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Feasibility Study of Commercial
Rainbow Trout Production in Lesotho

by

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May 1983

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Exchange Rates

Exchange rates ruling at the time of the study were:

Maloti (M) 1 = Rand (R) 1

Maloti (M) 1 = Sterling (£) 0.61

All cost and price data in this report are expressed in Maloti (M).

Introduction

Background to the Study

The Government of Lesotho has expressed interest in the feasibility of commercial trout production within the Kingdom. Accordingly, the British Development Division of Southern Africa (BDDSA) suggested that a feasibility study could be carried out under the UK Technical Co-operation Programme.

Subsequent correspondence between the BDDSA and the Geographical Department at ODA established Terms of Reference. Accordingly Mr D Robertson of Stirling University Institute of Aquaculture and Mr A D Marter of TDRI visited Lesotho in March and April 1983.

Terms of Reference

The Terms of Reference for the study were as follows:

1. To advise the Government of Lesotho on the potential for commercial trout production in Lesotho.
2. To identify potential sites for production units and to provide outline plans for production facilities.
3. To estimate production capacity and to advise on processing, distribution and marketing.
4. To consider the economic and financial viability of trout production. This will necessarily include detailed consideration of costs and effective demand, and will identify management and skilled manpower requirements.
5. To comment on the social and environmental implications of proposals put forward with regard to the protection of water supplies and water quality.
6. Prior to producing a final report the team should discuss their findings with the Government of Lesotho, and thereafter recommend whether or not commercial trout production in Lesotho would be viable. If the findings are positive the team should produce outline proposals for a commercial venture.

During the visit to Lesotho, discussions were held with a large number of officers from the Ministry of Agriculture, the Ministry of Planning, The Ministry of Water Affairs and Mining and the Lesotho National Development Corporation.

Visits were made to assess the viability of a large number of sites located on rivers and streams in Lesotho.

Numerous contacts were made in both Lesotho and South Africa with suppliers of equipment and services needed for trout production and with hotels, restaurants, retail outlets and caterers to obtain information on market potential.

At the end of the visit the team briefed the Permanent Secretaries of the Ministries of Agriculture and Planning on its preliminary findings. Mr Marter also called at the BDDSA in Lilongwe on his return journey to provide a similar briefing on findings.

Report Structure and Content

The objective of the study is to identify the technical, financial and economic feasibility of trout production in Lesotho. The approach adopted in this report is as follows:

Chapter 1 provides a brief outline of the physical conditions in Lesotho with particular reference to factors relevant to trout production.

Chapter 2 identifies the parameters which must be met in order to sustain trout production on an intensive/farm basis. These criteria are then used to evaluate potential farm sites within Lesotho.

Chapter 3 examines the current and potential markets for trout in Lesotho and South Africa, identifying the most feasible market areas which could be served, relevant price data and the likely share of markets which can be achieved.

Chapter 4 draws together the findings of previous chapters in financial and economic analysis of hypothetical examples of trout farms. Hypothetical examples are used since no viable site for a farm was found to meet technical criteria.

Chapter 5 concludes the study with a brief reference to the Highland Water Project where in future, if proved feasible, trout production facilities in various forms could be attached.

Summary

1. Lesotho has a temperate climate compared to other regions of Africa. Much of the rainfall occurs during violent thunderstorms giving rapid rises and falls of rivers. Severe erosion has led to many of the rivers carrying high levels of suspended solids.
2. A list of criteria for successful commercial rainbow trout culture was drawn up for Lesotho.
3. As a result of this, four geographical areas of Lesotho appeared to have potential for commercial trout culture. These were:-
 - a. The Mountain road area
 - b. Oxbow area
 - c. Sehlabathebe area
 - d. Semonkong area
4. Water quality in some of the rivers in these four areas was found to be suitable for commercial trout culture.
5. None of the rivers which had suitable water quality criteria had adequate minimum flow for successful commercial trout culture. In fact, many of the rivers visited have regularly dried up for periods up to three months over the twenty-five years of hydrology records available.
6. In summary, there does not appear to be a river in Lesotho from which water could be drawn of suitable quantity and quality and with sufficient reliability for viable trout culture.
7. The current markets for trout in Lesotho and South Africa are estimated at approximately 3 tonnes and between 250-300 tonnes per annum respectively. Since the Lesotho market is too small to support a trout farm of commercial size, marketing of trout in South Africa would be essential.
8. The two most viable markets in South Africa are "local" South Africa, i.e. the area adjacent to the North West border with Lesotho, and Johannesburg, with respective annual consumption of 8 tonnes and 60 tonnes per annum.
9. Ex farm sales prices for trout from a potential trout farm in Lesotho, net of transport costs and discounts needed to encourage sales, are estimated as follows:

Market Area	Price per kg
- Within Lesotho	M4.50 per kg
- "Local" South Africa	M4.15 per kg
- Johannesburg -	Wholesalers M3.05 per kg
	Direct outlets M3.75 per kg

10. The bulk of current market demand in all areas is provided by hotels with around 60% of the total, followed by restaurants with 30% and the remainder accounted for by a small retail sector.

11. Prospects for market expansion are generally limited since trout are a relatively expensive item compared to most other fish and meat products. Trout from Lesotho would therefore have to gain a share of the market primarily at the expense of existing suppliers, particularly in the large Johannesburg market.

12. Markets are currently supplied with frozen, gutted rainbow trout and "salmon trout" (i.e. rainbow trout bred in cages in estuary waters), generally weighing around 250 gr. per fish. Fish are produced on trout farms in the Republic and markets are currently oversupplied, particularly since the introduction of "salmon trout" during the past two years, which are now reported to have taken a 25% share of the total market.

13. A number of problems would arise in attempting to enter the South African trout market, namely:
 - Sales prices are relatively low (allowing for transport costs and discounts).
 - The market is currently over-supplied and many existing suppliers have direct links with market outlets and/or wholesalers.
 - Strong prejudice exists amongst many outlets and wholesalers against trout produced outside of the Republic.

14. Because of the problems above it would be necessary to engage a local (South African) marketing agency to promote trout from Lesotho, at least during initial market penetration. In part such services would also be needed since the potential project would supply whole chilled trout, which although superior in quality to frozen trout are, unfamiliar to consumers and also impose certain marginal costs e.g. for gutting.

15. As a consequence of marketing problems apart from in Lesotho itself it is likely that relatively limited shares of several markets would be obtained by Lesotho trout even at discount prices i.e.:

- Lesotho 80%
- "Local" South Africa 25-50%
- Johannesburg 20-30%

These shares represent total volumes in the range 16.5 to 27 tonnes per annum.

16. Other major South African markets would probably present similar problems to those identified above and would additionally entail greater transportation costs and hence lower net revenues.

17. As a result of technical factors, notably the variability of water flow and/or quality of water, no suitable site is currently available in Lesotho for trout farming. However, indicative costings of hypothetical farms are presented to provide an indicator of viability under present cost and market conditions. They are also provided since in theory it would be possible in the future to attach a trout farm to a dam site constructed for example for hydro-electric power generation, or for large scale water retention.

18. Two models are presented: (a) a 5 tonne capacity pilot farm; and (b) a 5 tonne pilot farm expanding to 25 tonnes capacity after a trial period of 2 years. 25 tonnes has been chosen as this represents a level of production close to the upper limit of current potential markets.

19. Costings generally present the "most favourable" possible case, i.e. cost of land and a dam are excluded, and the minimum likely cost levels for other items have generally been used. No allowance has been made for contingencies or for tax liabilities. Assumed revenues are for the most optimistic sales potential, with maximum sales to markets where higher prices can be charged.

20. Despite these optimistic assumptions neither model is financially viable. Large negative Net Present Values of -M302,155 and -M268,485 are obtained for the 5 and 25 tonne capacity farms respectively using a discount rate of 12%.

21. A major contributory factor to the negative outcome of financial analyses is the relatively high level of establishment costs, notably for buildings. These costs stem in part from the assumption that a farm would be established on a virgin site in a relatively remote mountain region.
22. Returns to the enterprise are also curtailed because of marketing constraints; if substantially larger volumes could be sold the negative influence of establishment costs could be partially off-set.
23. Economic analysis does not significantly alter the negative findings of financial analyses, primarily since virtually all costs and revenue arise within the Rand Monetary Area, thereby obviating shadow-pricing of foreign exchange.
24. The potential feasibility of commercial trout culture using compensation water from the proposed Highland Water Project has been considered. Whilst this would appear to be technically viable the scheme is still at the early planning stage and it is not possible to comment on its financial and economic viability.
25. In conclusion, under present circumstances commercial trout culture cannot be recommended since it is neither technically nor financially viable.

CHAPTER 1

THE KINGDOM OF LESOTHO.

Lesotho is situated within the Republic of South Africa between 28° - 30° south and 27° - 29° East. All of the country has an altitude in excess of 1,000 metres with the highest point being Thabana Ntlenyane at 3,842 metres, the highest point in Southern Africa. The country has an area of 30,300 kilometres and a population of 1.2 million, the majority of whom are involved in Agricultural Production.

Air temperatures seldom exceed 32°C in the summer and can drop to -20°C in the mountains in the winter. Lesotho has an average annual rainfall of 700 mms with more rain falling in the north of the country than the south. Maximum rainfall usually occurs in the summer during violent thunderstorms leading to very rapid rise and runoff of the rivers and streams. In the event of a severe drought this usually occurs in the summer period and as a result river flows are greatly reduced and water temperatures can rise to 30°C. Lesotho is currently experiencing a severe drought.

The soils are generally Stormberg in origin and in the mountains are derived principally from basaltic origin. Due to excessive cultivation and overgrazing there is much erosion being principally sliding erosion in the hills and gully erosion in the lowlands. During the heavy thunderstorms, great quantities of topsoil are washed into the streams and subsequently into the rivers leading to extremely turbid water conditions in the large rivers and tributaries, with concomitant high levels of suspended solids.

Whilst there are excellent roads from Maseru leading north, east and south much of the country is barely accessible by vehicle. The capital, Maseru, is the main business centre of Lesotho with good rail and road links with the Republic of South Africa.

CHAPTER 2

TECHNICAL FEASIBILITY OF RAINBOW TROUT CULTURE IN LESOTHO

2.1 Introduction

Several basic assumptions have been made as to the minimum acceptable water quality parameters required to produce acceptable growth, lack of disease and ultimately profitability of a commercial trout farming venture. These criteria take cognisance of the various climatic variables unique to Lesotho. The minimum criteria which have been adopted are as follows -

1. Water temperature less than 25°C
2. Dissolved oxygen greater than 6 mg/L
3. Carbon dioxide levels less than 10 mg/L
4. Total hardness less than 150 mg/L CaCO_3
5. pH between 6 - 8.5
6. Total suspended solids less than 100 mg/L
7. Zinc levels less than 0.1 mg/L
8. Lead levels less than 0.03 mg/L
9. Copper levels less than 0.1 mg/L
10. As a 5 tonne farm is the least likely viable size a minimum flow of 5000 Cu metres of water per day would be required throughout the year.
11. Suitable access for four wheel drive vehicle which is not seasonally flooded or impassable.

The methods used to test these parameters are described in appendix one.

After discussions with government officials and representatives of the Departments of Agriculture and Hydrology and Climatology, several areas of Lesotho were shortlisted as being the most suitable for trout farming.

These were:-

1. The streams and rivers on the mountain road to the east of Maseru.
2. The Oxbow area in the north east of Lesotho.
3. The streams in the national park at Sehlabathebe.
4. The Maletsunyane river at Semonkong.

These four areas were extensively investigated. Other areas of Lesotho were excluded from the short list as they were considered to be unsuitable for reasons discussed below.

Mokhotlong Area

There is reported to be extensive erosion in this area leading to heavy suspended solids in the streams, this was confirmed by flying over this area. Access by road is difficult and the area is very remote from services.

Sehonghong

Suspended solids in the Senqu river at Sehonghong were reported to be extremely high - this was confirmed by flying over the area. Access is difficult.

Mafeteng.

The rivers between Maseru and Mafeteng were observed from the road and had all either dried up or were excessively silted.

Mohale's Hoek.

This region was considered to be too warm and dry for trout culture.

Qacha's Nek.

The rivers in this area, in particular the Senqu, were considered to be too high in suspended solids for commercial trout culture.

Thupa - Kubu

This is a large river 14 kilometres from Maseru with a flow of approx. 10,000 cubic metres per day at the time of sampling. Suspended solids were very high at 4,100 mg/L and therefore this river is unsuitable for trout culture.

Koro-Koro River

A tributary of the Thupa-Kubu, 20 kilometres from Maseru, this river had virtually dried up and was heavily silted.

Mohlaaka-oa-Tuke

A small stream 37 kilometres from Maseru at altitude 1,800 metres. There is a small village which makes use of the water for clothes washing and animal watering. Stream bed is rocky with little silt.

Water Parameters

Water temperature	=	26°c
pH	=	7
Total hardness	=	61
Suspended solids	=	12 mg/ L
Dissolved oxygen	=	9 ppm
Flow	=	4,000 cubic metres/day
Access	=	Very good tarred road

There is a good site for a small farm 400 metres north of the road with a level area below the waterfall, however, there is no reliable hydrology data for this stream and it is likely that the stream flow and water temperatures would not be suitable for a commercial culture unit.

Streams at Nazareth, Machache and Bushman's Pass

These streams were all dried out and therefore unsuitable for trout culture.

Makhaleng River

A very attractive river situated at Ha Sempe at 1,850 metres, 53 kilometres from Maseru. The stream was surveyed at the road bridge, there was evidence of clothes washing and animal watering at this site. The stream bed was rocky and there was very little silt deposited in the quiet areas of the stream.

Water Parameters

Water temperature	=	15°c
pH	=	7.6
Total hardness	=	29 mg/Ca CO ₃
Dissolved oxygen	=	9.6 mg/L
CO ₂	=	2 mg/L
Total suspended solids	=	0.7 mg/L

Heavy metals

Zinc	=	< 0.08 mg/L
Lead	=	< 0.005 mg/L
Copper	=	< 0.09 mg/L
Flow	=	6,235 cubic metres/day
Access	=	Very good tarred road from Maseru

On water quality parameters this river looked to be very suitable for trout farming as it was relatively cool and clear, there were suitable areas south of the main road for building of a farm, although the valley sides were very steep approximately 2 kilometres from the main road. However, the hydrology recording for this river suggests that there would be serious water problems in 15 years out of 20 and therefore this river is considered to be unsuitable for commercial trout culture.

Stream at Molino - Nthuse Hotel

This is a very clear stream but the flow is likely to be too low for viable commercial trout culture (less than 500 cubic metres/day at the time of sampling)

Senqunyane River

This is a large river and was sampled at Marakabei approximately 100 kilometres from Maseru (2 hrs. drive) at an altitude of 1,720 metres. The stream was approximately 30 metres wide at the sampling site and although the water was relatively clear at the time of sampling there were large deposits of silt in the slow moving pools. There is a small village at Marakabei with a sheep dip on one of the side streams and there was evidence of clothes washing at the main river. Valley sides were very steep.

Water Parameters

Water temperature	=	23°c
pH	=	7.8
Total hardness	=	17 mg/L Ca CO ₃
Dissolved oxygen	=	9.1 mg/L
CO ₂	=	1 mg/L
Total suspended solids	=	7.2 mg/L

Heavy metals

Zinc	=	< 0.08 mg/L
Lead	=	< 0.005 mg/L
Copper	=	< 0.09 mg/L
Flow	=	35,000 Cubic metres/day
Access	=	Tarred road for 60 kilometres from Maseru followed by 40 kilometres of untarred graded road. There is a rough track south of the road bridge which gives good access to the river.

On water quality parameters and access the Senqunyane river looks suitable for trout culture. However, the river is prone to very severe flow fluctuations. During the rainy season it was reported that the river could rise as high as the road bridge, thus making a flood free site very difficult to find because of the very steep nature of the valleys. Also the hydro-logical data over the last twenty years indicate that there would be severe

water shortages 12 years in twenty. In addition, as this river has such a large river bed area, water quality would quickly deteriorate at high temperatures during drought conditions and thus the river would be unsuitable for commercial trout culture.

Mantsonyane River

The site visited was at the road bridge 10 kilometres east of Mantsonyane, 120 kilometres from Maseru at an altitude of 2,200 metres. There is a great deal of water use in the form of clothes washing and animal watering at the large village of Mantsonyane. Water flow at the time of sampling had virtually dried up (250 cubic metres/day). This would rule out this river as a potential site for trout culture.

Malibamatsu/Senqu River at Thaba-Tseka

The river was sampled below the junction of the two rivers east of Mochlanapeng, 200 kilometres from Maseru. The river is very large and was too big for conventional flow metre measurements. Suspended solids were extremely high at 3,200 mg/L. However, there had been heavy rain for the previous two days which may have influenced this result (although flying over the area 1 week prior to the visit showed the water to be very turbid). No other water quality parameters could be determined because of the suspended solids in the water. Access is difficult from Thaba Seka. Although water flow is adequate from hydrological records this site would appear to be unsuitable for commercial trout culture because of the very high level of suspended solids in the water.

Liphiring River at Roma

This river was very low at the time of sampling (1,000 cubic metres per day) and had large amounts of silt in the bed of the stream with heavy suspended solids in the water at 3,600 mg/L. It is thus unsuitable for trout culture.

Caledon River at Maseru

The sample site was near the border post between Lesotho and South Africa at 1,600 metres. The river is very large at this point (30 metres wide) deep

and fast flowing, however, suspended solids were extremely high at 4,482 mg/L, water clarity was less than 5 cms. No other parameter could be determined because of the suspended solids in solution.

The river is unsuitable for trout culture because of the high level of suspended solids.

2.3.

OXBOW AREA

No suitable rivers were found between Maseru and Butha-Butha - all rivers were either dried up or had very heavy silt loads with concomitant excessive suspended solids.

Malefiloane River

Site sampled near road 163 kilometres from Maseru, near the Moteng Pass at an altitude of 1,831 metres. No nearby village seen but some clothes washing in the river. The stream bottom was slab rock with some accumulation of silt. Much of this silt looked as if it had arisen from recent road building operation.

Water Parameters

Water temperature	=	19°c
pH	=	7.5
Total hardness	=	34 Mg/L CaCO ₃
Dissolved oxygen	=	8.9 Mg/L
CO ₂	=	3 mg/L
Total Suspended Solids	=	18 mg/L

Heavy metals

Zinc	=	< 0.08 mg/L
Lead	=	< 0.005 mg/L
Copper	=	< 0.09 mg/L
Flow	=	3,450 cubic metres/day
Access	=	very good along tarred road.

There are several level areas north of the road which would be suitable for siting a farm.

Water quality parameters were suitable on this river for trout culture, however, the river flow measurements were taken after heavy rain and therefore it is unlikely that minimum flow in this river would be sufficient to support commercial trout culture. Indeed 24 hours later the river flow had decreased to 1,000 cubic metres per day.

Hololo River

The site sampled was below the green footbridge at the foot of the Moteng Pass below a small settlement at an altitude of 2,150 metres, 180 kilometres from Maseru. This river is in an area of intensive cultivation. This site was chosen as downstream from here suspended solids were found to be excessive with much silting of the stream. The site sampled had a bed of slabrock and pebbles with small quantities of silt in slow moving areas.

Water Parameters

Water temperatures	=	15°c
pH	=	6.5
Total hardness	=	41 mg/L CaCO ₃
Dissolved oxygen	=	8.9 mg/L
CO ₂	=	3 mg/L
Total suspended solids	=	1 mg/L

Heavy metals

Zinc	=	< 0.08 mg/L
Lead	=	< 0.005 mg/L
Copper	=	< 0.09 mg/L
Flow	=	8,000 cubic metres/day (after heavy rain)
Access	=	Good tarred road from Maseru, several level sites close to the road.

On water quality parameters this river looked to be very suitable, however, an examination of the hydrology records showed that at Khutune 8 kilometres from the sample site there would be flow problems virtually every year.

Tsehlanyane River Oxbow

A very attractive clean river at the meteorological station with estimated flow of 80,000 cubic metres per day. No water quality samples were taken because of security arrangements in force at the time, however, the water quality looked excellent and there was a suitable site approximately 1

kilometre downstream of the meteorological station.

However, the hydrological records indicate that water flows would be extremely low for large periods of the year every year and thus this site would be unsuitable for trout culture.

Tlholahatsi River Oxbow

Another very attractive clean river which was sampled near the Oxbow Lodge Hotel at an altitude of 2,475 metres, 200 kilometres from Maseru. The stream bottom was slab rock and gravel with no indication of silting. Valley sides were very steep.

Water Parameters

Water temperature	=	11°c
pH	=	6.9
Total hardness	=	3 mg/L CaCO ₃
Dissolved Oxygen	=	8.15 mg/L
CO ₂	=	2 mg/L
Total suspended solids	=	1.2 mg/L

Heavy metals

Zinc	=	< 0.08 mg/L
Lead	=	< 0.005 mg/L
Copper	=	< 0.09 mg/L
Flow	=	150,000 Cubic metres/day
Access	=	Tarred road to Moteng Pass (20 kilometres from Oxbow) then gravel road with hairpin bends, but no suitable sites were seen because of very steep sided valleys

Water quality in this river was excellent and very suitable for trout culture and access was relatively good. However, examination of the hydrology records indicate that there would be severe limitations in flow every year and therefore this site would not be suitable for trout culture.

Malibamatso River at Kao

This river could not be visited as the road was impassable on the day allotted for sampling. Access to this area is considered to be too difficult at present as the road is impassable for many days throughout the year.

Leqooa River

This river was sampled at the bridge over the river on the road to Sehonghong at an altitude of 2,000 metres approximately 300 kilometres from Maseru via the mountain road of which 125 kilometres is difficult driving or 450 kilometres by the southern road. The river is attractive with a rocky bottom but some silt was seen in slow moving pools. The river has many pools and shallows as the gradient is gentle - there are many suitable areas for a trout culture site.

Water Parameters

Water temperature	=	18°c
pH	=	6.7
Total hardness	=	47 mg/L CaCO ₃
Dissolved Oxygen	=	7 mg/L
CO ₂	=	1 mg/L
Total suspended solids	=	3.7 mg/L

Heavy metals

Zinc	=	<0.08 mg/L
Lead	=	<0.005 mg/L
Copper	=	<0.09 mg/L
Flow	=	approximately 22,720 cubic metres/day
Access	=	very difficult except by air.

On water quality parameters the river looked suitable for commercial trout culture, however, from the limited hydrological data that we could obtain there would appear to be regular severe flow limitations. This, coupled with the difficulty of access would make the river unsuitable for commercial trout culture.

Tsoelikane River

This is a tributary of the Leqooa and was sampled near the junction with the

Leqooa River. The distance from Maseru is very similar to that of the Leqooa.

Water Parameters

Water temperature	=	20°C
pH	=	7.5
Total hardness	=	25 mg/L CaCO ₃
Dissolved Oxygen	=	7.4 mg/L
CO ₂	=	2 mg/L
Total suspended solids	=	5.2 mg/L

Heavy metal

Zinc	=	0.08 mg/L
Lead	=	0.005 mg/L
Copper	=	0.09 mg/L
Flow	=	approximately 2,000 cubic metres/day
Access	=	same as Tsoelikane River.

Water quality parameters were quite suitable, however, this river would be unsuitable for trout culture because of severely limited flow and difficulty of access.

Maletsunyane River at Semonkong

The site visited is 190 kilometres from Maseru, with very difficult access. Because of difficulty of access this river was only observed from the air by flying up the river from the Maletsunyane falls northwards. Water clarity was very good, however, flow was extremely low at the time and estimated at less than 2,000 cubic metres per day. The hydrological data for this area indicates that there would be severe flow restrictions 8 years out of 10. This coupled with very difficult access would make this area unsuitable for commercial trout culture.

It can be seen that there are several rivers in Lesotho that would be suitable for commercial trout culture on water quality parameters and suitable access. However, it would appear that none of the rivers have sufficient minimum flow of at least 5,000 cubic metres per day to maintain a viable trout farm. While it could be considered that a suitable recirculation and aeration system could be installed to reuse water in times of drought, this is likely to be infeasible as, the drought period can last up to 3 months and visible river flow can dry up completely. In addition severe drought periods usually coincide with high air temperatures in Lesotho and therefore water temperature would rise above the critical level and dissolved oxygen would drop below the minimum required level.

Chapter 3

Potential Markets for Trout Produced In Lesotho

3.1 Introduction

This Chapter deals with the market possibilities for trout produced on potential trout farms in Lesotho. The first part of the Chapter summarises the main features of the Lesotho and South African markets for trout in the context of markets for other food products, notably fish and meat. The structure of markets and problems likely to be faced in establishing market links are also briefly referred to.

The remainder of the chapter largely deals with three potential market areas for trout produced in Lesotho:

- (1) Within Lesotho itself
- (2) The "local" South African market⁽¹⁾
- (3) The nearest "major" South African market - Johannesburg

These three market areas are considered the most viable (in descending order) in relation to transportation costs from potential farm project sites. Other major South African markets are also briefly referred to in the conclusions to the Chapter.

For each market area the level of actual and potential demand for trout are identified, together with price data and information on current suppliers, the type of product required and the organisation of marketing. A concluding section of the Chapter summarises the major findings for each market area and highlights the potential for marketing Lesotho trout together with problems likely to be faced.

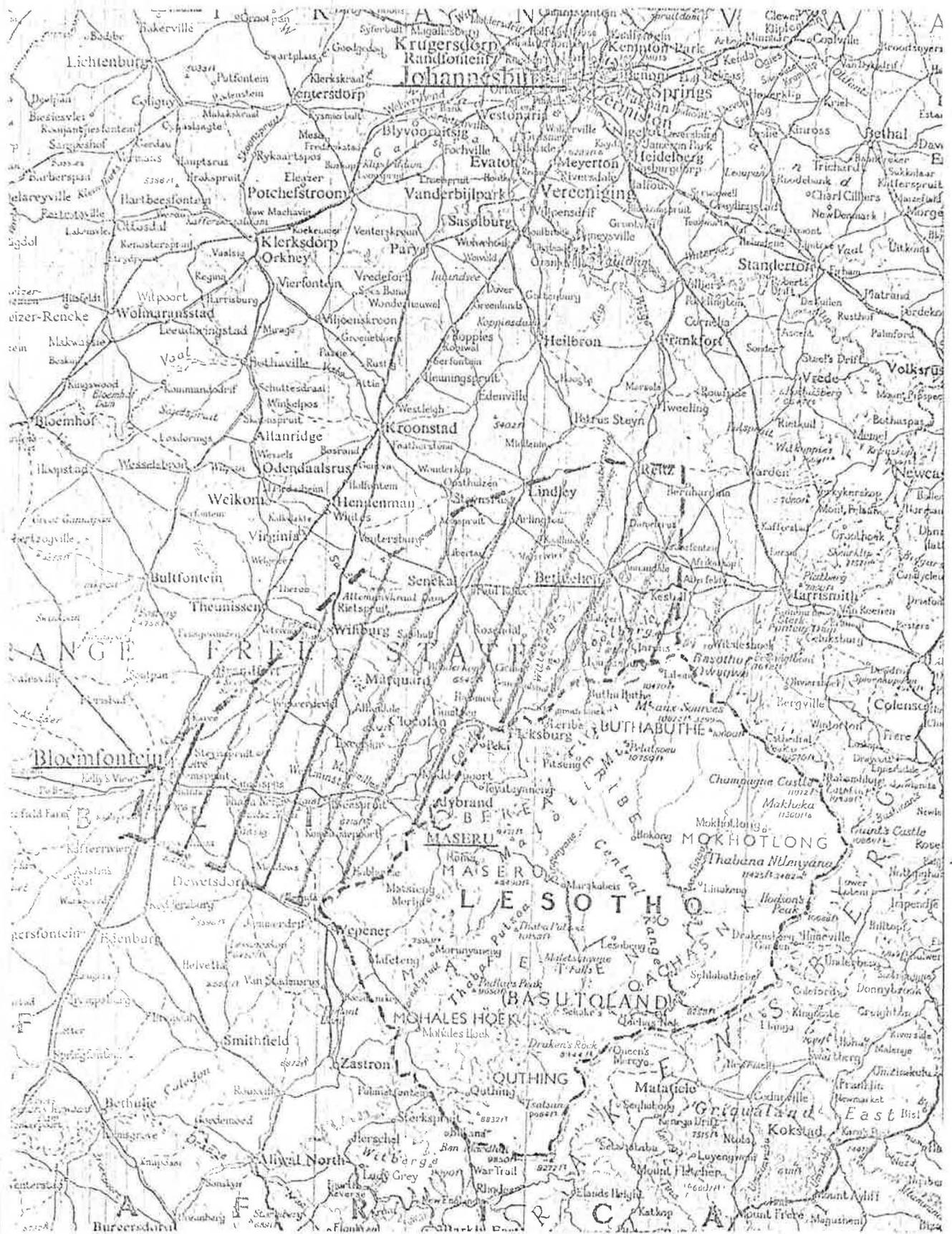
3.2 Summary of Trout Markets and Marketing in Lesotho and South Africa

The total current market for trout in South Africa is in the region of 250-300 tonnes per annum whilst in Lesotho a little over 3 tonnes per annum are consumed. Both markets have been expanding fairly slowly in recent years but it is not

-
- (1) Since the most viable potential sites for a trout farm in Lesotho in terms of access are located in the North/West of the country the 'local' South African market refers to adjacent areas across the border. These are defined as the area approximately 125 to 150 kilometres from the Lesotho border stretching in an arc from North to West. (see Map 3.1).

Map 1

Location of the 'Local' South Africa Market



 = 'Local' South Africa Market area

possible to put a precise figure on growth rates. It is clear that the Lesotho market, even allowing for possible expansion, is too small to support a trout farm of economic size (i.e. on the basis of experience elsewhere probably in excess of 20 tonnes production per annum). It is therefore essential to develop markets in South Africa as well.

The total market for trout is quite small even in South Africa and is likely to remain so primarily because trout are a relatively high-priced item. In the small retail market trout are generally priced at around M6-M6.50 per kilo in comparison to example to frozen hake at M2.00, whiting at M1.40 and plaice at M3.40. Meat is also competitively priced in the region of M's 3.25-4.00 per kilo (except for steak) and is generally of good quality. Since the potential market areas under consideration (see below) are all located a considerable distance inland, consumer preference for meat and meat products is strongly developed, in contrast to fish where tastes appear to be relatively undiscriminating. In the latter context cheaper fish/fish products, even of poor quality, are often preferred to more expensive items.

The main market outlets for trout are therefore confined to areas where higher quality food products are needed, i.e. in the better quality hotel and restaurant trade (for inclusion in a la carte menus). A much smaller outlet is provided by specialist caterers and fish retailers. Requirements are for fresh or frozen fish since the smoked fish market is very small indeed. The bulk of the catering and retail trade together with down-market restaurants, cafes and hotels have minimal if any requirements for trout, and concentrate instead upon cheap frozen sea fish and meat products. In South Africa, even the few retail outlets specialising in fish are not always interested in handling trout, and similarly with hotels of secondary quality.

The hotel trade comprises the most important outlet and probably accounts for about two thirds of the total trout market. Restaurants account for a further 30% with the remainder going to retail and catering. An important contribution to demand in hotels and restaurants stems from the tourist and visitor trade with demand for more cosmopolitan food dishes.

The market both in South Africa and Lesotho is currently supplied by trout farms located in several regions of the Republic. The bulk of supplies take the form of frozen, gutted rainbow trout with white flesh, however in the past two years the so called "salmon trout" (rainbow trout bred in cages in estuaries), has taken over an estimated 25% share of the total. In general fish weighing in the region of 250 gr. are required although in a few cases slightly larger fish are preferred.

Many of the major outlets for trout i.e. hotels and restaurants, have either direct links with individual trout farms, or are supplied by one of the small number of major frozen fish distributing companies which themselves retain close contacts with trout farms in the Republic. The market is currently over-supplied with trout and this factor together with interlocking interests of producers, distributors and outlets would make it difficult to promote trout from Lesotho if a trout farm project was otherwise viable. In addition, strong prejudice exists amongst many purchasers and distributors against handling trout produced outside the Republic.

3.3 Potential Market Areas for Lesotho Trout

3.3.1 Lesotho

The current market for trout in Lesotho is very small, i.e. it is estimated to be a little over 3 tonnes per annum. For reasons explained above (Section 3.2), outlets for trout are largely confined to the restaurant and hotel trade. In Lesotho in fact no retail market is in evidence, primarily because the upper income population likely to require high priced items such as trout is very small. Virtually all of the hotel and restaurant trade demand is confined to the capital, Maseru, since hotels and restaurants located elsewhere are either confined to supplying down-market food items or have access in some cases to fresh trout caught in mountain streams. Hotels appear to account for about 60% of market demand, the remainder going to restaurants.

The demand for trout is currently static as a result of a downturn in the number of tourists entering the country (particularly from South Africa), upon which the hotel and to a lesser degree restaurant trade are largely dependent.

Current delivery prices for frozen, gutted rainbow trout from the Republic for both restaurants and hotels are in the region of M5.30 per kilo. For "salmon trout" a premium of a few cents per kilo is sometimes charged. In the absence of retail sales no retail price data are available. The small volumes of fresh trout consumed by hotels and lodges in mountain regions are generally caught direct, with no marketing and price chain involved.

South African trout are currently supplied by wholesalers mainly operating out of Johannesburg. Virtually all deliveries are handled by a small number of firms and their subsidiaries, which account for the bulk of fish and other frozen food product deliveries in the Republic.

Although the current market for trout in Lesotho is static there would be good prospects for a potential local supplier, both to obtain a substantial proportion of the current market and to encourage greater consumption via promotion. For reasons outlined in Chapter 4 (Section 4.2) the proposed trout farm project would supply chilled whole trout with pigmented flesh rather than frozen/gutted fish with white flesh as at present. Whilst gutting of chilled trout would impose some (relatively small) additional costs on purchasers, the quality of the product is distinctly superior to frozen gutted trout. The superior quality of chilled pigmented fish is readily recognised by many outlets in Lesotho (especially in the restaurant trade). Most outlets are also keen to switch to a local source of supply which could then be promoted accordingly at the expense of imported food/menu items. From various trade sources it is estimated that demand could be doubled via promotion campaigns, i.e. to a total of around 6 tonnes per annum.

In calculating the required sales price to break into the market the following factors have to be considered:

- the current price of frozen, gutted trout
- the allowance required to cover the differential weight yield between whole and gutted trout
- the price discount required to obtain a significant entry into the market
- transport costs to outlets are internal to the potential trout form - see chapter 4.

The current price for South African trout is M5.30 per kg and a 10% reduction is needed to cover the weight differential between whole and gutted fish, indicating a price of M4.75 per kg. Because of the superior quality of chilled as opposed to frozen trout it might be possible to sell at the latter price, however, to ensure a significant level of sales a discount of up to 5% is probably needed, indicating a sales price of M4.50 per kg.

If trout from a potential farm could be supplied at the latter price it is probable that 80% of current and potentially expanded markets in Lesotho could be captured. Depending upon the degree and success of promotion, total demand for trout from the project could therefore be between approximately 2.5 and 5 tonnes per annum.

There appears to be no foreseeable mass market for trout in Lesotho. This conclusion stems primarily from the relatively high price of the item in

comparison to other fish and also meat products (e.g. frozen hake prices at M2.00 per kilo, canned pilchard and mackerel at around M1.72 and M2.00 respectively).

3.3.2 "Local" South Africa

The "local" South African market defined earlier (Section 3.1) is shown on Map 3.1. In the North the approximate limit of the area is represented by Bethlehem and to the West by Bloemfontein.

Only one major town falls within the area i.e. Bloemfontein, however additional centres of market demand in the region occur in the North with the concentration of hotels and tourist facilities around the Golden Gate. Total demand for trout within the area is probably in the region of 8 tonnes per annum, with Bloemfontein accounting for about 60%, and the bulk of the remainder by hotels around the Golden Gate. Although larger than in Lesotho the total market for trout in local South Africa is still relatively small.

The bulk if not all of demand for trout is provided by the hotel and restaurant trade, there being no retail sales apparent. Hotels account for approximately 60% of the total. Demand for trout is currently growing at a marginal rate, mainly in response to hotel requirements.

Current purchase prices for both restaurants and hotels are in the region of M5-M5.10 per kilo around Bloemfontein and slightly lower in the area around the Golden Gate. Since no retail trade has developed no price data are available.

As elsewhere, the market is supplied exclusively with frozen, gutted rainbow and salmon trout. Supplies are obtained from wholesalers operating from Johannesburg.

The current market for trout in "local" South Africa is relatively static and can be characterised as comprising a fairly conservative consumer group, with the partial exception of Bloemfontein and the Golden Gate area. Outside of the latter areas there are rural communities and small market towns where markets for trout are minimal.

The area where some future growth may be expected is in Bloemfontein and around the Golden Gate amongst the better quality hotel and restaurant trade, but such expansion is unlikely to be large. There are no real prospects for a significant development of the retail trade, even in Bloemfontein. Retail

markets primarily cover lower price/quality fish which are virtually all frozen products. The quality of such fish is often distinctly poor and there appears to be little appreciation for a quality item such as chilled trout which would be supplied by the potential project in Lesotho.

The market prospects for Lesotho trout therefore hinge upon the degree to which penetration of the restaurant and hotel markets can be achieved. It is doubtful that quality factors, with the possible exception of flesh pigmentation, will have much influence on marketing, in the initial phase at least, and therefore a significant reduction in price is needed to allow for weight differentials between whole and gutted fish and providing a discount on current delivery prices. With current delivery prices of M5.00 to M5.10 per kg a sales price of M4.50 to M4.60 would cover the allowance for weight differentials. A further 5 to 10% discount to encourage market penetration yields a sales price of between M4.10 to M4.30. After allowance for transportation costs a sales price of M4.15 appears the maximum feasible. It is difficult to predict the share of market which could be obtained at such prices since, although a fair degree of price sensitivity exists there is also some prejudice against supplies from outside the Republic. The need for gutting, even at discount purchase prices, may also act as a disincentive. At best a 25-50% share might be obtained, i.e. 2-4 tonnes per annum.

3.3.3 Johannesburg

The Johannesburg market (including suburbs of the city), amounts to approximately 60 tonnes of trout per annum, i.e. 20-25% of the total South African market. The city represents the nearest major market for trout of Lesotho origin (given the likely location of potential trout farms) and is sufficiently large to potentially support a trout farm of economic size. Demand stems primarily from hotels with around 67% of the total, followed by restaurants with 27% and a small retail and catering market accounting for the remainder.

Prices for trout are lower than in the two markets discussed above, primarily because of substantial supplies available from nearby trout farms. Delivery prices vary between those paid by wholesalers and those by hotels, restaurants and retail outlets. The former appear to pay around M4-M4.25 per kg at present, whilst the latter group (hotels, restaurants and retail outlets) purchase at around M5.00 per kg. A small retail market exists with retail sale prices in the region of M6-M6.50 per kg.

All supplies to market outlets and to wholesalers are in the form of frozen, gutted rainbow or salmon trout. Whilst the bulk of outlets obtain supplies from wholesalers, some have direct links with trout farms. Wholesalers

themselves also have direct links with local trout farms. The most important supplying centres appear to be the Magaliesburg, Krugersdoorp and Roodeport area, around 50 kilometres from Johannesburg.

The Johannesburg market for trout is reported to be expanding, but no firm indicators could be obtained as to precise growth rates. The market is in any event over-supplied since trout farming appears to have expanded rapidly in the supplying areas near the city and prices are consequently depressed. The situation has been exacerbated by the recent development of salmon trout production. In the past two years salmon trout are reported to have taken a 25% share of the market, partly because of an aggressive marketing campaign with back-up information supplied by marketing firms. The pink flesh of the salmon trout (probably derived from feeding on shrimp waste) is also said to be a positive quality factor.

Growth in market demand is largely linked to the expansion in requirements of hotels, and to a lesser degree by restaurants. Hotel demand is primarily related to a la carte menu items. The restaurant trade includes approximately 20 establishments specialising in fish and sea food, however, the latter tend to concentrate on items such as prawns rather than trout.

The retail market is small and unlikely to contribute much to growth in overall market demand. About 15 specialist retail fish outlets currently exist (although large numbers of stores sell frozen fish), but these often carry non-fish items and deal primarily with frozen sea fish. Only a proportion of such outlets carry trout and the latter appears to be a relatively unimportant item in terms of turnover. One major supermarket chain, OK Stores, is reported to carry trout but no evidence could be discovered of stocks in 3 of the 4 company stores in Johannesburg. Turnover is in any case reported to be minimal.

Prospective market growth via growth in demand from hotels and restaurants may be enhanced by a degree of market promotion, since several outlets currently emphasise trout from specific farms/areas. However, trout are generally a relatively minor item on menus and growth in requirements is likely to be modest. There is very little prospect for significant expansion in mass retail demand, the major emphasis, as elsewhere, resting upon relatively cheap frozen fish and meat products. Consumer requirements appear relatively unsophisticated since some of the frozen fish on sale is of very poor quality.

As in the "local" South African market it is doubtful whether the quality aspects of Lesotho chilled trout would be appreciated by the majority of market outlets, again with the possible exception of flesh pigmentation, and the (relatively minor) additional costs of gutting may act as a disincentive. The market is well supplied, with salmon trout representing a particularly strong area of competition. Many outlets and wholesalers have specific links with trout farms in the Republic. Finally, strong prejudice exists amongst many outlets and wholesalers against handling trout produced outside of the Republic.

For all these reasons a considerable marketing effort would be needed to obtain a significant market share. Links between trout producers and market outlets produce a degree of price insensitivity and a discount of at least 10% on current purchase prices would probably be needed to obtain a share of the market. Allowance for the weight differential between gutted and whole fish together with transportation costs would further reduce the selling price. Depending upon whether sales were made to wholesalers or direct to market outlets (hotels and restaurants), the required price would be approximately M3.05 or M3.75 per kg respectively. At such prices a perhaps optimistic estimate of a 20-30% of the market (i.e. 12-18 tonnes) might be obtained so long as an intensive marketing campaign is undertaken. Such a campaign would need to emphasise both the relatively low price of the Lesotho product and the enhanced quality of chilled as opposed to frozen fish. In view of the linkages within the South African market a fairly sophisticated campaign would be necessary, based upon a substantial local knowledge of market conditions. Under these circumstances it would appear necessary to engage a local (Johannesburg) marketing agency at least during the period needed to break into the market.

3.4 Conclusions

The total South African market for trout is believed to be approximately 250-300 tonnes per annum and that in Lesotho around 3 tonnes per annum. Two of the three most accessible markets for trout from Lesotho, i.e. Lesotho itself and local South Africa are both quite small, i.e. around 3 tonnes and 8 tonnes respectively. The nearest major market is Johannesburg with an estimated requirement of 60 tonnes per annum.

Delivery prices for trout depend primarily upon market location and in Johannesburg also upon whether wholesale or direct sales outlets are served. Delivery prices for trout from Lesotho, allowing for discounts to encourage market penetration, transportation costs and for weight differentials between whole and gutted fish, would currently be around M4.50 in Lesotho itself,

M4.15 in "local" South Africa and M3.05 and M3.75 in Johannesburg depending upon whether wholesalers or direct outlets were supplied.

One of the main problems faced by a potential farm in Lesotho is that the nearest markets for trout, where higher prices can be charged, are too small to support the minimum likely economic size of trout farm. In Lesotho sales of between 2.5 and 5 tonnes per annum may be possible (depending upon the degree and success of market promotion), and sales of between 2-4 tonnes in local South Africa. Total sales in these two markets would therefore be between 4.5 and 9 tonnes.

To support a viable project additional sales would be essential and the nearest major market, Johannesburg, would have to be penetrated. At delivery prices of either M3.05 and M3.75 depending on the point of sale, sales of between 12-18 tonnes may be possible. Total sales for all three markets could therefore be in the range 16.5 to 27 tonnes p.a. A number of difficulties are, however, involved in attempting to penetrate the Johannesburg market:

- (1) Delivered prices are relatively low.
- (2) South African suppliers are already well established and trout are generally over-supplied at present, particularly because of the recent expansion of salmon trout sales.
- (3) Links between outlets, wholesalers and fish farms frequently exist which tend to preclude the possibility of new entrants making significant sales.
- (4) Strong prejudice exists amongst a number of outlets and distributors against accepting trout of non-South African origin.
- (5) The additional cost to purchasers of gutting fish, although relatively minor, may act as a disincentive.
- (6) As a consequence of items (2)-(5) above it would almost certainly be necessary to obtain the services of a marketing agency to promote Lesotho trout, thereby incurring further costs to the project.

More distant major markets in South Africa, e.g. in Natal and Cape Town would present at least some of the problems indicated above for Johannesburg:

- (1) Delivered prices would be similar to those in Johannesburg, and revenue to the project would be further reduced by additional transportation costs.
- (2) Other major markets are also reported to be well supplied as is the case in Johannesburg.

It is also possible that, as in Johannesburg, links have developed between trout farms in the Republic and outlets and wholesalers (for example, in Natal several local trout farms exist, supplying the Pietermaritzburg and Durban markets). It is also possible that prejudice may exist against non-South African producers. Overall other major South African markets would probably present the same level of difficulty as that in Johannesburg itself, and returns per unit of sales would be lower due to higher transportation costs.

Chapter 4

Financial and Economic Feasibility of Trout Production in Lesotho

4.1 Introduction

In Chapter 2 it was established that currently no viable site for a trout farm exists in Lesotho owing to problems of periods of inadequate flow of water and/or in quality of water. However, indicative costings for hypothetical examples are presented in this chapter in order to illustrate the degree of financial and economic viability of trout farms under current cost and market conditions. These costings may be of value should other projects involving dam construction arise, where a trout farm could be considered to be attached as an additional facility (i.e. given sufficient guaranteed water flow and quality of water). Such projects could include for example hydro-electric schemes and, if proved viable in the long run, dams constructed for the Highland Water Project (see Chapter 5).

Two hypothetic trout farm costings are presented:

A 5 tonne "pilot" farm.

A 5 tonne "pilot" farm operated for 2 years to test technical viability of production leading to expansion to 25 tonnes capacity for the remainder of the project life.

A 25 tonne model has been chosen as this represents the upper limit to likely markets for trout from Lesotho identified in Chapter 3.

To be viable a trout farm would have to be located adjacent to an all season road. For the purpose of costings it has been assumed that the hypothetical farm location would be 100km from either Maseru or the nearest rail head to South Africa (to allow access for feed and transport out for fish). Because of the hypothetical farm location, some cost items can only be estimated, e.g. those associated with transportation of inputs and production, and on site costs such as feeder road requirements, pipes and drains etc.

Virtually all costs are local (Lesotho) or incurred in South Africa (e.g. for some equipment items and for feed). Since Lesotho is a member of the South African Customs Union, items required from South Africa are costed duty-free. Similarly all production is sold within the Customs Union.

The remainder of this Chapter provides a discussion of costings as follows. First, a brief physical description is provided of a farm operation, the

technical assumptions underlying production, and the nature of product produced. Subsequent sections outline the major elements included under establishment and operating costs (more detailed data and assumptions are provided in Appendix 2), together with calculations of revenue. The results of financial analyses are then discussed together with the implications of economic analyses.

As will become clear from the text, the most favourable alternative cost and revenue circumstances have been assumed throughout, nonetheless neither of potential projects (5 and 25 tonne capacities) are viable.

4.2 Technical Description of Trout Farm Operation

This section outlines the technical assumption and requirements for trout production which underly the costings of trout farms described in the remainder of the chapter.

Eggs would be bought in as eyed ova from South Africa or Europe preferably during the Lesotho winter, these would be hatched and subsequently fed in troughs and then transferred to 4 m² tanks at approximately 1 gramme in weight. The fry would then be grown on in the tanks to 40 grammes and then graded and released into the ongrowing ponds for fattening to market size of 250 grammes. Careful grading and feeding would ensure at least a 9 month selling cycle after year one.

A year round maximising use of facilities could be attained by buying in eggs "out of season" from northern hemisphere sources but this would require purchasing of a cooler for hatchery supplies of water.

It has been assumed that in the initial stages of the farm there would be a 50% mortality from the egg to fry stage and then 30% mortality from fry to selling. These figures would improve with experience.

It has been assumed that feeding would be to tables and that attention would be paid to fluctuating environmental variables such as dissolved oxygen levels. A food conversion ratio of 2:1 has been assured as a result of this strategy.

On maturity at 250 grammes size, fish would be killed and packed in ice for immediate transportation to market. Flake ice in the ratio 1:1 ice and fish by weight would be used for the purpose. Fish are not gutted since stream water is the only likely source of water to the project which, although filtered and chlorinated on site, could entail possible health hazards. Use of such water would however be acceptable for production of ice used in chilling whole fish.

4.3.1 Establishment Costs

Establishment costs for both the 5 and 25 tonne farms are summarised in Table 4.1 (more detailed cost information is provided in Appendix 2).

From the outset it must be noted that two cost items are excluded from the Table. The first is the cost of land. Since the costings relate to hypothetical locations in the mountain region it is assumed that the required land would be made available free of charge by traditional authorities. In exchange local communities could derive certain benefits from the project, notably a limited number of full-time employment opportunities.

The second item is the cost for a dam. Since dam costs will vary very significantly depending again upon the site chosen, it is not possible to provide a firm estimate. More important, because of the very large variations in flow of streams in Lesotho quite substantial structures are required, even for streams of relatively modest size for much of the year, owing to short periods of very much higher flow. As an example the Senqunyane river at Marakabe would require a dam costing at least M2 million. It is clear that a trout project of the scale envisaged (i.e. up to 25 tonnes capacity), could cover only a fraction of such a high level of capital expenditure. It is therefore assumed that dam costs for the farm project are zero and that costs are instead met by other projects, e.g. hydroelectric power schemes.

From the cost summarised in Table 3.1 it is apparent that for an output of 5 tonnes, the most important items are included under building costs which comprise 57% of the total. Second in importance are major items of equipment (i.e. vehicle, ice machine and generator), with 18% of the total. The cost of ponds and piping etc represent only 12% of the total, reflecting the low level of production capacity.

At the 25 tonne level the pattern is changed, since although building costs remain the most important item at 46% of the total, the cost of ponds etc is around 30%. Costs of major equipment items are relatively insignificant at this level.

In both cases, i.e. at the 5 and 25 tonne level, building costs are relatively high. This feature arises for two main reasons. The location of potential farms is necessary in relatively remote mountain regions and this raises the cost of many materials needed for construction. The situation is exacerbated since a "virgin site" has to be assumed with no existing structures or local accommodation (e.g. for the farm manager), unlike many commercial

Table 4.1
Establishment Costs

	5 tonne Capacity		25 tonne Capacity	
	M	%	M	%
Buildings	112,100	57	151,000	46
Ponds and Pipes	24,700	13	99,500	30
Major Equipment(1)	34,700	18	42,900	13
Other	24,550	12	35,400	11
Total	196,050	100	328,000	100

(1) Major equipment = Vehicle, ice machine and storage, generator

farms in for example, South Africa where existing agricultural farm buildings may be utilised.

The influence of relatively high building costs is clearly diminished at higher levels of production capacity as relatively limited expansion in buildings is needed (primarily for the hatchery). In contrast, costs of ponds etc increase closer to pro-rata levels.

For a "virgin site" farm it is desirable to plan for maximum feasible production levels in order to minimise the influence of high building costs. In the examples shown expansion from 5 to 25 tonnes capacity only requires a 60% increase in total establishment costs including a 35% expansion in building costs.

4.3.2 Operating Costs

Operating costs are summarised in Table 4.2 (more detailed cost data and assumptions are shown in Appendix 2).

At the 5 tonne level the major operating cost items are jointly those of feed, and the cost of a (trained counterpart) manager, each with a little under 30% share of the total. Initially a manager with experience of trout farm operation would be required at a salary level well above that shown in the Table. It is assumed however that a counterpart would be trained on site to take over farm operations after two years at a salary below that initially required to attract an experienced farm operator (see Appendix 2). Other cost categories are much less important and include all other labour (14%), diesel fuel (11%), and vehicle maintenance etc (5%).

At the 25 tonne level the most important cost item by far is that of feed, since costs increase pro-rata with production, unlike other cost items. Other cost items are much less significant, the most important being the (counterpart) manager and other labour costs.

Overall operating costs are more sensitive to changes in the scale of production than are establishment costs, the move from 5 to 25 tonnes requiring a 166% increase in operating costs.

4.3.3 Revenue

A summary of revenue for a 5 and 25 tonne farm is shown in Table 3.3 (more detailed analyses is shown in Appendix 2).

Table 4.2

Operating Costs

	5 tonne Capacity		25 tonne Capacity	
	M	%	M	%
Eggs and Feed	7,820	28	39,100	59
Manager ⁽¹⁾	8,000	29	8,000	12
Other Labour	3,900	14	5,580	8
Fuel	3,100	11	3,850	6
Vehicle Maintenance	1,450	5	2,400	4
Other	3,680	13	7,380	11
Total	27,950	100	66,310	100

(1) Manager = Trained counterpart manager

Table 4.3

Sales⁽¹⁾, Pricing⁽¹⁾ and Revenue

	5 tonne Capacity			25 tonne Capacity		
	Volume of Sales	Price per kg	Revenue	Volume of Sales	Price per kg	Revenue
	kg	M	M	kg	M	M
Lesotho	5,000	4.50	22,500	5,000	4.50	27,500
Local South Africa ⁽²⁾	-	-	-	4,000	4.15	16,600
Johannesburg ⁽³⁾	-	-	-	16,000	3.75	60,000
Total	5,000	-	22,500	25,000	-	99,100

(1) For details of sales potential and pricing, see Chapter 3.

(2) For definition of market area, see Chapter 3.

(3) Johannesburg = sales direct to outlets (i.e. hotels, restaurants and retail).

Revenues hinge upon the volumes sold in each of the markets identified in Chapter 3. For both the 5 and 25 tonne capacity farms the most optimistic level of revenue has been calculated, i.e. with maximum sales in markets where higher prices can be obtained. Prices shown in Table 4.3 include an allowance for transportation costs. In practice, revenue may be significantly lower depending upon the degree of success in penetration of markets (see Appendix 2 for indications of alternative revenue calculations).

Revenues do not increase pro-rata since to sustain higher sales levels (i.e. at the 25 tonne level) it is necessary to sell a proportion of production in markets where lower prices are required (notably Johannesburg).

4.4 Results of Financial and Economic Analyses

Financial analyses using the costs and revenues identified above have been carried out for both the 5 and 25 tonne capacity level. The scheduling of costs and revenues flows is shown in Appendix 3.

Costs include allowances for working capital sufficient to cover one year's operating costs, since trout will not be of sufficient size for marketing until year two of the projects lifetime. Working capital is recouped at the end of the assumed project lifetime of 10 years.

At the 5 tonne level the project is clearly not viable since operating costs at M27,950 (after year 2) exceed a revenue of M22,500 (from year 2 onwards). Using a 12% discount rate the Net Present Value (NPV) for a 5 tonne capacity farm is -M302,155. Use of a discount rate of 12% is in fact optimistic as this represents a relatively favourable rate charged by the Lesotho National Development Corporation (LNDC), for commercial loans.

A farm with 25 tonne capacity (after an initial trial period of 2 years at 5 tonnes), generates positive net revenue from year 3 onwards of the project lifetime. However, net revenues are relatively low in comparison to establishment costs and again discounting at 12% a negative NPV of -M268,485 is obtained.

These negative results are achieved despite the fact that the minimum level of costs and the maximum revenue have generally been allowed for. As noted above cost of land and more particularly the cost of the dam have been excluded. Costs also do not allow for contingencies and various items have been kept to the minimum likely to be incurred. Similarly revenues assume maximum sales in markets where higher prices can be charged, and no allowance

has been made for marketing costs if an Agency in South Africa is needed to promote sales. (Chapter 3).

The financial analyses also exclude taxation. The project might attract tax exemption status for up to 6 years operation if it was designated a Pioneer Industry (via the Pioneer Industry Board operating under the aegis of the Ministry of Commerce, Trade and Tourism). However, even the latter benefit would not extend for the full lifetime of the project with consequent adverse effects on net revenue.

Certain off-setting items could serve to make the project marginally more attractive, notably the possibility of obtaining the training grant via the LNDC covering 75% of the cost of counterpart training during the first two years of the project. However, such items do not make any appreciable difference to the negative conclusions of the financial analyses presented.

A major reason for the negative outcome of financial analyses are the high establishment costs associated with the development of the trout farm on a virgin site in a relatively remote mountain location. The impact of high establishment costs is partially off-set as trout production capacity is increased. However, marketing constraints impose a limit on the level of production desirable, i.e. a 25 tonne capacity farm is the largest which can be envisaged without attracting a high degree of risk with regard to potential marketing of production.

Economic analyses would not alter the major negative conclusions of financial appraisal. Virtually all items in the costings may be obtained within Lesotho or from South Africa. Since Lesotho is a member of the Rand Monetary Area its currency is linked to the South African Rand and as a result, the use of shadow-pricing for foreign exchange does not apply.

Some allowance could be made for shadow-pricing of unskilled labour, given the limited employment opportunities available within Lesotho. However, unskilled labour requirements form only a small proportion of total operating costs (Table 4.2), which are themselves relatively low in comparison to establishment costs. Shadow-pricing of unskilled labour therefore has only a marginal impact on the negative results derived from financial analyses.

4.5 Conclusions

For technical reasons no viable site is currently available in Lesotho for commercial trout production, however hypothetical financial analyses have been carried out to:

- (a) Provide an indicator of viability under present cost and market conditions and
- (b) To provide a preliminary guide to feasibility should a dam site become available in future (e.g. via a hydro-electric power scheme) where a trout farm could be attached.

Establishment costs for both a 5 and 25 tonne farm are relatively high at M196,050 and M328,800 respectively. The major contributor to these costs are building requirements since a virgin site is assumed and since building costs items e.g. materials, are likely to be high in remote mountain locations. In comparison, operating costs are modest at M39,950 and M78,310 respectively, for 5 and 25 tonne capacity farms.

Overall, assumptions have taken least likely cost levels and hence represent a fairly optimistic view, and a similar procedure has been used in calculating revenue, i.e. again the most optimistic assumptions have been used. Despite these assumptions financial analyses yield strongly negative results. At the 5 tonne level revenue does not even cover operating costs and an negative NPV of -M302,155 is derived using a 12% discount rate. A 25 tonne farm yields positive net revenue after year two but again a negative NPV is obtained of -M268,485.

Negative results are exacerbated by the relatively heavy establishment costs accruing to the project. Whilst establishment costs decline with increasing scale of production, market limitations impose a ceiling at around 25 tonnes capacity.

Economic analyses do not significantly alter the results of financial appraisal, since virtually all costs and revenues accrue within the Rand Currency Union, hence obviating the need for shadow-pricing of foreign exchange.

The overall conclusion of this chapter is that even if it were technically possible, commercial trout production cannot be recommended in Lesotho. In future, should dam sites become available, it is possible that the same conclusions would hold true, however an updated financial analysis would be necessary.

For some years the Lesotho Government have been considering the possibility of diverting the headwaters of the Senqu (Orange) river system by building a series of dams and transferring the water to the Vaal basin in South Africa. This has now reached the stage of tendering for a feasibility study which is expected to take two years. If this feasibility study is positive, impoundment of water is expected between 1990 and 1995. The proposed dam sites are shown in fig. 2.

After discussions with Dr. Henri De Baulay, Chief Hydrologist for the Lesotho Government, and Mr. Lyle Hixenburg, Consultant for the Highland Water Project, it became apparent that there would be compensation flows between the major dam sites of:-

1. Oxbow dam	21,600 Cubic metres/day
2. Pelaneng dam	43,200 Cubic metres/day
3. Polihali dam	43,200 Cubic metres/day
4. Taung dam	86,400 Cubic metres/day

It is expected that this water would be drawn off from the middle of the dam. Based on our observations in the Oxbow area the water quality is likely to be suitable for trout culture. However, because of the altitude and the fact that the water will not be drawn from the surface of the resultant lake, the dissolved oxygen content of the water may be low. However, if a suitable slipway is provided, rapid reoxygenation would result. Water temperatures are likely to remain stable as the water will be drawn off from below the surface.

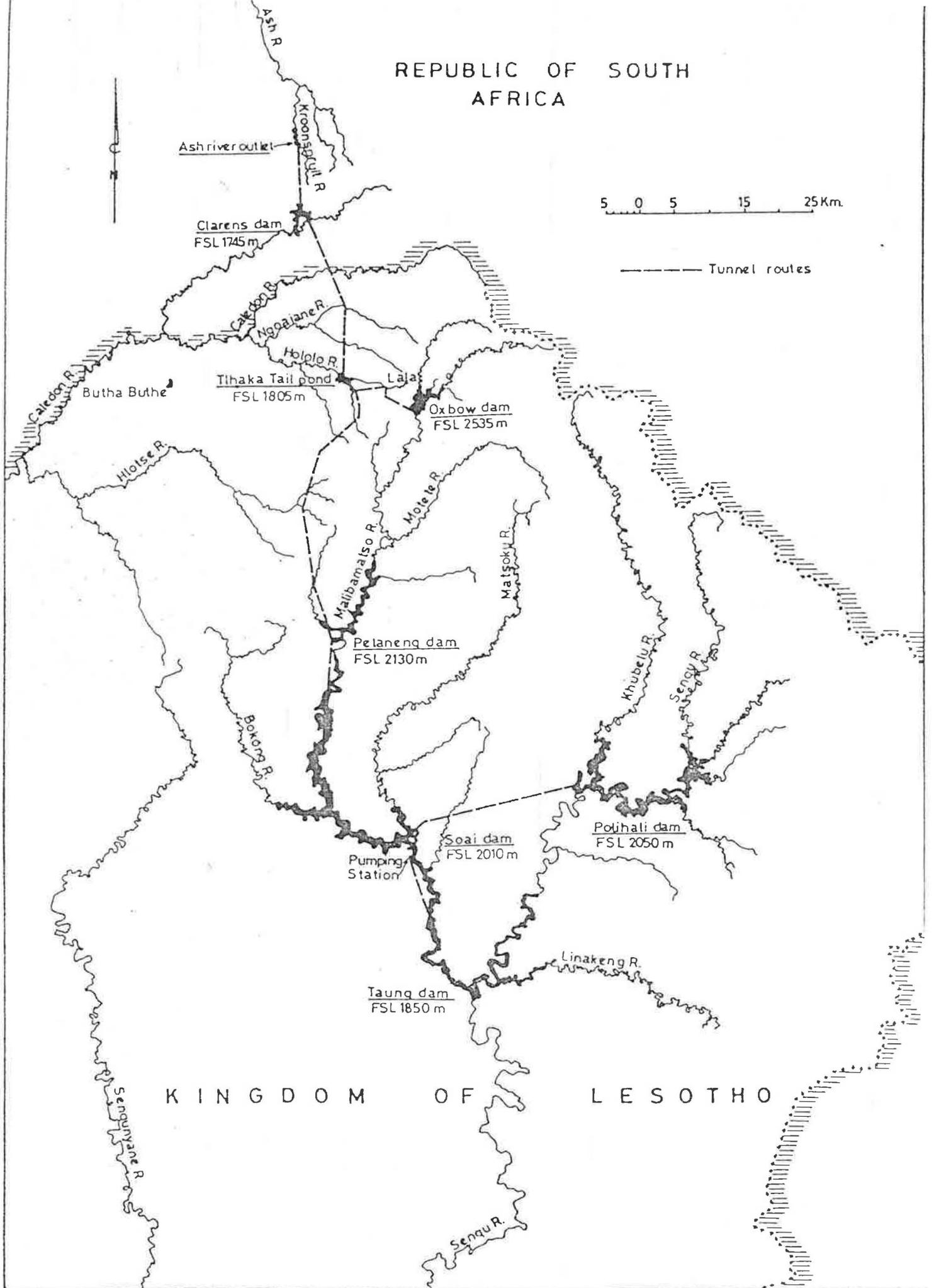
This water resource could be utilised for trout culture provided that all weather access roads exist up to the potential farm site.

Two types of trout culture would be envisaged

1. Conventional trout culture in tanks or ponds using the compensation flow.

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From this it would be possible to produce a total of approximately 200 tons at the four proposed dam sites.

2. Cage culture within the lakes - production levels achieved would depend on subsequent water quality requirements, and would require further study of the ability of the system to break down waste products from fish farm operations.

3. A further market for fish produced from either of these schemes would be for restocking of the resultant lakes which would have great angling potential.

SUMMARY

Trout culture would appear to be technically feasible using water from the Highland Water Project, however, as the scheme is so far in the future, it is not possible to comment on the economic feasibility of production and also of marketing fish produced. It may be possible to utilise compensation flow from other dam projects such as small scale hydro schemes, providing there is 24 hour compensation flow, and on the economic side, providing the cost of the dam is excluded from the costing of the trout farm.

APPENDIX ONE

Methods used for testing water parameters

1. Water temperature

By use of a lab grade thermometer, where possible, water temperatures were taken between 10-12 a.m.

2. Dissolved Oxygen

This was measured in the field at the time of sampling using the Azide modification of the Winkler method which uses phenylarsine oxide as the titrate. The titration was carried out with a digital titrator.

3. Carbon Dioxide

This was measured in the field using the Phenolphthalein titration with 3.61 n Sodium Hydroxide Solution, using a digital titrator.

4. Total hardness

This was measured in the field by the Man Ver 3 hardness indicator method titrated with 0.794 M EDTA with a digital titrator.

5. pH

This was measured in the field with a Griffen pH meter checked against standard buffers and also using a colorometric method with wide range pH indicator solution.

6. Total Suspended Solids

This was measured by filtering one litre of stream water through a pre weighed filter in the field. After returning to Stirling the filter papers were oven dried and reweighed to give the total amount of suspended solids as mg/L

7/9 Heavy metal analysis

100 ml water samples were collected in Lesotho in prewashed plastic bottles and "fixed" with one drop of chloroform. They were then tested for heavy metals at Stirling using atomic absorption spectrophotometry.

10. Water Flow

- a. This was measured in the field where possible with a flow metre. The flow was then expressed as cubic metres per day.
- b. Hydrological data for each river sampled was obtained by consulting the Government Hydrology Records. For some of the larger rivers this covered the period 1956-82. A minimum flow of 5,000 cubic metres/day was assumed to be the minimum flow required to support a rainbow trout farming enterprise of 5 tonne of fish per year. This is irrespective of the economic viability of such a plant. A series of typical hydrology records are attached - days asterisked are those when flow falls below 5,000 cubic metres/day.

Appendix 2

Costs and Revenues Used for Financial Appraisals

Notes for Costings Tables

Since no suitable site is available for a trout farm in Lesotho (owing to variable water flows and/or inadequate water quality), the costings below are based on hypothetical examples for a 5 and 25 tonne capacity farm. The hypothetical nature of the projects means that some cost items can only be estimated approximately.

Table 1 Establishment Costs

(1) Land

The land area for the farm site is estimated at 1,600 square metres for 5 tonnes capacity and 10,000 square metres for 25 tonnes capacity. No cost has been allocated as the potential project would be located in the mountain region on communally owned land. It is assumed that the required land would be made available by traditional authorities since the project would provide some local benefits e.g. permanent employment for a small number of people.

(2) Dam

Dam requirements depend upon the site chosen. As an example, on the Senqunyane River at Marakabei a dam would be required costing at least M2 million. Other sites would similarly require substantial sums primarily because of the irregular flow of streams with short periods of very high water and virtually zero flow at others. It is clear that a trout project of the scale envisaged (5 and 25 tonnes) could not support such a level of expenditure and it is therefore assumed that use is made of dams constructed under other projects (e.g. for hydro-electric power generation, or in the long run the Highland Water Project).

(3) Access Roads

Access road costs are hypothetical since no suitable site is available. The requirement would be for a link from the nearest all-weather road to the main farm building, and depending upon precise location, costs could be substantially above the figure used.

(4) Loading and Garage Area

This item comprises a concrete raft and corrugated iron roof, suitable for garaging of the project vehicle and for loading and unloading. The total area cost is 56 square metres.

Appendix 2

Table 1 Establishment Costs of Hypothetical Trout Farms with capacities
of 5 and 25 tonnes of fish p.a.

(Maloti)

	5 tonne Capacity	25 tonne Capacity
Major Establishment Costs:-		
(1) Land	-	-
(2) Dam	-	-
(3) Access Road	15 000	15 000
(4) Loading/Garage Area	5 600	5 600
(5) Main Farm Buildings	74 500	113 400
(6) Manager's House	32 000	32 000
(7) Breeding Tanks and Roof	6 500	32 500
(8) Ponds	7 000	35 000
(9) Pipes, Valves and Drains	3 200	16 000
(10) Settling Pond	8 000	16 000
(11) Fencing	2 500	6 400
Other Establishment and Equipment Costs		
(12) Vehicle and Container	21 000	21 000
(13) Ice Machine and Storage Bin	6 200	14 400
(14) Generator	7 500	7 500
(15) Salter Balance	1 200	1 200
(16) Nets	800	1 600
(17) Fish boxes	1 150	5 750
(18) Water Storage Tank and Filters	650	650
(19) Office Equipment	1 500	2 000
(20) Protective Clothing	500	800
(21) Other items	1 250	2 000
TOTAL	196 050	328 800

(5) Main Farm Building

The building would take the form of a single storey block, comprising the following:

- Office
- Feed store
- Packing area
- Hatchery
- Toilet

The total building area for a 5 tonne farm is 112 square metres and for a 25 tonne farm 182 square metres, the additional area being required primarily for expansion of the hatchery, (costs include allowance for hatchery troughs). Buildings comprise concrete floors and cement rendered block walls and corrugated iron roof, with insulation to prevent over-heating during summer months. The packing area includes clay tiled floors and tiled walls.

(6) Manager's House

A house for the farm manager and/or counterpart running the farm is considered essential. Because of the likely location of the farm no suitable accommodation is likely to be found in the immediate locality. Accommodation on-site is also desirable in view of the need for continuous supervision of production and immediate response to any problems arising.

The house costed is of standard construction with a total area of 80 square metres including two bedrooms.

(7) Breeding Tanks

Breeding tanks are positioned outside of the main farm building under a roofed area (to prevent excessively high water temperatures during the summer months).

For a 5 tonne farm, 5 four metre diameter tanks are needed under a roofed area of 150 square metres. For a 25 tonne farm, 25 4 metre tanks are needed under a roofed area of 750 square metres. Tanks are constructed with corrugated iron sides and cement bases. Roofing is in the form of corrugated iron supported by posts.

(8) Ponds

For a 5 tonne farm 5 ponds with dimensions of 30m x 5m x 1m depth are required. Each pond has rock-lined edges. For a 25 tonne farm 25 ponds of the type

above are needed. Ponds are costed at rates need to cover manual excavation. (Excavation with earth-moving equipment is much more expensive because of the remote location of potential farm sites).

(9) Pipes, Valves and Drains

Valves required are 75 mm plastic ball valves. Piping and drains require 150 mm and 75 mm PVC piping. Whilst valve costs can be precisely calculated (i.e. the number needed to service each tank etc), pipe and drain costs are estimates as these will depend upon precise farm location and layout.

(10) Settling Pond

The settling pond simply consists of an excavated area to a depth of 1 metre. For a 5 tonne farm a 1,000 square metre pond is needed and a 2,000 square metre pond for a 25 tonne farm. Ponds are costed at rates needed to cover manual excavation.

(11) Fencing

Fencing in the form of 2 metre high chain link is required. For a 5 tonne farm approximately 180 metres are needed and 400 metres for a 25 tonne farm. Requirements will vary slightly depending upon precise farm location and layout.

Other Establishment and Equipment Costs

(12) Farm Vehicle

Because of the remote location of the potential farm a farm vehicle is deemed essential to ensure supplies of feed and other materials and transport out of chilled fish. The vehicle comprises a diesel pick-up Landrover together with an insulated container with a capacity to carry $\frac{1}{2}$ tonne of chilled fish (i.e. $\frac{1}{2}$ tonne of fish and $\frac{1}{2}$ tonne of ice). The vehicle is scheduled for replacement every 3 years of the project lifetime, with a sale value of 25% of original purchase price.

(13) Ice Maker and Storage Bins

An ice making machine with a capacity of 200 kg and one half tonne of ice per 24 hours is required respectively for a 5 and a 25 tonne farm. The machines costed produces flake ice suitable for packing of chilled fish. Bin storage is provided for three days production, i.e. 600 kg and $1\frac{1}{2}$ tonnes of flake ice.

(14) Generator

Because of the remote location of the potential farm it is proposed that electricity requirements are met by a diesel generator located on the site. Costs refer to a generator with a 10 kW capacity, 3 phase.

(15) Salter Balance

A balance required for weighing fish etc has been costed for both the 5 and 25 tonne farms. The capacity of the balance would be 100kg.

(16) Nets

Nets required for both the 5 and 25 tonne farms are seine nets and hand nets.

(17) Fish Boxes

A stock of reusable plastic fish boxes is required for the project. For a 5 tonne farm an initial stock of 100 are needed (i.e. approximately 2½ months production) and 500 boxes for a 25 tonne farm.

(18) Water Tank and Filtration System

Because of the remote location of the potential farm it is proposed that water requirements (primarily for ice making and cleaning) are met from river water. Costs include a storage tank together with a filter/chlorination system.

(19) Office Equipment

This item includes a table, chairs, filing cabinet, safe, typewriter and minor items.

(20) Protective Clothing

Water-proof clothing and footwear for all staff at the farm have been included in costings under this item.

(21) Other Items

These include the costs of a radio/telephone link since phone connections in potential project areas are likely to be prohibitively expensive.

Table 2 Operating Costs

(1) Eggs

Eggs are costed throughout the project lifetime although in practice a farm could produce at least a part of its requirements via brood stock. The number of eggs required includes allowance for mortality at all stages in the growth cycle. Depending upon the time of purchase eggs may be obtained either from South Africa or from Europe.

(2) Feed

Suitable feed is available from South Africa. A conversion ratio of 2 parts feed by weight to 1 part weight of fish has been assumed (although better conversion rates can be achieved in practice). Feed costs including costs of transportation from South Africa (Johannesburg) to Lesotho.

(3) and (4) Labour: Manager and Counterpart

(3) Manager: Because of the level of management required to operate a trout farm it is essential that a farm manager is employed who has had previous experience of operating a trout farm. To attract such an individual would require a fairly high salary and costings allow for the minimum that is likely to be needed.

(4) Counterpart: It is proposed that during the initial 2 years operation of either a 5 or 25 tonne farm a counterpart is trained in all aspects of farm operations and is sufficiently well-qualified to take over from the manager in year 3 of the project. It is assumed that the counterpart's salary would be below that needed to attract the initial manager of the project.

(5), (6) and (7) Other Labour Requirements

(5) Driver: A driver to operate the farm vehicle has been costed throughout the lifetime of the project.

(6) Unskilled Labour: For a 5 tonne farm 2 unskilled labourers would be needed and 4 labourers for a 25 tonne farm.

(7) Watchman: A watchman has been costed for both the 5 and 25 tonne farms.

(8) and (9) Vehicle Spares and Maintenance

(8) Spares: Because of the remote location of a potential farm and the nature of mountain roads, spares costs, notably tyres, are likely to be

Appendix 2

Table 2 Operating Costs for Hypothetic Trout Farms with capacities
of 5 and 25 tonnes of fish p.a. (1)

(Maloti)

	5 tonne Capacity	25 tonne Capacity
Operating Costs:-		
(1) Eggs	600	3 000
(2) Feed	7 220	36 100
(3) Labour - Manager	12 000	12 000
(4) " - Counterpart	8 000	8 000
(5) " - Driver	1 380	1 380
(6) " - Unskilled	1 680	3 360
(7) " - Watchman	840	840
(8) Vehicle - Spares	1 250	2 000
(9) " - Servicing	200	400
(10) Fuel - Vehicle	750	1 500
(11) " - Generator	2 350	2 350
(12) Replacement - Fish Boxes	290	1 440
(13) " - Nets	400	800
(14) Medication Items	250	1 250
(15) Other Minor Items	500	1 000
(16) Insurance - Vehicle	1 050	1 050
- Buildings	1 190	1 840
TOTAL	39 950	78 310

relatively high. Spares costs include an allowance for a complete change of tyres after 15,000km.

(9) Maintenance: For the same reason frequent maintenance for the vehicle is necessary, for a 5 tonne farm 2 services per annum and 4 services per annum for a 25 tonne farm.

(10) and (11) Fuel for Vehicle and Generator

(10) Vehicle Fuel: Vehicle fuel requirements are a function of the assumed consumption per km and distance run. The official Landrover diesel consumption rate is 11km per litre, but in view of the likely location of the farm in the mountain area this has been reduced to 9km per litre. Because costings are for a hypothetical farm site, running distances have been calculated on a hypothetical basis also. It has been assumed that the project has been located 100km from Maseru or the nearest point where feed can be delivered by rail and fish collected for transportation to market. The number of round trips needed has been calculated on the assumption that 1 tonne of feed can be collected per trip and/or one half tonne of trout delivered (i.e. $\frac{1}{2}$ tonne of fish plus one $\frac{1}{2}$ tonne of ice).

(11) Generator Fuel: The 10kW generator requires approximately 2.3 litres of diesel per hour of operating time. Costings assume a 50% operating time over a full year (365 days).

(12) Replacements of Fish Boxes

A loss of 25% of the initial stock of fish boxes per annum has been costed for both the 5 and 25 tonne farm levels.

(13) Replacement Nets

It is assumed that 50% of nets will have to be replaced each year.

(14) Medication Items

These items are costed pro-rata for the 5 and 25 tonne level.

(15) Replacement of Minor Items

This item includes replacement of 50% of protective clothing requirements per annum and also office operating costs.

(16) Insurance

For the farm vehicle, insurance costs are calculated at 5% of the protected value. For farm buildings insurance costs are calculated at 1% of the protected value.

Appendix 2

Notes for Revenue Table

The following Table and notes are an illustration of the method used to calculate potential revenue accruing to the projects. A farm with 25 tonnes capacity is used as an example. For financial analyses (see Chapter 4), the most optimistic, i.e. highest, level of revenue has been used for both a 5 and 25 tonne farm.

Table 3 Alternative Revenue Calculations

(1) and (2) Volume of Sales

(1) Minimum Sales

Volumes are derived from estimates of total market size and potential share of markets described in Chapter 3. In the case of Johannesburg, sales can either be made to wholesalers or direct to outlets (i.e. to restaurants, hotels and retail).

(2) Maximum Sales

Volumes are derived in the same manner as for (1) above, assuming maximum potential penetration of markets.

(3) Prices

Current market prices are identified in Chapter 3. Prices in the Table refer to current market prices less an allowance for the following:

- A variable discount in the range 5-10% to encourage market penetration
- A 10% discount to allow for the differential between whole and gutted fish
- A variable margin to cover transport costs to each market

(4) and (5) Revenues

(4) Minimum Revenues

Revenues are calculated by multiplying sales volume in each market (row 1) by appropriate prices (row 3). Since sales in Johannesburg can either be to wholesalers or direct to outlets, two minimum total revenue figures are derived i.e. M56,150 and M64,550.

(5) Maximum Revenues

These are calculated by multiplying row (2) i.e. maximum sales by row (3)

Appendix 2

Table 3 Alternative Revenue Calculations for a Hypothetical Trout Farm with a capacity of 25 tonnes of fish p.a.

		Lesotho	Local S. Africa	Johannesburg: Wholesale <u>OR</u> Direct	TOTAL
<u>Sales</u>	(1) Minimum (kg)	2,500	2,000	12,000	14,500
				12,000	14,500
"	(2) Maximum (kg)	5,000	4,000	18,000	25,000
				18,000	25,000
<u>Prices</u>	(3) Sales price (M)	4.50	4.15	3.05	-
				3.75	-
<u>Revenues</u>	(4) Minimum (M)	11,250	8,300	36,600	56,150
				45,000	64,550
	(5) Maximum (M)	22,500	16,600	48,800	87,900
				60,000	99,100

prices. Since the Table refers to a 25 tonne capacity farm maximum revenue calculations assume sales of 5,000kg in Lesotho, plus 4,000kg in local South Africa, and 16,000kg in Johannesburg (although 18,000kg could possibly be sold, see Chapter 3).

Appendix 3

Financial Analyses of Hypothetical Trout Farms with 5 and 25 tonne capacities ⁽¹⁾ (Maloti)

Year	0	1	2	3	4	5	6	7	8	9	10
<u>5 Tonne Capacity Farm</u>											
Establishment Costs	(196,050)	-	-	-	-	-	-	-	-	-	-
Replacement Capital Costs	-	-	-	-	(12,375)	-	-	(12,375)	-	-	4,125
Operating Costs	-	(39,950)	(39,950)	(27,950)	(27,950)	(27,950)	(27,950)	(27,950)	(27,950)	(27,950)	(27,950)
Working Capital	-	(39,950)	-	-	-	-	-	-	-	-	39,950
Total Costs	(196,050)	(79,900)	(39,950)	(27,950)	(40,325)	(27,950)	(27,950)	(40,325)	(27,950)	(27,950)	16,125
Revenue	-	-	22,500	22,500	22,500	22,500	22,500	22,500	22,500	22,500	22,500
Cash Flow	(196,050)	(79,900)	(17,450)	(5,450)	(17,825)	(5,450)	(5,450)	(17,825)	(5,450)	(5,450)	38,625
5 Tonne Capacity Farm NPV at 12%	=	-M 302,155									
<u>25 Tonne Capacity Farm</u>											
Establishment Costs	(204,250)	-	(124,550)	-	-	-	-	-	-	-	-
Replacement Capital Costs	-	-	-	-	(12,375)	-	-	(12,375)	-	-	4,125
Operating Costs	-	(39,950)	(39,950)	(66,310)	(66,310)	(66,310)	(66,310)	(66,310)	(66,310)	(66,310)	(66,310)
Working Capital	-	(39,950)	-	(26,360)	-	-	-	-	-	-	66,310
Total Costs	(204,250)	(79,900)	(164,500)	(92,670)	(78,685)	(66,310)	(66,310)	(78,685)	(66,310)	(66,310)	4,125
Revenue	-	-	22,500	99,100	99,100	99,100	99,100	99,100	99,100	99,100	99,100
Cash Flow	(204,250)	(79,900)	(142,000)	6,430	20,415	32,790	32,790	20,415	32,790	32,790	103,225
25 Tonne Capacity Farm NPV at 12%	=	- M 268,485									

(1) For details of costs and revenues and associated assumptions see Appendix 2.