO BOX 814, SALDANHA, 7395	083 236-8810
ORNAMENTAL FISH					
JONES	CLIFF	RHODES UNIVERSITY	c.jones@ru.ac.za		(046) 603 8415
PRAWNS					
EVANS	LAURENCE	AMATIKULU PRAWNS	laurence@amatikulu.co.za	PO BOX 272, GINGINDLOVU, 3800	(035) 337 4572
SALMON					
RATTE	THEO	SALMON SALAR SEA FARMING			(021) 875-5565
TILAPIA					
BEKKER	KRIEK	AQUASTEL (PTY) LTD	aqua@sun.ac.za	PO BOX 3135, MATIELAND, 7602	(021) 882 8530
THOMPSON	NIC	WALLACEDALE HATCHERIES	nic@clad.co.za	2 PORTER AVENUE, MELROSE NORTH, 2196	083 357 6765

SURVEY CONTACTS

SURNAME	NAME		E-MAIL	TELEPHONE
Backeberg	Gerhard	Water Research Commission	gerhard@wrc.org.za	(012)3311136
Brink	Danie	Stellenbosch Univeristy	db@sun.ac.za	
Britz	Pete	Rhodes University	P.Britz@ru.ac.za	(046)6038415
Coetzer	len	Dept of Agriculture (Mpumalanga)	len@laeveld1.agric.za	(013) 752 6128
De Beer	Theo	Lydenburg Fish Production (trout hatchery)		(013)2352395
de Viellers	Atti	Marbel Hall Fisheries (Mpumalanga)		(013) 235 3075
Engelbrecht	Johan	Mpumalanaga Parks Board	jseng@intekom	836266303
Fick	Lorraine	DWAF (Pretoria)	deb@dwaf.pwv.gov	(012)336 8224
Gertenbach	William	Dept of Agriculture (Elsenburg)	william@elsenburg.com	(021) 808 5220
Goetze	Stephen	Makatini Research Cenre (KZN)	goetzes@makrs.kzntl.gov.za	(035) 572 5303
Henk	Stander	Stellenbosch Univeristy	hbs@sun.ac.za	(021)8085833
Henning	Willie	Dept of Agriculture, (Eastern Cape)	willie@dohne.agric.za	(043)6831240
Impson	Dean	Nature Conservation (Western Cape)	impsond@cncjnk.wcape.gv	(021)8891560
Kaiser	Horst	Rhodes University	H.Kaiser@ru.ac.za	(046)6038415
Kalid	Salie	Stellenbosch Univeristy	ks1@sun.ac.za>	(021)8084770
Livhuwani	Ndou	Dakari Fish Venture (Limpopo Province)		724466005
Madiba	Rebecca	Itereleng Fishery Project (limpopo Province)		083 7259033
Mapponya	Kagiso	University of the North		726330484
Meyer	Eddie	University of the North	meyere@north.ac.za	(015) 268 2151
Phosa	Jacky	Dept of Agriculture (Limpopo Province)	phosa@mweb.co.za	(015) 295 7090
Qonya	Eric	Pirie Hatchery (Eastern Cape)		(043) 741 2210
Ramsay	Keith	National Dept of Agriculture	keith@nda.agric.za	(012) 3197448
Rouhani	Qurban	Rhodes University	Q.Rouhani@ru.ac.za	(046)6362230
Roussouw	Jacques	DWAF (Western Cape)		(021) 950 7100
Siwelave	Richard	Mpumalanga Parks Board		(013) 235 2396
Sulvester	Bernard	Trout farmer (Cape Olive Farm - Western Cape)		084 5233080
Theron	Johan	University of the North	johant@unorth	(015) 268 2295
Viljoen	Richard	Agriculture Research Council	rviljoen@ing1.agric.za	(012)8424029