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FRENCH - SOUTH AFRICAN PROGRAMME OF COOPERATION IN SCIENCES AND TECHNOLOGY 1997 - 1999

«Definition of scientific basis for the development of an overall aquaculture masterplan for South Africa»

Report of the mission in South Africa from 9 to 15 February 1998
Project definition and detailed workplan for 1998

By
A. Dosdat, J. Fuchs, J. Mazurie and P. Paquottte - IFREMER
C. Mariojouls - INA PG

Abalone hatchery site - Hermanus bay

List of Diffusion

South Africa :

- Rhodes University - Prof Tom Hecht , Dr P.J.Blitz;
- University of Capetown - Dr P.Cook
- French Embassy - Mrs M. Herlem

France :

- Ministère de l'Education Nationale, de la Recherche et de la Technologie, Délégation des Relations Internationales et de la Coopération - Monsieur A.Prevos
- IFREMER - Direction des Relations Internationales, Direction des Ressources Vivantes, Direction de l'Environnement et de l'Aménagement du Littoral
- INA PG - Mrs C.Mariojouls

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After the decision taken by the French - South African committee to reduce the budget and the duration of all the selected proposals of the first call, Rhodes University and Ifremer decided to revise their joint proposal and organized a meeting in South Africa in february 1998.

A multidisciplinary team composed of economists and specialists in different fields of aquaculture spent on week in South Africa (9 and 15 february 1998) with Prof Hecht and his team in Rhodes University, in order to precise the proposal and define detailed actions to be carried out within the next two years.

The present report summarises the principal conclusions of the survey in term of general approach , detailed methodologies and planning for 1998.

1 - OBJECTIVES OF THE SURVEY

The main objective of this first survey in South Africa was to review the project in regard to the budget and time reduction (218 KF in total and maximum two years). Three tasks have been carried out :

a) Analysis of the situation of SA aquaculture and its potential and constraints in light with the experience of the French team. A two-day field trip has been organized in the mains areas where aquaculture is currently developped (South-West and South-East coasts);

b) Define a general approach to launch the proposal and precise the different steps of the project. Two days have been spent in Rhodes University to deeply discuss and define the workprogramme;

c) Detail the 1998 workplan with a special attention to the sujects which will be carried-out by one SA and one French students.

2 - PARTICIPANTS

The composition of the multidisciplinary team was the following :

South Africa :

- Rhodes University : Prof Tom Hecht (coordinator), Dr P.J.Blitz;
- University of Capetown : Dr P.Cook

France :

- IFREMER : J.Fuchs (coordinator), P.Paquotte (aquaculture economist), A.Dosdat (fish specialist), J.Mazurie (shellfish specialist);
- INA PG (National Institute of Agronomy of Paris Grignon) : Mrs C.Mariojouls (economist, specialist in seafood chain analysis).

3 - ANALYSIS OF THE SITUATION OF AQUACULTURE DEVELOPMENT IN SOUTH AFRICA.

The present situation of SA aquaculture has been evaluate using publications existing on the subject and through a two-day field visit of the most typical sites where marine aquaculture is being developped (mainly abalone, mussel and oyster farms). This analysis only reflects the general opinion of the French team on the potential and constraints of SA aquaculture but does not pretend to be an exhaustive study of all the existing , nor future possible developments.

3.1 General context :

Marine aquaculture is considered as a new and exciting endeavour in South Africa and seems to have scope for expansion and for the development of commercial ventures which could provide employment for historically disavantaged coastal communities. As precised by our partner, this would make a significant contribution to the aims and objectives of the Goverments Reconstruction and Development Programme.

At present, the development of aquaculture in South Africa takes place on an *ad hoc* basis and is driven entirely by industry and research community. South Africa does not have a cohesive National Plan for the development of this sector and this has been identified as one of the serious shortcomings of aquaculture in South Africa. Scientists involved in aquaculture research programmes estimate that there is a need for expertise to contribute to the realization of an Aquaculture Development Plan for South Africa whereas administration has an important role to play in implementing measures for safe production.

3.2 Investigations on some South-African operations

The analysis carried out by the team on some characteristical aquaculture operations can be summarised as follows :

Abalone culture (*Haliotis midae*)

* *Description of rearing technic*

First attempt in rearing abalone was in 1990 . At present 11 farms are operating on the South and West coasts (see map attached in **annex 1**). They generally belong to large companies already involved in fisheries industry (Sea Harvest, Irvin and Johson, Premier Fishing...). The first production of cultured abalone in controled conditions began in 1997. The production target is 600 tonnes per year, equivalent to the fishery production. The main markets are Japan (live animals) and Hong-Kong (canned) were this species is well valued (32-35 US$/kg ex-farm). Hatchery technics have been specifically developped with the support of University of Cape Town (UTC) and Rhodes University to adapt existing

technologies (larval settlements in plastic bags, uses of natural diatoms, no breeders management) . Juveniles are tranfered to ongrowing farm at the size of 10 mm (6 months). The usual ongrowing farming system is based on onshore facilities through pumping, rearing in concrete tanks, and utilization of artificial feed (including fish meal, developped by Rhodes University).The major problem actually faced by industry is pathological infestation of th eshell by worms *Sibella*; technological improvement is under study on tank design to facilitate feeding efficiency.

Ther is a sea-ranching experiment on the north of West-Coast, where this species is not endemic. Good return ratios are obtained, up to 40%.

* *Comments of the team :*

This activity is considered as highly capitalistic for what concerns investment, vertical integration, marketing for export markets. Some specific advantages have been underlined as original artificial feed, existing commercial trade, advanced hatchery technology, water quality. One of the characteristics of this aquaculture is the original developpement, from local research, with quick application and active support from Cape Town University, and Rhodes University.

The major comment of the group concerns the possible under-evaluation of risks and more specifically the long turn over duration linked to ongrowing period (4-5 years before the first commercialisation). Also, the limited knowledges in production costs linked with technical results is regarded as a risk.

Mussel culture (*Mytilus galloprovincialis*)

* *Description of rearing technic*

The bulk of the production consists in the Mediterranean species *Mytilus galloprovincialis* which makes about 97% of the production, and the native *Choromytilys meridionalis* makes up the rest. The major production site is Saldanha Bay (150 km West Cape Town, **annex 1**). Two companies, one big (50 ha) employing 48 people and a smaller one (15 ha), are producing 3000 tons of mussels per year in 75 rafts on 65 ha. 300 additionnal hectares have already been allocated to increase production. Natural spat is collected on ropes, which are suspended under the rafts (Spanish technique). Growth period is 6 months. Production cost ex-farm is 1.15 rd/kg which can be compared to 1.2 rd/kg in New Zealand. Mussels are processed on sites (by Sea Harvest) up to freezing through steeming and chucking. 20% are sold whole fresh (3.8 rd/kg), 30% half-shelled frozen (40% meat content, 11 rd/kg), and the remaining as frozen meat (average 12 rd/kg). Environmental monitoring and quality control are done by the farm. PSP phytoplancton can occur.

* *Comments of the team*

Mussel aquaculture is characterized by the low level of technicity (basic Spanish know-how).The production is until now for domestic market. Further development would rely on an increase of domestic market, and some export. Production is presently integrated but attention is given to expend this activity through alternative private industry and/or social input from local communities with a project of 50 small-scale farms.

Extended and internationally recognized environmental monitoring and products quality control is lacking and interrogations have been expressed on the possible extension to other sites (closed or semi-closed bays)

Oyster culture

San Helena Bay hatchery and salt marshes ponds at Paternoster (San Helena Bay, Premier Fishing, manager : Cleffie SMIT) have been visited during the trip (see map in **annex 1**).

Oysters culture in South Africa is not much developed and ten producers marketted around 700 tons in 1997. Most of them operate in a few bays and estuaries.

The species cultivated is *Crassostrea gigas*. No natural settlement occurs in S.A. One hatchery sells 5 million spat/year (19mm) to each of the 5 largest producers. Eyed larvae or spat are occasionnally imported from England or USA.

The most common technique in Bays is suspension in baskets, under floating rafts. At smaller scale, bottom frames (exposed coasts), trestles (earth ponds) or racks (remote estuaries) may be used.

Thants to favourable temperature (average 15°C) and upwelling that prevail on the west coast , market size can be reached within one year. Oysters are marketted whole fresh in the main large cities (Johannesburg...). The price off farm runs about 1,2 Rds/oyster.

The market is chronically undersupplied but its potential of development seems limited.

** Comments of the team*

The limits for oyster production in South Africa are :

- lack of protected sites (culture in estuaries is under investigation),
- red tides (only on the west coast, not on the east coast),
- small domestic market.

Fish culture

The only fish operation visited was at Rhodes University in Grahamstone. It consists in an experimental facility dedicated to ornamental fishes where the whole cycle of several species has already been closed.

One experiment on seatrout has been conducted at Paternoster by a freshwater trout producer. Although excellent preliminary growth results, the experiment faced problems related to red tide in this site. The production cost seems to be also a limiting factor with an estimated cost of 22 rds/kg ex farm. Investigation is being conducted in order to select more suitable sites on the East coast.

Shrimps culture (Penaeid)

Two farms are operating in Natal province with a total production of 100 tons/years *(P. monodon and P. indicus)*. No extension is planned at present in SA. Constraints seem to be related to low temperature in winter time (<24°c). South African farmers and entrepreneurs are in the process of setting up shrimp farm in Mozambique.

Seeweed culture

One farm is operating seeweed culture (*Gracilaria*) but no detailed informations have been collected during the survey.

3.3 Conclusion

Aquaculture in South Africa is actually limited to some thousands of tons per year and the species grown in seawater are mainly mussels (3000 tons) and abalone.

Major constraints which have been identified concern :

- site availability with very rough coast and high price of land in certain areas (up to 1 Million rd/ha),
- access to technology transfer and limited R&D facilities,
- large fishery sector with excedent on some species (hake..),
- low national seafood product consumption (5kg/capita), but very heterogeous according to the social category,
- distance from the main markets.

Despite these constraints, SA have several interesting advantages which can be summarized as follows :

- presence of upwelling with rich waters in the west and partly south coasts, and excellent water quality,
- very active fisheries industry sector,
- excellent distribution network within the country,
- efficient relationship between research and industry with possibility of funding R&D,
- big companies interested in investing in this sector,
- strong political request to develop aquaculture in remote areas,
- available manpower at moderate cost...

Based on this general impression, the group tried to analyse how these constraints could be counterbalanced by comparative advantages and how aquaculture potential could be defined and precised.

4 - GENERAL FRAMEWORK FOR THE EVALUATION OF AQUACULTURE POTENTIAL IN SOUTH AFRICAN COASTS

The team of experts focused its attention in the definition of a general framework to anticipate the work programme. The proposed approach is based on an analysis of different states in aquaculture development (ongoing, transferable, potential) in SA and in the definition of specific topics of research to investigate for each group.

4.1 Definition of the main states of aquaculture development in SA

In order to facilitate comprehensive analysis of the potential, three states of aquaculture development have been defined based on the experience of SA partners and the analysis made by experts from IFREMER and INAPG.

State 1 - Expansion of existing aquaculture operations

This state 1 concerns the possible extension of ongoing aquaculture operations for mussel, oyster, abalone and shrimp. The objectives are :
a) to improve existing technologies in the sites where the activity in already implemented
b) to analyse the possibility of extension to new sites corresponding to new technologies.

State 2 - Adaptation of new aquaculture activities

Four possible new activities have been identified :

a) Sea trout farming :

Trout is very popular in SA but the extension of its culture is limited by lack of freshwater. The project will consist in analysing the possibility of transferring sea trout technology (sea cages or on-shore ponds) and investigate cost of production.

b) Turbot farming :

The purpose would be to estimate the viability of turbot farming in RSA (problem of creating a local market, problem of access to international market) in building a test of the domestic market. The possible substitution of sole by turbot is to be investigated as natural sole *Austroglossus pectoralis* stocks are declining.

c) Scallop culture :

The local species is slow growing with low potential. Hatchery technique for scallop is well developped in France. The non indigeanous *Argopecten purpuratus,* already present in SA, is an interesting candidate species to be adapted. Bottom culture seems to be a good way to grow them. The problem lies in authorization to grow them in the open sea. Another system is actually tested is growing scallops in salt marshes ponds.

d) Bottom culture of mussel (*Perna perna*) :

Some commercial operations have been run in Port Elisabeth but they failed due to concurrence with saldanha bay where growth rate is much faster.

A traditional intertidal harvest of *Perna perna* exists along the North-East coast, but faces overexploitation.Experiments of collecting spat for recolonization have been undertaken but not really successful until now.

State 3 - Forecasting alternative prospective new developments

Prospect could concern :

- Local finfish farming for food consumption (Spotted grunter, Kob). The couple species*technics is to be applied to available sites.
- Ornamental fish

4.2 Steps of works

To each of the three groups of species correspond three majors steps which have to be approached in different ways, according to the state of development. Thus, this analysis has to be crossed with :

Step A - Sites and technologies :

Site availability has to be investigated at different levels (local, regional) by introducing specific constaints linked to each species and production technique.

Step B - Adequation supply/demand

Specific advantages and disadvantages of the RSA will be investigated for each group in term of global survey for domestic and international market with the help of technical and financial project analysis.

Step C - Socio-economic organization

Here, we consider the question of the potential actors for the development which have to be identified in order to evaluate the socio-economic integration. The experts propose that organisation of culture chain could be included in the framework of the cooperative project.

Given these levels, the objectives for each state of development will necessary use specific tools to be investigated. For each state, the following table describes the concerned species and the topics to investigate in priority.

State of development/ Steps of work	**State 1** Expansion of existing activities (shellfish)	**State 2** Adaptation of new aquaculture activities (seatrout, turbot, scallops)	**State 3** Prospective development (local finfish species)
Step A Sites and technologies	- mussels /Rafts : new sites (bays) ? - mussels/long Lines : semi -open bays? - oysters /Bottom culture : Sites?	- Sites characteristics - Technologies : cages, on-shore ponds, bottom culture .. - existance of sites (cost, access, pumping feasability..)	- screening of species - screening of sites according to the main requirements of the species
Step B Adequation supply/demand	- new markets for mussels - production cost with new technics - project analysis	- market survey : domestic and international market - preliminary project analysis : cost of imputs in SA, comparative advantages	- market target identification : for fish (1) upgraded products equivalent to lined fish (2) standard quality fish
Step C Socio-economic organization	- who are the potential actors? - organization of the product chain according to the type of actors	- suppliers : food, equipments - producers : new operators, existing operators - processors ?	- define clear objectives : (1) reconversion for unemployed people (2) development of private companies in « niche markets »

4.3 Detailed working method for each state

* *State one : Expansion of existing activities (shellfish)*

Step A - Fine tuning for site evaluation is the primary requirement, given the species*technic couple (for example, the potential of protected bays to support mussel rafts or long-lines)

Step B - Market and project analysis are necessary to investigate the relationship between new markets (price, quality, commercialisation) and expected production costs. Quality includes precise monitoring of the environment.

Step C - The modality of social input is part of the project analysis (example vertically integrated structure or small-scale organisation). The whole organisation of the chain is dependent on all these choices.

State 2 : Adaptation of new aquaculture activities (turbot, seatrout, scallops)

Step A - Adequation of sites to the production system and species is to be investigated more generally (water temperature, waves energy). Two major ways need to be studied : onshore facilities and/or coastal operation. The scale of this investigation is necessarily bigger than in the previous level : pre-selection for potential estimation.

Step B - A global survey of the demand is to be built, either for domestic market and international market. At that level, detailed project analysis is not required, and specific constraints or advantages are to be put in evidence first.

Step C - Capacity of investors and social structures to incorporate new technologies is a key point. It includes suppliers for feed, equipments, etc... An evaluation of induced employment will be also necessary.

** State 3 : Prospective development (local finfish species ..)*

At this stage of the reflexion, investigations would focused mainly on screening local species (finfish, molluscs..) for possible aquaculture development.

5 - WORKPROGRAMME

Due to the reduced time and budget allocated to the projet, the partners decided to approach the subject in :

- clearly defining the repartition of work between the partners;
- planning the timing of the 2 years activities
- limiting the study in a first step to a few case studies;

5.1 Selection of case studies

For each state of development, groups of species to investigate in priority have been defined as follows :

State 1 - Expansion of existing technologies

The priority has been given to feasability study of **mussel farming development**. Thus, the expansion of farming is strongly dependent on the market : development of consumption of internal markets, and institutional incentives in the choice of modality of development (through small scale farms or integrated ones). Other driving factor is ecological ability (site definition and quality). The choice is enforced by the present state of the production, managed by two private companies and the potential for increasing production through the exploitation of new sites.

This analysis will be then tentativelly extended to other filtering bivalves (oyster) if further investigation is required.

State 2 - Adequation to new aquaculture activities

Existing know-how and market are favourable elements that lead to the choice of **sea-trout farming** in a first step. French technological know-how on that species will meet the competencies of the RSA counterpart in defining species requirements in the process of site selection.

This approach will enable an easier tranfer of knowledge to be used for other models (turbot?) in a second step.

State 3 - Prospective development

Experience of France in the screening of species (fish and mollusc) will be used to define the major criteria to take into account (biological, technical, economic..) for the selection of potential **local marine finfish species** for aquaculture.

5.2 Repartition of task between partners

Step A - sites and technologies

These aspects will be mainly undertaken by the South African teams by using GIS tools. Step A will be divided in two phases :

- in a first phase, a general description of the whole coastline will lead to exclude the sites that will be considered as non-available for aquaculture in all aspects (e.g. shell-fish and fish);
- in a second phase, for every selected couple species*technics, specific criteria (physical, biological,economic ;..) will be introduced to select suitable sites and then evaluate their potential in terms of production (detailed informations of criteria to take into account are precised in UNEP document).

Expected outputs are thematical maps of aquaculture potentialities of the whole RSA coast.

Step B - Adequation supply/demand

These aspects will be undertaken mainly by the French team. Market surveys for domestic and international market , including statistical data collection for global and trends estimation, field enquiries for production cost and structure evaluation will be carried-out. These later data will bring informations for preliminary project analysis. Specific advantages and dis-advantages of the RSA will be investigated, according to the selected market chain.

Step C - Socio-economic organization

This work will be carried out within the market survey (Step B) as a first screening of the RSA situation. These aspects will nevertheless be handled in more details during the second phase of the project.

5.3 Timing

5.3.1 Planning of activities

Planning of activities is presented in the following table:

State of development/ Steps of work	**State 1** Expansion of existing Activities	**State 2** Adaptation of new aquaculture activities	**State 3** Prospective Development
1998	Finalised for mussels	Preliminary investigation on seatrout	no investigation
1999	Possible extension to others models (Oyster?)	Detailed investigation on seatrout, possible expansion to others models (turbot?)	Preliminary investigation on local marine finfish screening

5.3.2 Planning of missions in France and South Africa

Tentative mission planning - 1998 and 1999 in presented in the following table :

	1998	**1999**
French student in SA	3 months field work in East and West coast	(?)
SA student in France		1 month in early 1999 for methodological exchanges
Missions in SA	5 in February 1998, 1 or 2 in late 1998 if necessary	2 in early 1999
Final workshop		*final workshop and field trip

* Final workshop will be tentativelly organized in september 1999 in France. The objectives are (1) to present and discuss the final results of the research work (2) to realize a general field trip in the mean aquaculture sites interesting SA. SA delegation will include scientists and potential industry managers interested in aquaculture development.

6 - DETAILED 1998 WORKPLAN

The detailed workplan for 1998 will include two main topics.

6.1 Site and technologies :

A detailed 1998 workplan will be prepared by South African team.

Ifremer will assist Rhodes University in participating to the definition and selection of relevant criteria to take into account for investigating the two parts of the study :
- general description of the coastline in excluding sites that will be considered non-available for aquaculture in all aspects (e.g. shell-fish and fish).
- sectorial approach (shellfish, seatrout..)

A particular attention will be given in the choice of GIS softwares to ensure that they are compatible when exchanging data or methodologies between Ifremer and Rhodes University. The software used by Rhodes University are : Arc view v.3, TNTMips.

A mission in France is planned for the SA student in early 1999 to exchange methodologies and discuss preliminary results with specialists in GIS.

6.2 Adequation supply/demand

This part of the project will be supervised by Ifremer and carried-out in strong collaboration with INAPG through a 6 months student research work. The CV of the selected student is presented in **Annex 2**.

The detailed content of his work, discussed during the survey, is presented here. He will stay 3 months in SA in order to collect informations during field trips and organize enquiries. During his stay in Rhodes University, he will work very closely with the SA student in charge of site investigations. The results will be reported in october 1998. They will serve as a base for discussing the 1999 workplan.

One or two missions of Ifremer scientists will be planned in late 1998 if necessary, in orer to precise the 1999 workplan.

WORKING PLAN OF THE FRENCH TRAINEE

The French student will concentrate its research on two main topics

I - DEVELOPMENT OF THE MUSSEL CULTURE ACTIVITY IN SOUTH AFRICA

1.1. Objectives

The objectives of the study are :
- to study of the possible expansion of the domestic and international markets
- to investigate how can small scale mussel operators enhance their income within the existing industry or within a new organisation of the activity ?

The work will be carried out by taking into account the possible expansion of mussel culture in new sites (closed bays, semi-open bays) as revealed by the GIS programme of Rhodes University.

I.2. Market

1.2.1. Characteristics of the present market

The following parameters will be studied :

- trends in consumption of food and seafood in particular (apparent consumption, consumption mission with the help of panels if available),
- characterisation of the different mussel products regarding quantities, prices, quality, seasonality,
- identification of the main economic operators (production, processing, wholesaling, retail level, catering) and of the organisation of the different distribution channels.

1.2.2. The range of mussel products available on the European market

The following parameters will be identified for the whole range of products in the main consuming countries (Belgium, France, Italy, Spain) : origin, characteristics (fresh or frozen, raw or cooked, with or without topping), packaging, trademarks, distribution channels, retail price.

1.2.3. Study of the possible evolution of the domestic market for mussels

Preliminary remark :

A consumer's attitude survey through an inquiry, crossed with reliable statistical data on the consumption trends would be an efficient method for this study. Considering the limited duration and budget which are available, we shall recommend a different approach.

Proposed methodology :

The main operators in the distribution and the processing sectors may be regarded as experts for aspects related to consumer's demand and to specific constraints existing in the mussel production chain in South Africa. So, we propose to carry out interviews of the

principal operators, following a list of questions prepared after the previous steps (1.2.1., 1.2.2.).

1.2.4. Study of the possible extension to European markets

* Identification of the regulatory constraints, and of the means that should be involved in South Africa to cope with them

* Study of the positioning of the South-African mussel products regarding to :
  - volumes,
  - prices (taking into account production costs, shipping cost, tariffs),
  - quality,
  - seasonality.

1.3. Study of the organisation of the mussel culture chain and of its possible evolution

This analysis will be undertaken in the zone of Saldanha Bay, considering the present activity and its extension in new sites using rafts or long-lines.

The issues of this step are :

- identifying the main actors for production, processing and the institutional context (administration, research, extension facilities, banking system, professional associations),
- trying to understand the practices, the production costs, the strategies and expectations of the economic actors through interviews,
- analysing these informations and consider the most likely scenarii for the future organisation of the mussel culture chain, with focus on their respective advantages and constraints.

2. PRELIMINARY STUDY FOR THE ASSESSMENT OF SEA TROUT FARMING POTENTIAL IN SOUTH AFRICA

2.1. Objectives

This study is a preliminary step for a project analysis for sea trout farming. We will gather some information that should help to decide whether or not sea trout farming could be a valuable activity in South Africa. If yes, this study will facilitate the design of a possible project.

For this purpose, we shall investigate three legs :
- the possible sites for that activity,
- the specific assets and constraints of South Africa,
- the possible markets for sea trout products.

2.2. Pre-selection of sites

The potential farming zones will be identified according to :

- the biological requirements of sea trout,

- the suitability of the coastline spots for standard sea trout farming techniques, considering the characteristics of the coastal line pointed out in the GIS.

2.3. Assets and constraints of South African trout industry for developing a marine activity

This study being a first approach of the topic, the main tools used for collecting information will be some interviews with economic operators and experts, during which different type of questions will be asked for the two following issues.

2.3.1. Insertion in the existing trout industry

An overall approach is necessary to look at the possible insertion of the marine activity in the existing trout farming chain (also, some new operators could be interested in marine trout farming). Different aspects will be considered :

- understanding the motivations of the producers for marine farming (as a response to constraints in fresh water activity or others),
- checking the ability of local industries to supply the specific inputs for this new activity (food, oxygen, equipment, etc),
- investigate the possibility for linking seatrout farming with abalone farming (use of existing pumping system),
- evaluating the capacity of trout farmers to provide juveniles for marine farming : available quantities, seasonality, characteristics of the strains (growth potential, ability for sea farming),
- evaluating the needs for specific training and technological transfer.

2.3.2. Costs of the production factors

The objective of this step is to estimate the costs for the main production factors : land, manpower, energy, equipment, food, juveniles, oxygene, shipping to markets, taxes, etc.

These data will be compared with the equivalent information collected in some countries in Europe and America.

In the present study, it will not be possible to have a precise idea of the provisional production costs. Indeed, such a result would need a complete identification of a project (site, technique, size, zootechnical standards) which is not programmed yet at this level of the programme.

2.4. Market

We shall consider only the possibilities offered by the domestic market.

2.4.1. Insertion of sea trout in the market for fish

* Study of the trends in fish consumption

* Characteristics of the salmonid products present on the market (quantities, prices, presentation, species, presentation, distribution channels)

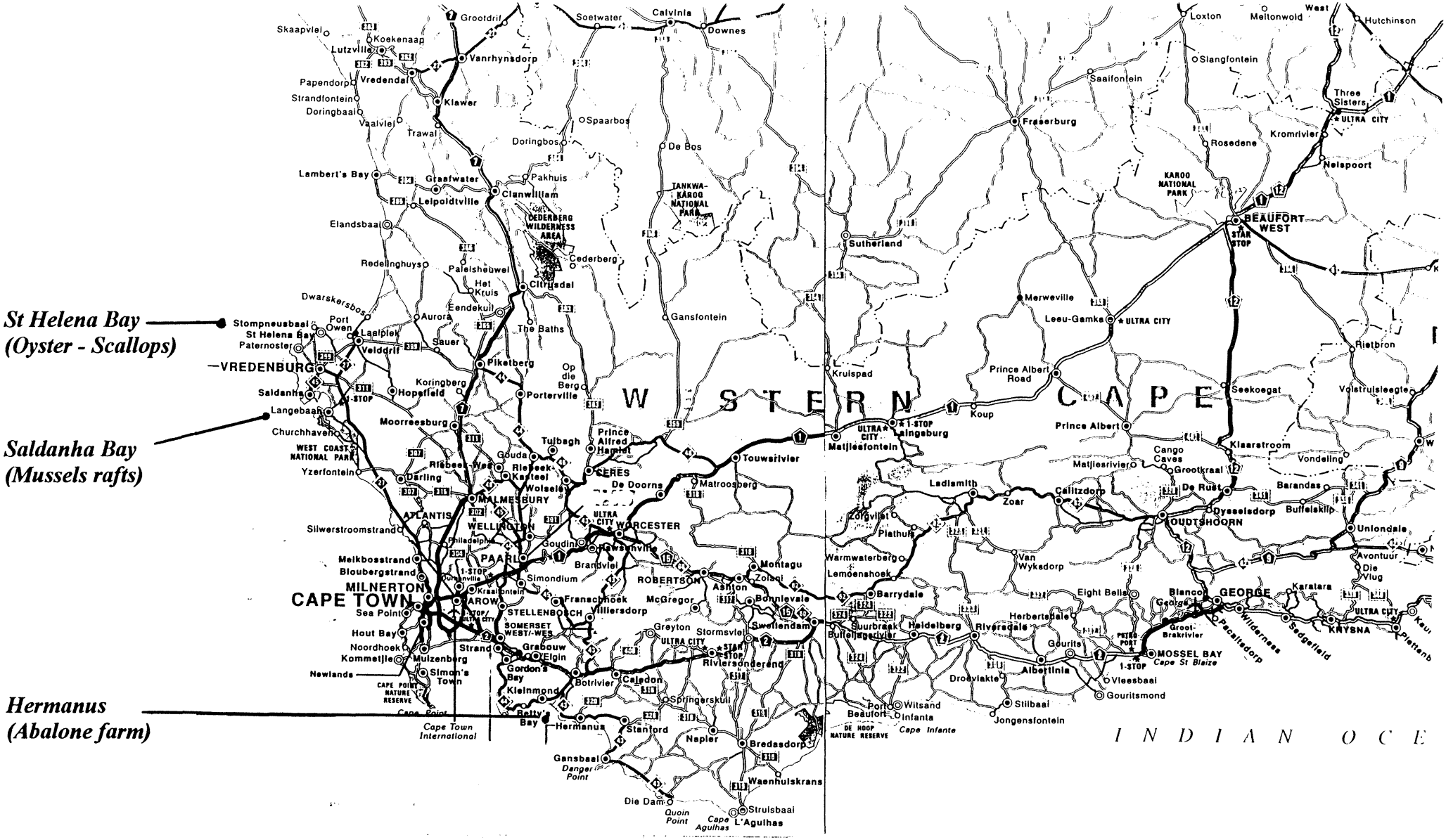
* Identification of the products which could be offered by marine trout farming and of their positioning in the range of fish products (with an approximate acceptable price).

2.4.2. Analysis of the competition with salmonids products available on the international market

Salmonids are now commodity products. Therefore, South African production will have to face competition from major suppliers (Norway, Chile, European Union, Canada etc.). In the framework of this study, we shall try to present the main characteristics and trends of the world wide supply (quantities, quality, presentations, prices). The issue of the tariffs evolution with regard to the GATT has to be taken into account.

ANNEX 1

MAP OF THE PRINCIPAL MARINE AQUACULTURE SITES OF THE WEST COAST OF SOUTH AFRICA



Map of Aquaculture sites visited during the survey in South-Africa - 9 to 15 February 1998