PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

PROJECT FOR THE CONSTRUCTION OF AQUACULTURE RESEARCH CENTER

REPORT OF BASIC DESIGN STUDY

OCTOBER 1985

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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PREFACE

In response to the request of the Government of the People's Democratic Republic of Yemen, the Government of Japan decided to conduct a Basic Design Study on the Project for the Construction of Aquaculture Research Center and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the People's Democratic Republic of Yemen a study team headed by Dr. Yoshinori OGAWA, Director of Aquaculture Division for the Nansei Regional Fisheries Research Laboratory, Fisheries Agency, from June 26 to July 20, 1985.

The team had discussions on the Project with the officials concerned of the Government of the People's Democratic Republic of Yemen and conducted a field survey in Al Marsa, Aden. After the team returned to Japan, further studies were made and the present Report has been prepared.

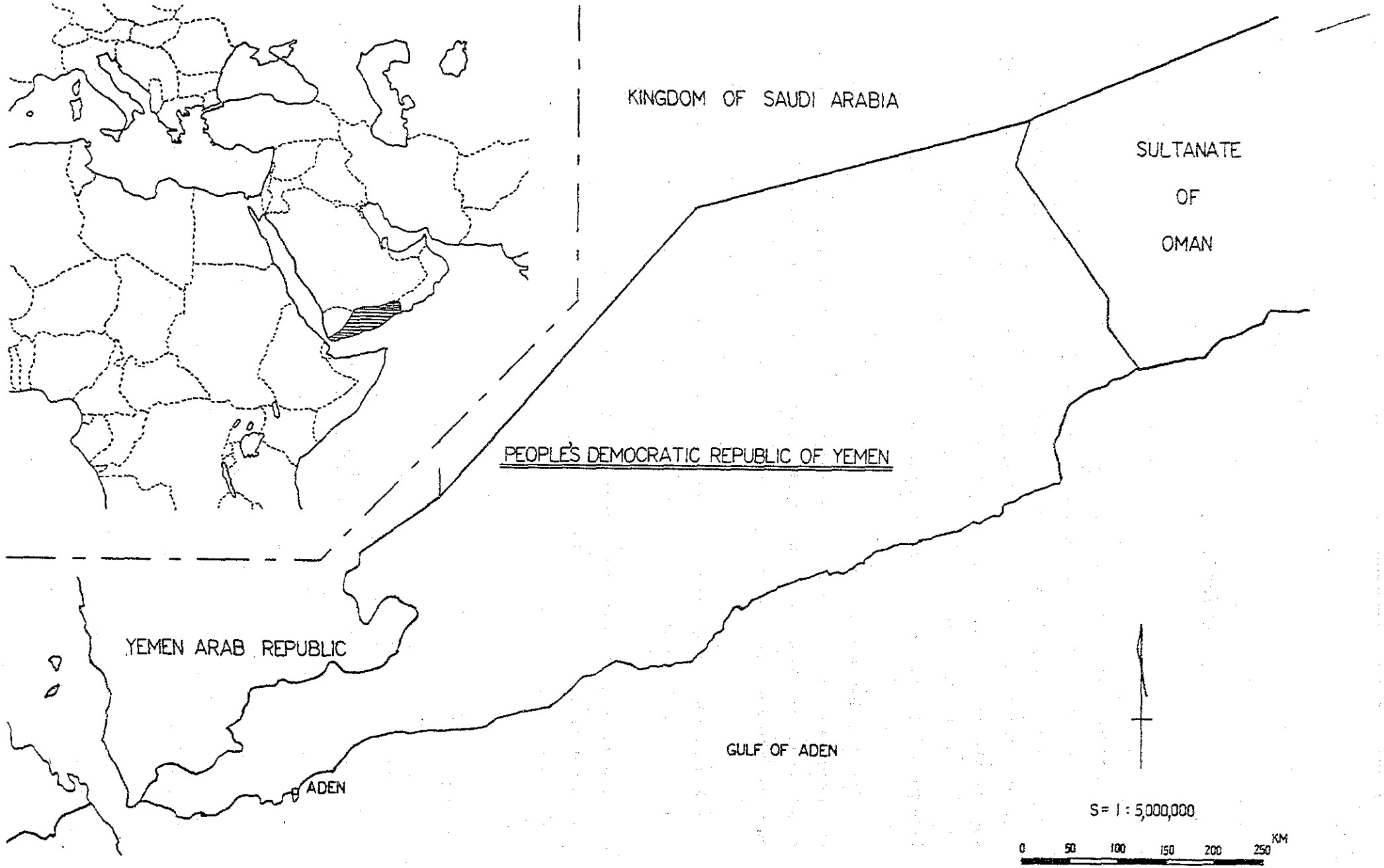
I hope that this Report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the People's Democratic Republic of Yemen for their close cooperation extended to the team.

October, 1985

Keisuke Arita

Keisuke ARITA
President,
Japan International Cooperation Agency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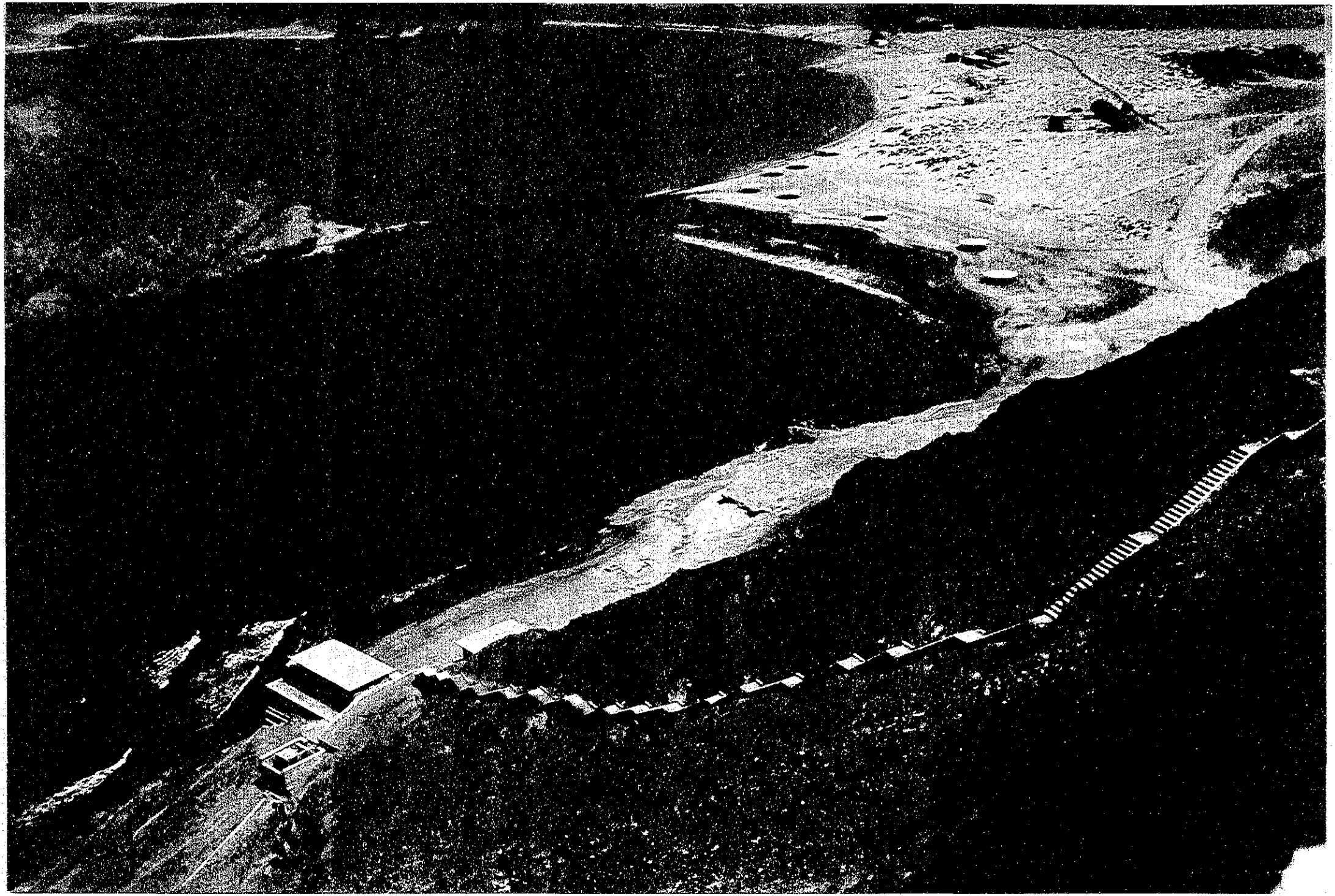
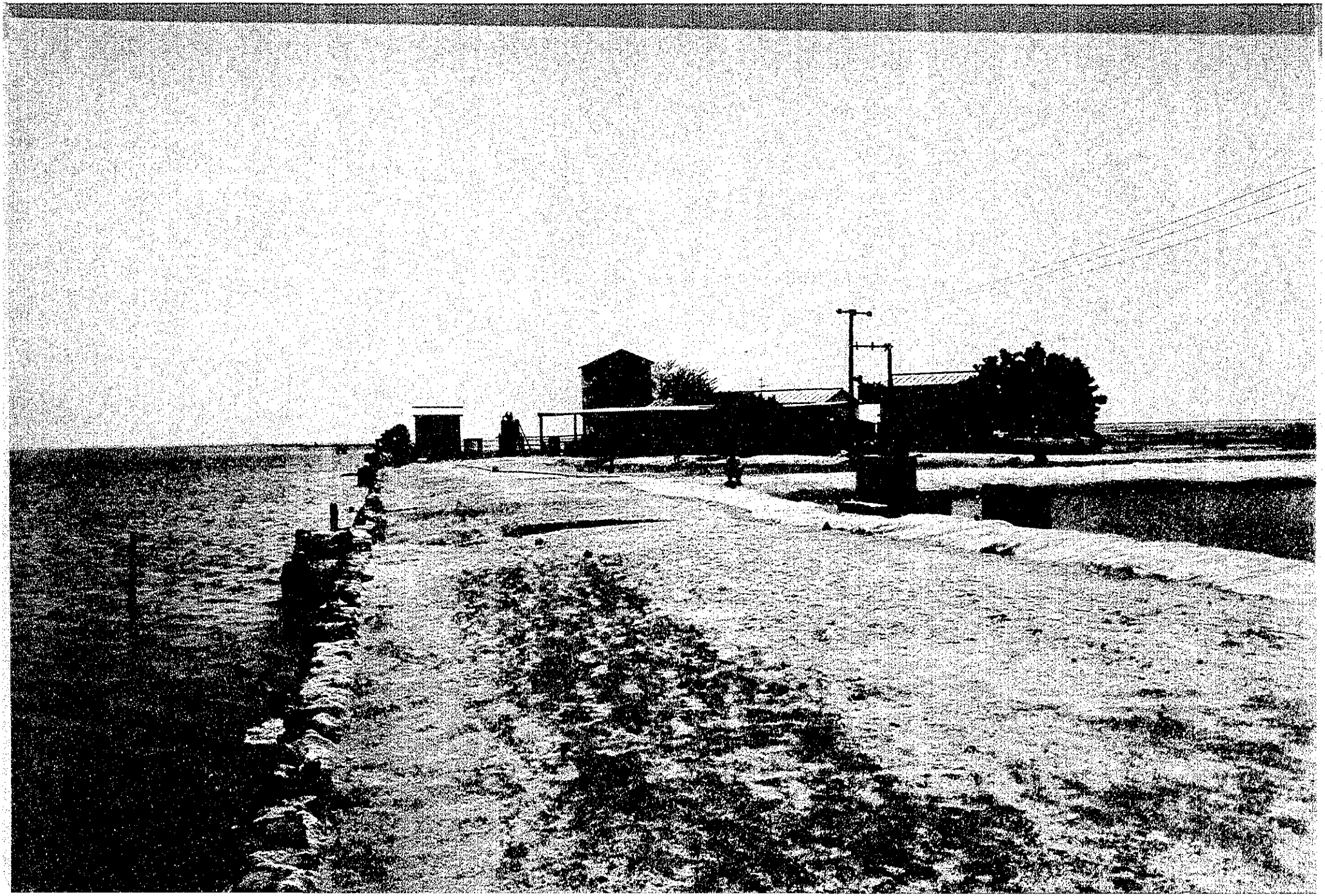




SUMMARY

The People's Democratic Republic of Yemen (hereinafter referred to as the PDRY) has no particular resource other than fish wealth. For that reason, the country positions the fisheries development project as one of the most important policies in the Third five year plan. The fisheries development project aims, through the promotion of fisheries, to increase exports and to raise the supply level of animal protein to the citizens of the PDRY.

Although the country has successively introduced modernized facilities such as fishing boats, processing plants, cold storage, etc. by benefitting from financial and technical aids, joint venture, etc. with Japan, Soviet Union, China and other international organizations, they can not be considered to be being used effectively because of acute shortage of specialized engineers and the declining tendency of cuttle fish stocks.

Under these circumstances, the country decided to raise the level of technical competence in fisheries related matters such as fishing, processing and distribution, to strengthen management and make it more efficient, and to consolidate the infrastructure in the framework of the fisheries development project. For this purpose, the country is now planning or implementing a Project for Construction of Fishery Manpower Development Center for the aim of personnel training of fisheries engineers, the Aden Fisheries Harbour Project, the Fishing Village Development Project, and others.

Furthermore, the interests of the country are not limited to technical improvement and enforcement or manpower development for conventional 'catch fisheries' alone, but also include the promotion of aquaculture.
For some time past, the country has been trying to introduce basic aquacultural techniques with the technical assistance of Japanese companies. However, technical improvements for seed production and culture practice, the personnel training and research and development are necessary for the commercialized aquaculture on a full scale.
The country, this time, requested the Japanese Government to accord a grant aid for the Project for the Construction of an Aquaculture Research Center.

In response to that request, the Japanese Government decided to carry out a basic design study on the project, and the Japan International Cooperation Agency (JICA) sent a basic design study team to the PDRY for the period from June, 26th to July 20th, 1985.

The team executed the field survey of the existing aquaculture experiment center and had discussions with the officials of the Ministry of Fish Wealth, the Ministry of Construction, and the Aden Province, etc. for studying the background of the project, the appropriateness of the project, the relationship with the other projects, the managing organization, and other matters. As a result, the team confirmed the necessity for the promotion of aquaculture in the country for the following reasons:

① For the country which has few exporting goods, it is significant to project the aquaculture of prawns, which are worldwide marine products in place of cuttle fish in order to improve the balance of international payments.

② The country has sufficient suitable land and water necessary for aquaculture, and has abundant stocks of unused resources for feed, such as sardine and mackerel.

③ As the country's citizens are inclined to favour a fish diet. For that reason, there is a promising demand for fish to be cultured in this project.

As a result of the field survey, the discussions with the authorities concerned and the investigation of fisheries and aquaculture conditions, it was concluded that aquaculture techniques are still mainly at the research level. For improvements in seed production and culture practice techniques, and for personnel training and the research and development necessary for the promotion of aquaculture, the construction of the aquaculture research center was considered to be most effective.

The center will perform the following functions:

① Research and development of seed production and culture techniques toward commercialized prawn aquaculture.

② Basic research and development of seed production and culture techniques for cuttle fish and other fishes.

③ Training of aquaculture researchers and technicians.

④ Expansion of aquacultural techniques.

The facilities required for the above-mentioned project consist of administration, research, seed production, middle breeding & culture, and training sections. Taking into consideration the necessary conditions that they should be adaptable to local weather and climate and must be energy saving, functional and easy to use, there will be two main buildings; one gathering administration, R & D, and training sections, the other for seed production and open air culturing ponds.

The general outline of the facilities and their scale are as follows:

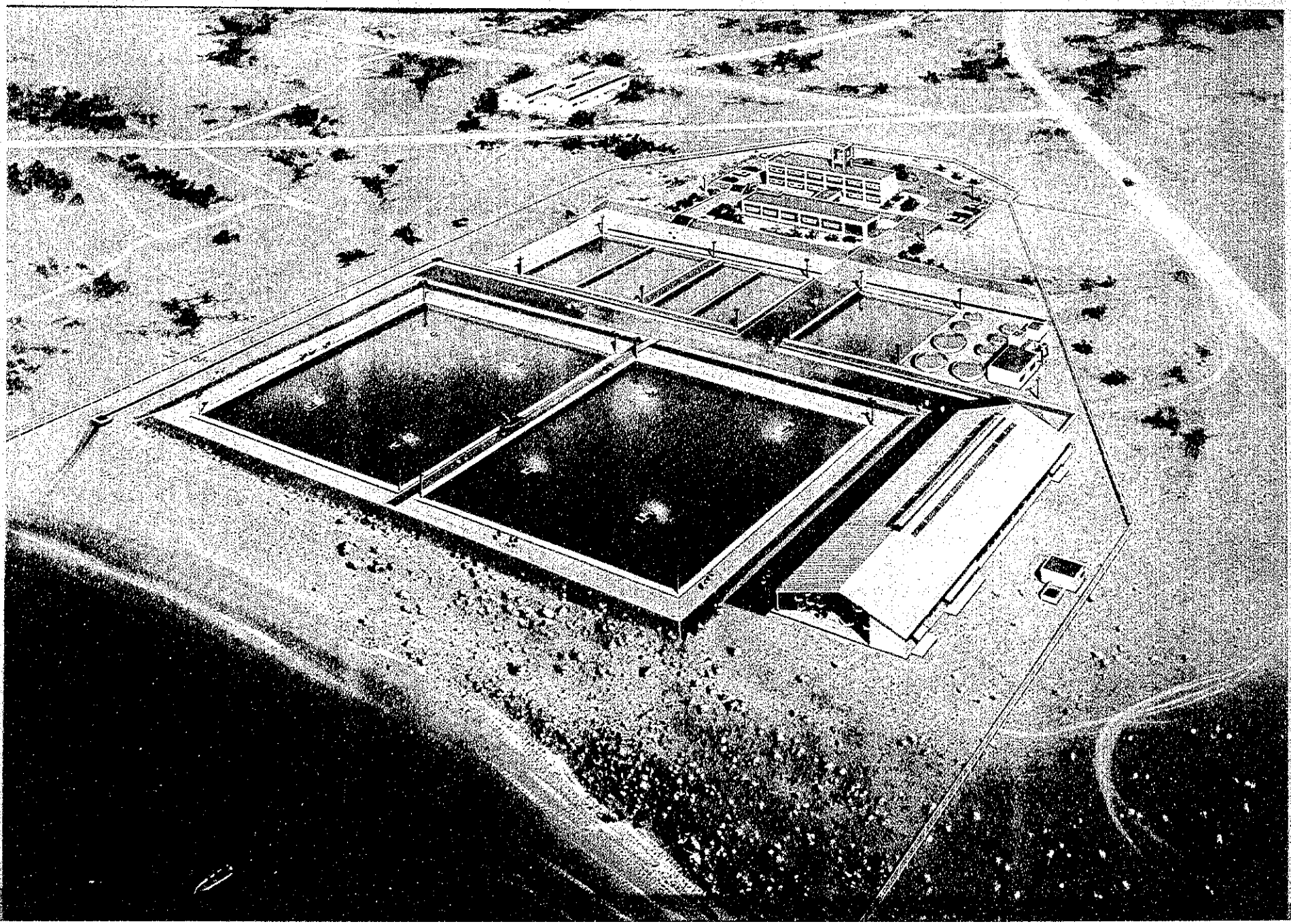
Administration & research building		
Administration section	Director's room, assistant-director's room, administration office, etc.	75 m^2
Training section	Dining room, conference room, trainees' lodging, etc.	140 m^2
R & D section	Researchers' room, dry laboratory, laboratory, archive, etc.	243 m^2
Others	Covered walk, lavatory, garage, porch, etc.	365 m^2
Total		823 m^2
Seed production building		
Production section	Seed production room, feed preparation room, constant temperature laboratory, cold storage, etc.	990 m^2
Others	Workshop, storage, etc.	130 m^2
Total		1,120 m^2
Machine room	Power generator room, blower room, etc.	100 m^2
Machine room	Pump room	24 m^2
Grand Total		2067 m^2
Outdoor culture pond		6800 m^2

The planned site for the project is located in Little Aden district, 20 km southwest from Aden, and facing coast adjoining the Little Aden bathing beach. Its area is about 3 ha. In some area of coastline rock-base is exposed, but its major part is covered by rough grain sand. So the coast is gently undulated sand beach. There is the hospital of the Yemen Oil Refinery at 500 m far from the planned site.

The period necessary for the construction is estimated as follows: Starting from the completion of the Exchange of Notes between both governments, 2.7 months are required for the detailed design. 2.3 months for bidding and contract, 3 months for procurement and transport, and 9 months for construction works total 17 months. The supervising authority of this project is the Ministry of Fish Wealth. The center will be an institute under the direct control of the Ministry after completion. The personnel of the center will be 37 and 151,000 YD are estimated as annual administration and operation cost.

As the Ministry of Fish Wealth showed zeal for the aquaculture and positions, this project also for the man power development as one of the national project, if the technical problem for the aquaculture is resolved, the commercialization of aquaculture in the future will be fairly promising. If such technical problems are solved by the construction of the center and the culture engineers are trained as the country's authority desires, the center should be considered as nucleus for commercial aquaculture enterprises in the future, with consequent benefits to the fisheries and general economy of the country. Therefore, it is concluded that the present project is fully appropriate for the grant aid of the Government of Japan.

COMPLETION MODEL OF THE AQUACULTURE RESEARCH CENTER



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CHAPTER 1 INTRODUCTION

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The People's Democratic Republic of Yemen (hereinafter referred to as PDRY) has no particular resource other than fish wealth. There is little room for agricultural growth because of its desert climate. Moreover, the oil refineries which constitute the biggest manufacturing industry of the country have seen a lower operation rate due to the diminution of oil consumption, the wearing out of facilities and the construction of refining facilities in neighboring oil producing countries. For that reason, the finances which support the country's economy are the income from the ships entering and departing into/from Aden port, the remittance from nationals working abroad, and aid from foreign countries and international organizations.

The fisheries were once an important foreign currency obtaining industry. The main fish export is the common cuttle fish, but its catches vary from time to time and amounts are decreasing from year to year. To cope with this adverse condition, the government introduced a policy for promoting and developing fisheries. In this policy, the establishment of the fisheries personal development center, the consolidation of the infrastructure, the assistance to the fisheries cooperative for the promotion of coastal fisheries, and the building of new fishing boats for the establishment of public corporation fisheries are planned.

The country is also deeply interested in aquaculture and has performed a small sized aquaculture experiment with the technical assistance of a Japanese private company has achieved some successful results in the seed production and breeding of prawns, cuttle fish, etc. Basic techniques for prawn seed production, small size breeding techniques for rearing up to commercial size, and the small size technique for natural seed taking, artificial seed taking, hatching and breeding of cuttle fish have been acquired.

On the basis of the experience obtained from the above-mentioned aquaculture experiment, the country has planned to culture high class fish like prawns for export, to implement research and development of the cuttle fish seed production and culture, to set up mullet and rabbit fish cultures in the coastal zones for the purpose of supplying animal protein to the population.

To attain this objective, aquaculture techniques must be improved and ideas disseminated throughout the country. The Aquaculture Research Center as an organization will play three roles in the aquaculture field; "Research and development", "Personnel training" and "Propagation of knowledge".

In concrete terms, the following are considered necessary for the project. Seed production and breeding techniques for aquaculture, biological and ecological research, investigation of the eating habits of fish, improvement of breed, design for optimal feed blend, countermeasures to fish diseases, the collection of culture related information, etc. The country projected the construction of the Aquaculture Research Center in Aden for the above-mentioned production, research, investigation and experiment, and the personnel training and the propagation of technical know-how.
For this scheme, the authorities have called on the Japanese Government to accord grant aid.

In response to the request, the Japanese Government, through the Japan International Cooperation Agency (JICA), sent a basic study team to the PDRY, headed by Dr. Yoshinori Ogawa, Director of Aquaculture Division for the Nansei Regional Fisheries Research Laboratory, Fisheries Agency, from June 26 to July 20, 1985.

The team had discussions on the Project with the officials concerned of the Government of the People's Democratic Republic of Yemen and conducted a field survey in Al Marsa, Aden. After the team returned to Japan, further studies were made and the present Report has been prepared.

The conclusions of the discussion and survey were that the promotion of aquaculture is an urgent necessity if the country is to realize its objectives. The production of exportable fisheries products to obtain foreign currencies is vital as the improvement of the national nutritive level through increasing the fish supply as animal protein. It was agreed mutually that the construction of the Aquaculture Research Center is necessary for these aims.

The the study team members are as follows, and its schedule, the members list of meeting, the minutes of discussion are appended.

Leader	Yoshinori Ogawa	Director of Aquaculture Division, for the Nansei Regional Fisheries Research Laboratory, Fisheries Agency
Planning, administ-ration	Hirotsugu Yoshitake	Grant aid cooperation project investigation department, Japan International Cooperation Agency (JICA)
Aqua-culture development project	Tatsuo Yoshimatsu	Nichiro Gyogyo Kaisha, Ltd.
Const-ruction & facilities	Yuji Koh	Nichiro Gyogyo Kaisha, Ltd.
Water works & public works	Shoichi Nakamoto	Nichiro Gyogyo Kaisha, Ltd.
Seed production	Noritada Endo	Nichiro Gyogyo Kaisha, Ltd.

CHAPTER 2 BACKGROUND OF THE PROJECT

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2-1 Outline of the country

(1) General Situation

The People's Democratic Republic of Yemen (PDRY) is located on the southern end of the Arabian peninsula and is bordered by Saudi Arabia, Oman and North Yemen. The area of the country is 333,000km^2 and the total population of this country is 2,100,000 (1983, Statistics of the International Bank for Reconstruction and Development). The country is in the typical Desert Zone, which means high temperature and dryness.

After Turkey had captured Aden in 1538, the country came under the rule of the Ottoman Empire. The United Kingdom captured Aden in 1839 and the country then came under the direct colonial rule of the United Kingdom. Aden prospered as a relay point in the Far East policy of the United Kingdom.

In 1967 the country became independent of the U.K. as the People's Republic of South Yemen and the government began socialist oriented policies. In November 1970, the country changed the name of state to the People's Democratic Republic of Yemen. The country, following the pro-Soviet line, keeps close ties with the Soviet Union and Eastern European countries in both the political and military spheres. On the other hand, it seeks to improve the relations with Western European countries and neighbouring Arabic countries and is active in introducing their capital and technology.

The capital of the PDRY is Aden. Its port has prospered since older times as a free port which is situated on the relay point of the trade line from Europe to India and the Far East. But because of the closing of the Suez canal which was due to the third war of the Middle East, the uncertainty over the shipping of oil, the superior resources and expansion of neighbouring ports and the advent of large-sized ships which can navigate overlong distances without refueling, all these factors have led to a decrease in the number of ships calling at Aden. So Aden is not as prosperous as it once was.

In the last years, as the increase of oil import for energy source impose a burden on the country's economy, the country makes effort to develop the petroleum and mine industry, as well as is promoting the fisheries aiming to increase foreign currencies income. those development and promotion policies are much expected.

(2) The economic conditions

The sources of foreign currencies in the PDRY are the oil refinary in Aden, the port of Aden, and the fisheries. Other sources are negligible. The capacity for the oil refinary of Aden is 170,000 B/D, but it was running at a loss in 1982 and 1983, and marked a deficit of 6 million dollars at the end of both years, so attempts are being made to get into the black by improvement of facilities. Although the port of Aden was once the fourth ranking refueling port in the world, the closing of Suez canal from 1967 to 1976 isolated the area from sea traffic and after the reopening of the canal, because of the better facilities and the expansion of the neighbouring ports and the improvements in the navigation of large-sized liners, the number of the ships calling at Aden was reduced to a third of the figure for 1966, the period of highest prosperity. Reserves of bottom fishes such as common cuttle fish and lobster decreased. Consequently, the products of the oil refinary in Aden now make up 90% of the total exports of the PDRY.

The deficit trade balance reached 7.7 hundred million dollars in 1984, however, private remittance from Yemenite who were working in neighbouring Arab countries was 4.7 hundred million dollars, public donations amounted to 0.8 hundred million dollars and loans totalled 1.7 hundred million dollars. So the total balance of the international income and expenditure showed a deficit of 50 million dollars.

Table 1 Balance of International Payments of the PDRY

Unit: Million $

Year	Import	Export	Trade balance	Invisible trade balance	Balance of payments
1979	430.5	38.8	-391.7	460.1	68.4
1980	669.9	59.6	-610.3	672.0	61.7
1981	781.7	48.6	-733.1	773.9	40.8
1982	747.3	37.9	-709.4	719.2	9.8
1983	769.0	40.0	-729.0	740.8	11.8
1984	808.6	42.0	-766.6	720.4	-46.2

Table 2 Details of Invisible Trade Balance

Unit: Million $

Item	1979	1980	1981	1982	1983	1984
Service	24.1	49.5	51.2	43.1	21.7	29.6
Private transfers	313.6	348.6	409.4	467.3	468.7	468.7
Grants	29.2	78.2	119.0	125.7	52.7	75.6
Drawings on loans	68.0	95.0	180.1	187.9	172.8	174.3
Repayments of loans	-4.6	-9.3	-4.3	-10.7	-13.3	-27.8
Private capital and errors and omissions	29.8	110.0	18.5	-94.1	38.2	-
Total	460.1	672.0	773.9	719.2	740.8	720.4

Economic development of the country depends mainly on the increase of exports by the promotion of the fisheries, and the exploitation of oil field and the mines, and the acquisition of as much economical and technical aid.

(3) The economic and social development project

① The second five year plan (1981 - 1985)

The objects of this plan are as follows:

a. Fullfilment of the fundamental national needs such as need for food, consumer products, housing, employment, medical treatments and so on.

b. Improvement in the productivity of the industry and agriculture.

c. Consolidation of infrastructure.

d. Development of mineral resources.

e. Raising of educational and technical levels.

f. Increase in export of home products.

The total investment for the second five year plan is about 15 billion (about twice that of the actual investment of for the first five year plan, about 1 billion dollars of which is going to be supplied by foreign countries). And the distribution of the investment is as follows: 29 per cent to industry, 17 per cent to agriculture and fisheries, 23 to transport/correspondence and construction, and 31 per cent to the others. The plan was an ambitious one which was initiated with 10 per cent of growth rate of GNP during this plan period but is far short of its goal because of 1 billion dollars in red due to the big flood in 1982.

② The third five year plan (1986 - 1990)

The plan which is being drawn now will be defined at the third conference of the Yemen Socialist Party in October this year. The outline of this program is as follows:

In this plan, ideal development of fish wealth was ranked as the second, next to the development of oil and mineral resources, and the target of supplying agricultural products to meet the national needs was ranked as the third. The total investment of the third five year plan 1986 - 1990 is estimated to be 2 billion dollars. However, there is a big problem of how such a large amount could be financed.

2-2 Fisheries Situation

2-2-1 Fishing Situation

The fisheries which had once occupied approximately 10 percent of GDP and 50% of total exports of that country showed its decline, down to about 3 per cent of GDP and 16% of total exports in 1981. The coastline stretches for 1,500km and the continental shelf at a depth of less than 200m below sea level covers an area of 22,000km^2.

Strong seasonal winds blowing near the coast produce the surface current from northwest which increases its intensity for the period from spring to autumn (*1).

Note (*1) The wind is named by the direction from which it blows, and the current by the direction to which it goes. Southwest wind prevails in the monsoon of the PDRY and the surface current caused by the wind runs to the northwest.

The current induces a water circulation from the seabed, which brings up nutritious salts, particularly phosphate, to the surface and makes that area a good fishing place.

The coastal waters of the country are habitats of ordinary southern bottom fishes (sea bream, grouper,etc), large pelagic fishes (tuna, swordfish, bonito, etc.), and shallow water fish (mackerel, sardine, etc.). And it should be noted that the coastal waters from the PDRY to Oman used to be rich in common cuttle fishes and the annual catch of these fishes once amounted to 20,000tons.

The fishery of the PDRY can be divided into three categories according to its form: Category of fishing cooperative, the governmental category, and the category of joint ventures and foreign ships.

(1) The category of fishing cooperative

The category of fishing cooperatives is subdivided into fishing coopera-

tives and private fisheries for the sake of convenience, but they are basically the same. There is no statistics concerning the private fisheries before 1979 and the same figures, 15,000tons, are given after 1979. Although there is the item concerning the fishing cooperatives in the statistics of the International Bank for Reconstruction and Development, neither item of private fisheries nor the figure about it can be found.

The catch by the fishing cooperatives dropped from 30,000 tons in 1979 and 1980 to 20,000 tons after 1981 for the following reasons. Since 1979, the fishermen were permitted to sell by themselves up to 40% of their catch through the cooperatives and allowed to set a price maximum 50% higher than the official price. So they have been inclined to put their products directly on the market. The item of "private fisheries" seems to have been introduced for the sake of statistics as it was difficult to make a clear picture of such individual selling.

The small scale coastal fishing of that country is carried by the 5,000 fishermen who live in 40 small fishing villages scattered along the coastline of 1,500km long. The fishermen join the fishing cooperative and can be broken down into three groups according to the size of the boat they use.

The smallest fishing boat, "Houri" is a canoe-shaped boat driven with a sail or an outboard engine. 800 boats of this type exist. Usually two men are on board and catch up to 10 tons per boat a year is possible.

The boat called "Sambuk" comes second in size. There are 200 of this type. The boat is equipped with an outboard engine of 6-10hp and catch about 20tons per boat a year with 3 or 4 crews on board.

The largest traditional fishing boat, "Sambuk" which numbers around 100 is 15 meters long and is driven by an inboard diesel engine of maximum 45hp. A maximum of 12 crewmenboat can be on board and some boats of this type catch 100tons per boat a year.

These boats are all made of wood, but the expense of building and mending

of the boats recently became very high because the price of imported wood has risen suddenly. The local wood material which is used for a framework is scarce, and the skillful carpenters in the PDRY are classified in the highest wage group.

The fishermen in coastal regions join fishing cooperative and their fishing boats are owned by the cooperative. The fishermen who uses the boat must pay fees for the following items at a certain percentage of his catch: 10 per cent as fuel expense, 15 per cent as repayment and maintenance expense, and 10 per cent as tax and levy.

All the captured fish used to be sold through the cooperative before, and the income of fishermen was suppressed because the official price of fish was low. So an increasing number of fishermen stopped fishing to get a higher and more stable reward.

To solve this problem the government decided to allow the cooperative to sell 40% of the catch directly in the market and to set a price maximum 50% higher than the official price. So an increasing number of people are now coming back to the cooperative.

(2) The governmental category

The governmental category means the fishery in industrial scale whose history is relatively short only starting early in the 1970's. It comprises four public corporations: Yemen Fishing Corporation (YFC), Coastal Fishing Corporation, Yemen Fish Meal Company, Marine Product Distribution Corporation. YFC catches seabed fishes, cuttle fishes, lobster and prawn by trawling. Coastal Fishing Corporation catches pelagic fish, lobster, prawn, etc., with round haul net,.small trawl net, and gill net. Yemen Fish Meal Company had once produced 500tons of meal a day in a factory ship, but the company sold the ship to a foreign country because of short supply of material.

The Ministry of Fish Wealth acquired fishing boats of 200 and 2,000 gross

tonnage from foreign countries. The country possessed 24 ships at the time of the basic design study. 14 boats belong to Yemen Fishing Corporation (YFC), 4 to Coastal Fishing Corporation, and 6 to Yemen Fish Meal Corporation.

The country's fishing industry suffers low operation rate of fishing boats because of non-existence of mending facilities for large-sized boats and shortage of fishery engineers. Under such circumstances, the country tries to solve the problems by construction of floating dock and mending shop in the framework of the Aden Fishing Harbour Project of the Fisheries Development Project, and of fisheries personal development center of the Fisheries Project.

(3) The category of Joint Venture and Foreign Ships

In regard to the category of Joint Venture and Foreign Ships, a joint venture with the Soviet Union for catching seabed fishes, cuttle fishes, lobster, prawn, etc., by trawling continues to operate since 1971. Actually 26 Soviet boats are operating on fishing fee.

(4) The problems of Fishery Education and Training

Since 1979, the number of officials in the Ministry of Fish Wealth has increased from 300 to 3,500, and is expected to be 4,600 at the end of 1985. In order to strengthen the supervisions on the expanded activities of the Ministry, the post of Second Deputy Minister was established in 1980.

17% of the officials of the Ministry are engineers and specialists: 23% of officials work in administrative posts, and the remaining 60% are semi-skilled or unskilled workers. The problem of the officials is that there is only a small number of staff who are suited to the position requiring engineering skills because of a lack of education and training, as is mentioned later. The country is still dependent on foreign specialists mainly from the Soviet Union and Japan.

There are, for example, many crewmen who have not even the minimum requirements for the job such as the certification of captain or qualification

Catch by sector and fish species is given in Table 4.

Table 3 Catch by sector and fish species

unit:ton

Year	Class	Pelagic fish	Bottom fish	Cuttle fish	Lobster	Prawn	Others	Total
1980	Government	8,772	1,167	2,106	338	19	81	12,433
	Fishing cooperative	34,872	-	-	-	-	-	34,872
	Private fisheries	15,000	-	-	-	-	-	15,000
	Joint, foreign vessel	-	19,149	7,513	426	40	251	27,379
	Total	58,594	20,316	9,619	764	59	332	89,684
1981	Government	8,377	1,693	804	355	11	66	11,306
	Fishing cooperative	21,596	-	-	-	-	-	21,596
	Private fisheries	15,000	-	-	-	-	-	15,000
	Joint, foreign vessel	-	27,281	2,173	496	122	-	30,072
	Total	44,973	28,974	2,977	851	133	66	77,974
1982	Government	378	2,792	1,467	183	12	10	4,842
	Fishing cooperative	20,424	-	47	-	-	-	20,471
	Private fisheries	15,000	-	-	-	-	-	15,000
	Joint, foreign vessel	-	27,549	1,372	121	376	-	29,418
	Total	35,802	30,341	2,839	351	388	10	69,731

1983	Government	209	3,720	1,030	317	188	21	5,485
	Fishing cooperative	21,071	-	-	83	-	-	21,154
	Private fisheries	15,000	-	-	-	-	-	15,000
	Joint, foreign vessel	-	31,156	597	234	497	-	32,485
	Total	36,280	34,876	1,627	634	686	21	74,124
1984	Government	665	3,730	1,788	371	7	22	6,583
	Fishing cooperative	22,627	-	-	139	-	-	22,766
	Private fisheries	14,960	-	-	40	-	-	15,000
	Joint, Foreign	-	37,253	2,048	119	358	-	39,778
	Total	38,252	40,983	3,836	669	365	22	84,127

for chief engineer. Unless the country makes constant efforts to increase qualified engineers, there is the possibility that it cannot use effectively a lot of facilities and equipments received from abroad as aid.

Fishing skill training on a high level is not available in the PDRY. So a small number of people are studying in foreign countries through binational or multinational aid programs. About 70% of Yemenites are now given grants to learn on a level of higher education mainly in the Soviet Union.

The Fisheries Training Center which is on a level of secondary education was founded in Aden in 1970 with the help of the Soviet Union. The Center started with a 2 year curriculum, but the learning period was extended to 4 years in 1980 and further extended to 5 years in 1982. The subjects to be taught in the Center are navigation, ocean fishing, processingof marine products, engine for ships, electrical engineering, freezing, and fishing economy. However, the courses do not go satisfactorily because of the shortage of teachers, accomodations, educational facilities, etc.

Considering this state of affairs in the Fisheries Project in the Fishery Development Project of the country, the construction of the Fisheries Manpower Development Center (see the details on the page) with the aids of IDA, IFAD, EEC and FAO, will be taking place from 1986 onward in order to prepare engineers.

The programs of the Fisheries Manpower Development Center are as follows: The trainees shall be graduates (or students) from the 8 year's Unity School, and learn about navigation, fishing, ship engineering, manufacturing, and merchandise distribution in 5 years. In the first and second grades they learn general subjects such as Arabic, English, mathematics, physics and chemistry. In the third, fourth, and fifth grades they learn their own specialities. The students coming from their own house will receive 11.5YD a month as scholarship and the boarding students 16.5YD a month.

For the officials now in post, the following kinds of trainings are available:

① 1 - 6 months training course. After the training, the officials are able to be appointed to higher posts.

② 3 - 6 months training course. It aims to develop the skills to increase productivity at workplace.

③ 1 - 3 months training course. It is the education on stock keeping, sales, marketing, etc.

In addition to this, the practical activity center will be established in Aden, Mukalla and Muhayfif, where fishing is actively made. This is called the Fishing Extention Service. The objectives of the service will be teaching about the method and practice of how to mend and maintain fishing boats or engines, and how to handle marine products.

2-2-2 Fish Wealth

(1) Bottom fishes and pelagic fish

A survey ship, "Dr. Fridtjob Nansen" of Norway's Bergen Ocean Research Institute conducted a fish stock survey, using a scientific fish-finder in 1975 and 1976. And according to the results, the fish wealth in the sea of the PDRY can be estimated at 313,000tons at maximum and 215,000 at minimum. The catchable stock is equally estimated from 215,000tons to 125,000tons. The Institute advised that the lower number is preferable to be considered in the Fishery Development Project.

The government of the PDRY estimates the amount of the fishwealth in the mainland offshore and near Socotra island as follows:

Unit: thousand tons

Sea Zone	Bottom Fish		Floating Fish	
	Stock	Catchable stock	Stock	Catchable stock
Mainland offshore	164-238	34-42	376-495	132-173
Near Socotra Is.	55-116	10-20	112-224	39- 78
Total	219-354	44-62	488-719	171-251

The Norwegian survey ship, "Dr. Fridtjof Nansen" performed a stock survey of the coastal zone of the PDRY, using a scientific fish-finder and trawl in the period from February to March and from August to September, 1984. The following results were obtained.

* Up welling current is remarkable to the east of 47°30 east longitude, but it is seldom seen to the west.
* The estimated stock of the small pelagic fishes is 125,000 tons near the coast, 140,000tons offshore, and 265,000tons in total.

(2) Cuttle fishes Resources

A Japanese private company and Tokyo University Ocean Research Institute has been conducting a joint study about cuttle fishes resources since 1972. The summary of the observation on cuttle fishes in the 1983 fiscal year (submitted to the Ministry of Fish Wealth of the country on July 5, 1984) is as follows:

The boats which caught cuttle fish in the coastal area in 1983 are fifteen 650tons-type trawlers, one 1,500 tons type trawler, and one 150tons type trawler, adding up to 17 ships in total.

The catch of cuttle fishes in 1983 was 1.157 tons, and CPUE (real catch/catching labour) reduced notably to 2.5 tons as compared with 3.4tons in 1982 and 6.6tons in 1981.

The team analized the drop of CPUE and gave the following recommendation.

* The catching labour is too great comparing to the resources
* Judging from the fish body, there are only a small number of spawn-laying groups. Therefore, the country could not expect a significant increase of the stock in 1984.
* Consequently, unless the country further reduces catching labour, sets fishing period, and protects spawn laying places, the reduction of the stock will continue. The government should set a strong control over fishing to re-create the resources.

2-2-3 Aquaculture situation

The aquaculture of the PDRY has been carried out in the aquaculture laboratory and the aquaculture experiment station which is succession of the first, and Japanese private enterprises have been according technical assistance. The history and summary of the aquaculture in the country is as follows:

Year	Item of aquaculture experiment
Japanese assistance	
8 - 10, 1977	Field survey for investigating the possibility of prawn aquaculture
5, 1978	Construction of prawn aquaculture laboraroty (Slave Island)
5 - 10,	Experiment of stocking water with cuttle fish
10 - 11,	Distribution survey and catch of natural adult prawn
1 - 3, 1979	Success in production of prawn seeds
8 - ,	Stocking water with prawn (Penaeus, semisulcatas)
	Catch of seed and breeding experiment of cuttle fish
	Production of blue crab seeds
9, 1980	Starting works of aquaculture experiment station (Little Aden, North Coast of Farisi Creak)
12 -	Completion of aquaculture experiment station
2 - , 1981	Breeding experiment of prawn (Penaeus, semisulcatas) in open pond
	Breeding experiment of prawn (Penaeus, indicus) in open pond
8 - ,	Culture experiment of feed plankton,
	Development survey of new fishing ground for getting adult prawn
12, 1981	Establishment of the system for getting small fishes for feed
Enforcement in the PDRY	
2, 1982	Production of prawn (Penaeus semisulcatas) seeds
3,	Stocking water with 50,000 young prawns
7,	Improvement of the open experiment pond
8,	Catch of natural seeds of prawn (Penaeus indicus) and their breeding to commercial size in the open pond

2 - 4, 1983	Success in production of prawn (Penaeus indicus)seeds
5 - 6,	Survey of adult prawn fishing ground with JICA training vessel
8 - 11,	Experiment of cuttle fish seed collection and young fish and seed production
1 - , 1984	Experiment of prawn in open pond. Survey on injurious fishes.
	Experiment of transportation of live adult prawn.
10 - ,	Catch of natural seeds of mullet and milkfish
	Mixing nutrition of mullet and milkfish in open pond
1 - , 1985	Successive breeding experiment of Penaeus semisulcatas and Penaeus indicus.
	Successive breeding experiment of mullet and milkfish

Outline of the Aquaculture Experiment Station

(Please refer to photo behind the cover.)

① Place: on the north shore of Farisi inlet in Little Aden

② Installations:

A. Prawn culture pond	1	1,000m^2 (40m x 25m)
B. Floodgate	1	1m wide x 1.2m high x 0.1m thick
C. Pump	2	2.2kw x 2 sets (150 - 200L/minute)
D. Water Filtering System	1	filtering tank x 2 storage tank x1
E. Growing-up tank	1 unit	Various tanks in round and square shape
F. Water supply system	1 unit	VP50mm Ø , VU50mm Ø , VU50mm Ø ,

2-2-4 Processing, distribution and trade situation

YFC in the governmental category catches bottom fishes, common cuttle fish , and lobster which are mainly for exportation and sells them to the Marine Products Distribution Corporation. CFC catches horse mackerel, sardine, lobster, prawn, etc., and sells horse mackerel and sardine to tinning works and prawn and lobster to the Marine Products Distribution Corporation.

The fishing cooperative catches fishes mainly by gill net, and sells them for domestic consumption, in the state of fresh fish and processed products such as salted fish, salted dry fish, and smoked fish. Shark fin, trepang, and lobster are exported through the Marine Product Distribution Corporation. The corporation keeps 40-55% of selling price as its selling expenditure.

Out of the catch by the joint venture, a part of fishes are sold to tinning works and the domestic market, and cuttle fishes, deep sea lobster, and prawn are sold to Singapore, etc. The catch from the category of foreign ships (only the Soviet Union), paying fishing fee, is supplied partially to tinning works and the domestic market and the remaining is exported.

The fish processing in the country consists of traditional methods such as dried shark fin, dried trepang, dry fish, salted dry fish, and salted fish, and modern methods such as freezing and tinning. The whole capacity of cold storage of the country is: 2470 tons cold storing and 67 tons freezing per day, and 60 tons ice making per day. There are two tinning works, having a capacity of 13,400,000 cans per year.

In regard to the distribution of the marine products, a part of the catch is sold directly by public corporation, fishing cooperatives, and fishermen, but the major port is sold to the Marine Product Distribution Corporation which freezes it for selling in the domestic market or ships it for export. The Marine Product Distribution Corporation is also dealing the export of the catch by joint venture.

Table 4 Price of marine products

Unit: fils = 1/1000YD

Class	Fishing cooperatives to Distribution corporation	Fishing corporation to Distribution corporation	Distribution corporation to Consumer	Fishing cooperatives to Consumer
super	400 fils/kg	480 fils/kg	600 fils/kg	750 fils/kg
first	300	480	500	675
second	250	320	400	570
third	50	-	200	270

(1 US$ = 0.342YD)

(Notes)

1. There are four Soviet vessels. They are fishing on conditions that a catch from one vessel out of those four should be totally supplied to the PDRY, and also catches of common cuttle fish from all the four vessels should be supplied to the PDRY.

2. Dry fish means a kind of processing method practiced in the regions where no freezing facility exists and are located far from the market such as Socotra and Mahara Province. Sharks, Spanish mackerel, sardine, etc. are processed in this way. Fishes caught are arranged on the coast, salted at ordinary temperature for 3 or 4 days, then water washed, and dried at sunlight for 1 to 60 days.

3. Smoked fish is made by boiling fish of less fat like tuna and drying it at sunlight.

Amount of export and price according to species

Species	1980		1981		1982		1983		1984	
	amount	price	amount	price	amount	price	amount	price	amount	price
	(M/T)	$1,000	(M/T)	$1,000	(M/T)	$1,000	(M/T)	$1,000	(M/T)	$1,000
Cuttle Fish	4,224	11,072	1,523	3,416	1,855	4,310	1,397	3,189	2,859	5,975
Deepsea Lobster	142	1,300	207	1,689	46	369	81	698	32	276
Rock Lobster	75	871	38	490	60	925	116	1,908	108	1,722
Red Shrimp			87	130	242	374	346	401	301	336
White Shrimp							118	395	72	558
Shark Fin	80	836	73	919	104	1,479	54	603	32	350
Fish Meal	800	278	1,121	471						
Others	1,408	3,715	40	879	1,674	710	733	315	1,436	553
Total	6,729	18,072	3,809	7,994	3,981	8,167	2,845	7,509	4,840	9,770

(by the Ministry of Fish Wealth)

2-3 Outline of related plans

(1) Fishery Administration

The main supervising authority of fishery in the PDRY is the Ministry of Fish Wealth. Public Corporation for Fish Wealth is founded in 1970 had been taking charge of fishing administration but advanced to the Ministry in 1977.

(2) Fishery Development Project

The three year plan (1971 - 73) and the five year plan of the Fishery Development Project, which is a part of the economic development plan of this country, emphasized on the hardware section such as fishing port, freezing facilities and cold storage, fish meal plant, and fishing boats (*2). However, such hardware did not show the results as expected because of shortage in software section. Reconsidering the fact, the government made the following priority order in the second five year plan (1981 - 1985).

1) Consolidation of infrastructure to encourage fishing industry.
2) Renewal of fishing boats and increasing efficiency in the fishing of public corporations.
3) Improvement of the marine products processing facilities (especially, betterment of the facilities and improvement of the management).
4) Bringing up of the fishing cooperative (especially, enforcement of accounting and management ability).
5) Enrichment of the facilities for distribution (especially, of software).
6) Preparing fishing ports.

The details of the third 5 year plan has not been finally decided yet, but the total amount of investment is said to be $90,000,000 and the main projects are as follows.

1) Aden Fisheries Harbour Project

With the help of the Soviet Union, the construction is now being made since 1980 and scheduled for completion in 1987. The contents of the project are as follows:

Cold storage	3,000 tons (freezing capacity, 25 tons/day)
Ice making facilities	200 tons (icemaking capacity, 100 tons/day)
Quay	600m
Floating dock	1,500 GT
Maintenance workshop	1
Administration building	1
Office building of the Ministry of Fish Wealth	1
Net mending workshop	1

2) Fisheries 3 Projects

This will be done with the financial supports from IDA, IFAD, EEC and by technical aid of FAO from 1986 to 1988. The total amount of investment will be $240,000,000. And the details will be shown in the next section ((3) Fisheries Projects).

3) The second feasibility study about the privatization of Fish Meal enterprises. As the first attempt failed, the second research is necessary.

4) Development of FRP boat

The fishing boat "Houri" and "Sambuk" which are used in coastal fishing are made of wood. The building expense of these ships is very high because it is hard to get the wooden material and the high wage for ship carpenters. The project is going to make FRP boats in their own land in order to solve the problem.

5) Promotion Program of Coastal Fishing

It aims to develop new fishing tools and methods, and to increase the number of fishermen who live along the coastline.

6) Renovation of existing tinning works.

7) Survey of fish wealth.

(3) Fisheries Project

In the PDRY they are carrying on a fishing development project called "Fisheries Project" as one of fishery development projects.

Fisheries 1: Expending $550,000,000, they built a cold storage of 800tons' capacity in Mukara, and made 100 Sanbuk type fishing boats, and finished in 1978.

Fisheries 2: Expending $5,500,000,000, they built port facilities for many purposes, and finished in 1984.

Fisheries 3: It is to consolidate the building of the Fisheries Manpower Development Center which is to be completed between 1986 and 1988, fishing encouragement project which is to be applied to five fishing villages (*3), and enlargement of the Marine Science and Resource Research Center. They will end in 1987.

Fisheries 4: Starting in 1987, it mainly consists of the plan to apply the fishing encouragement project to another 5 fishing villages, assessment and analysis of fishing resources and construction of 40km of road to connect fishing villages.

Note (*2) The years of 1979 and 1980 are for preparations.

(*3) The Fishery Village Development Project means the plan to develop the four fishing cooperatives including five fishing villages and to make them a commercial enterprise which is wholly independent of NFMC and able to control all its fishing activities in its own right.

2-4 Details and Contents of the Request

2-4-1 Background of the Request

The government of the PDRY has been putting considerable weight on the development of fishing resources in its socio-economic development plan. Out of the floating fishes which are caught, only a small part is supplied fresh as food and the species are mackerels and horse mackerels (big type). Most part of fish is supplied as material for fish meal. On the other hand, bottom fishes such as cuttle fish, lobster, and prawn are important for exportation. As they have been trying to increase such products for exportation as cuttle fish and lobster, the catching amount is becoming small because of the resources problem and the weight of marine products in the whole exportation is becoming less than before.

The main source of protein in the country is fish in the coastal area, and cattle inland. But the enlargement of cattle raising is restricted by the condition of fields and rain, etc. On the contrary, the coastline of the country stretches over 1,500km and offers the vast seaside area which is suitable for fishing and aquaculture.

There is no educational organization about aquaculture nor aquaculture farming. There is only an Aquaculture Experiment Station for Prawn, but its scale is small and there is no educational equipment. Therefore, students have no choice other than going to foreign universities and institutions to study about aquaculture.

These conditions made the country plan to promote the development of fisheries by founding the Aquaculture Research Center,where they try to promote the basic study of fisheries, education and training about fisheries and to propagate the knowledge of aquaculture.

2-4-2 Outline of the Project

(1) Goal of the Project

The purpose of the project is to promote development of fisheries of the PDRY in order to produce marine products for export, to gain foreign currency and to improve the national diet level by increasing domestic supplies of seafood as a source of animal protein.

(2) Objectives of the Project

In order to achieve the above mentioned goal, it is necessary to level up the aquacultural techniques and to spread them in the country. So the country made a conception for the Aquaculture Research Center as an institution in the following three fields of aquaculture:

Research and development
Man power training
Propagation of knowledge

As concrete measures for the above mentioned purposes, production, research,

investigation and experiment in aquaculture should be carried out in the said center. At the same time, the center should meet also the need of personnel training and propagation of techniques. In this way, the country decided a plan for construction of the Aquaculture Research Center in Aden, capital of the country.

2-4-3 Contents of the Request

Basic Design Study		
Request	Contents of Examination	Final Conclusion
13-15 tons FRP research vessel	In order to perform marine transportation of adult fishes, seeds and young fishes caught, trial catch of small fishes in simple marine observation of neighbour waters,etc. Small sized outboard motorboat is indispensable	7-9 m size outboard motorboat with live bait tank and small sized davit
Man made gathering place for fish	Too much cost, difficult evaluation of its effect, location in Mahara Province too far from capital of the country, necessity of heavy machines for establishment, marine information in relation to establishment,etc.	A subject applicable to the man-made fish gathering place in future will be included in the basic ecological research of the center.
Cuttle fish seeds, 1,000,000	Basic techniques is not established, but the basic research is necessary for the resource culture in future	For basic culture experiment research, production of 50,000 seeds.
Tilapia seeds 100,000	There is no water surface suitable for the stable fresh water aquaculture in the suburbs of Aden and the inland vases.	Seawater aquaculture experiment of small-scale cultural seeds
Mullet seeds 100,000	Natural seeds exist abundantly	production Production of 10,000 seeds and commercial aquaculture

Prawn seeds 1,000,000	The basic technology has generally been transferred.	experiment As requested
Prawn products 300,000	The aquaculture techniques for prawn products (commercial size) and commercializing training are not yet determined.	small-scale industrial experiment, aquaculture in-service training, 40,000

CHAPTER 3 CONTENTS OF THE PROJECT

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3-1 Objectives

Fishery is the main industry of the People's Democratic Republic of Yemen. It has once occupied about 10 percent of GDP and more than 50 percent of its export amount. Before, its main exporting fish was cuttle fish, but due to the stock problem, the country is expecting the prawn aquaculture as another means of support.

The fish diet of the people in this country is approx. 20 kg/person.year which is twice the world average. In the coastal sea of the PDRY, small fish such as sardines is living but the people traditionally seem to prefer larger sized fish to small species. Because of this, the authorities concerned are thinking about expanding aquaculture for the inland, using these small species as feed.

Thus the Government expects to expand aquaculture for export and also for inland. However, there is no aquaculture enterprise nor facilities for teaching or training in the PDRY. The reality is that there are only a few people who learn aquaculture techniques from the few prawn aquaculture experiment centers or by studying in France, U.K. or USSR.

From the current situation, the Government has thought of the urgent needs of "Research & Development", "Personnel Training", and "Propagation of Aquaculture Techniques" concerning the aquaculture for the inland of the PDRY. Thus, it has planned to build the Aquaculture Research Center and requested the Japanese Government to accord a grant aid.

3-2 Examination of contents of the request

The Basic Design Study Team has confirmed the needs of development of aquaculture enterprise in the People's Democratic Republic of Yemen for the following reasons as a result of investigation on the current situation of the country's fishery and aquaculture.

① Research and development of seed production and culture techniques for commercialized prawn aquaculture.

② The country has sufficient suitable land and water necessary for aquaculture, and has abundant stocks of unused resources for feed, such as sardine and mackerel.

③ As the country's citizines are inclined to favour a fish diet.
For that reason, there is a promising demand for fish to be cultured in this project.

It was found out that before the independence of the country, there existed techniques of stocking and breeding fish as an industry but after the independence the technique drained abroad. It is estimated that it is too early to bring in an industrial aquaculture to the country for the time being.

At the shrimp cultivable experiment station, the basic level aquaculture techniques is being transferred by a technical cooperation of a Japanese enterprise and the team has concluded that the country has to start the aquaculture from the level of "Research & Development", "Personnel Training", and "Propagation of Aquaculture Techniques" based on these techniques.

The country has reached the level of self-sufficiency in poultry due to its long tradition of rearing live stocks. As it is possible to apply a part of the ingredients of poultry feeding to the aquaculture feeding, from the activities of the center and its demonstration effects, the team believes that the base for aquaculture development will be established.

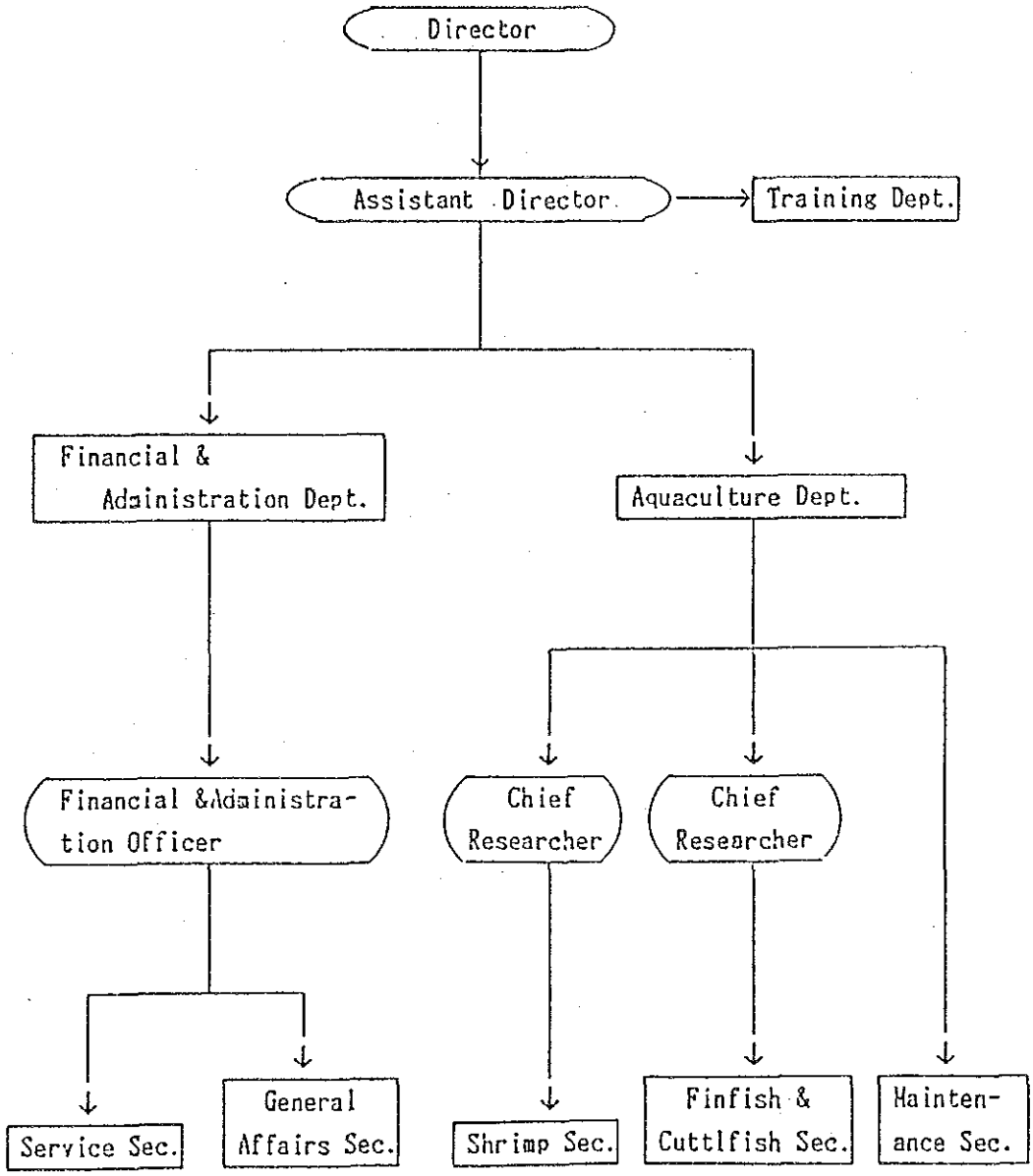
3-3 Executing authority and administrating organization

(1) Administrative and operating system of the project

The administrative and operating organization of the project in the People's Democratic Republic of Yemen is the Ministry of Fish Wealth. The direction of the center will be under the direct control of Mr. Abdul Wahab Sharaf who is the First Deputy Minister for Fish Wealth of the said Ministry.

Thus, the existing shrimp station will be absorbed in this center, and will be abolished.

(2) Organization of the Aquaculture Research Center



CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Design policy

The followings are the basic policy in designing the facilities as well as the materials and equipments of the Aquaculture Research Center for the planned grant aid.

① To examine fully the request made by the PDRY and to make designs suitable for its objective, function and capacity.

② To aim at labor-saving and energy-saving in making designs in order to reduce management and maintenance cost of the Ministry of Fish Wealth.

③ To pay special regard so that the maximum function and capacity can be displayed with the minimum cost.

④ To consider the local laws, customs, conditions of location, weather, etc. in making designs.

4-2 Examination of designing conditions

① Although the PDRY aims at aquaculture enterprises utilizing its vast. coastal area, the present aquacultural techniques are still in an embryonic stage.
The Aquaculture Research Center has three functions of full-scale aquacultural techniques: "Research and development", "Personnel training" and "Propagation of knowledge". The designs should be made on the experimental aquaculture scale serving as a step for commercializing the aquacultural techniques in the future.

② When considering the surrounding construction situation and conditions of location, attention should be paid to arrangement of each facility, reduction of the construction cost as well as the adoption of as simple structure and method as possible.

③ Since the sea is shallow to a good distance from the shore in the bay, water should be taken through pipes, the design shall take tide level and waves into consideration.

④ Sea water supply system should be so designed that both raw sea water and filtered water may be supplied according to the production cycle.

⑤ Judging from the objective and function of the Center, sufficient materials and equipments necessary for "Research and development", "Personal training" and "Propagation of knowledge" for the aquacultural techniques should be chosen.

4-3 Operation plan

The center will serve as basic facilities for development of the aquaculture enterprises in the PDRY. The plan was made, setting "Research and development", "Personnel training" and "Propagation of knowledge" as its basic objectives. The scope of operations in the center is as follows:

① Development of seed production techniques
② Development of aquacultural techniques for growing fish to the marketable size
③ Development of aquaculture feed
④ Ecological and economic survey concerning aquaculture
⑤ Training of aquaculture engineers
⑥ Propagation of knowledge by offering courses, issuing pamphlets and so on
⑦ Collection and arrangement of documents and information relating to world aquaculture techniques

4-3-1 Seed production, breeding plan

(1) Project making policy

The scale of the Aquaculture Research Center depends not only on seed production but also largely on the culturing plan from seed to adult fish. The present project for seed production and breeding was determined on the experimental aquaculture scale from seed to adult fish on the basis of the field survey and discussions with the PDRY's officials concerned.

① Prawn (Penaeus semisulcatas)

One million seeds will be produced as a minimum unit for the seed production in order to establish basic techniques for mass seed production in the PDRY. A part of these seeds (approx. 130,000) will be cultured in a pilot culture pond by plural methods such as extensive and semi-intensive aquaculture aiming at the production of 40,000 prawns of commercial size. In this way, the optimum aquacultural method in the PDRY will be seeked along with the acquisition of appropriate aquacultural techniques. The remaining 870,000 seeds were used for the intermediary culture and for stocking of the Little Aden Tideland area for experimental purpose.

② Cuttle fish

As the basic aquacultural techniques for this species have not been established yet anywhere in the world. Therefore, 50,000 seeds (one month after hatching) will be produced and will be subject of experimental aquaculture to be carried out in order to make a basic ecological survey.

③ Mullet

Extensive commercial aquaculture experiments will be carried out utilizing natural seeds. The short-term goal will be set at the establishment of domestic animal protein supply system as a remedy with immediate effect, and in the long run the integrated aquaculture system consisting of development and training of artificial seed production techniques will be aimed at.

④ Other fish

Natural adult fish and seeds such as Tilapia, rabbit fish, grouper and milk fish will be collected and aquaculture experiments, artificial seed production, distribution and ecological surveys will be carried out. Aquacultural experiment facilities for prawns, cuttle fish and mullet will be commonly used for these species.

2) Selection of species for aquaculture development

Item	Species for aquaculture					reference
	Cuttle fish	Tilapia	Mullet	Rabbit fish	Grouper	Prawn
Existence of inhabitancy on the spot	◎	×	○	○	○	○
Assuring seeds						
Availability of natural seeds on the spot	◎	X	○	▲	▲	▲
Difficulty of cultured seeds	○	◎	▲	▲	▲	◎
Possibility of securing adult fishes	○	X	○	○	○	◎
Growth						
Commercial size	500g <	500g <	300g <	200g <	500g <	15g <
Culture period to the same as above	6mon.	9mon.	12mon.	18mon.	12mon.	6mon.

Aquacultural techniques						
Existance of aquacultural techniques	▲	X	▲	X	X	○
Cost of equipment Appraisal of cost	○	○	◎	○	○	○
Difficulty of getting feeding	▲	◎	◎	○	○	○
Yield	X	◎	◎	○	○	◎
Distribution Demand						
Distribution form	frozen	fresh frozen	fresh frozen	fresh frozen	fresh frozen	frozen
Market Price	◎	▲	○	▲	▲	◎
Demand	◎	○	◎	○	○	◎
Suitable place for aquaculture	◎	▲	◎	◎	◎	◎
Appraisal (ranking)	2	4	1	3	3	super 1

(3) Fish species for aquaculture

Japanese name	Scientific name	Local name	English name
Kurumaebi Kumaebi Indoebi	 Penaeus. semisulcatas Penaeus. indicus	ZINGA	Prawn. Shrimp
Kohika	Sepia. pharaonis Sepia. sarmgnyi Sepia. prashadi	BINGIZ	Cuttle Fish " "
Bora	Crenimugil. crenilabis Valamugil. seheli	ARABI	Mullet "
Terapia	Oreochromis. niloticus Oreochromis. mossambicus Oreochromis. aureus	TILAPIA	Tilapia " "
Aigo	Siganus. SPP.	ZIZAN	Rabbit Fish
Hata	Epinephelus. SPP.	GARGUR	Grouper
Sabahi	Chanos Chanos	SALMANY	Milk fish

(4) Production scale

Fish species	Seed production	Culture
Prawn	1,000,000	40,000
Cuttle fish	50,000	500
Mullet	10,000	4,000

5) Production Cycle

Species	Months	1	2	3	4	5	6	7	8	9	10	11	12
Prawn	Cultural seeds	→	→								←		
	Middle rearing	→	→	→								←	
	Cultivation	←											→
Cuttle fish	Natural spawning								←			→	
	Young cuttle fish production									←			→
	Cultivation experiment	←											→
Mullet	Natural seeds				←				→				
	Cultivation experiment	←											→

4-3-2 Seed producing and breeding method

(1) Prawn (Penaeus semisulcatas)

① How to collect adult prawns

For the time being, natural adult prawns will be used for prawn aquaculture. However, the basic study will be carried out in order to make it possible to produce seeds from cultured adult prawns on a commercial scale in the future.

A. Natural adult prawn

Experience and surveys from 1977 up to the present show that natural adult prawns can be caught in the waters shown in Fig. 1.

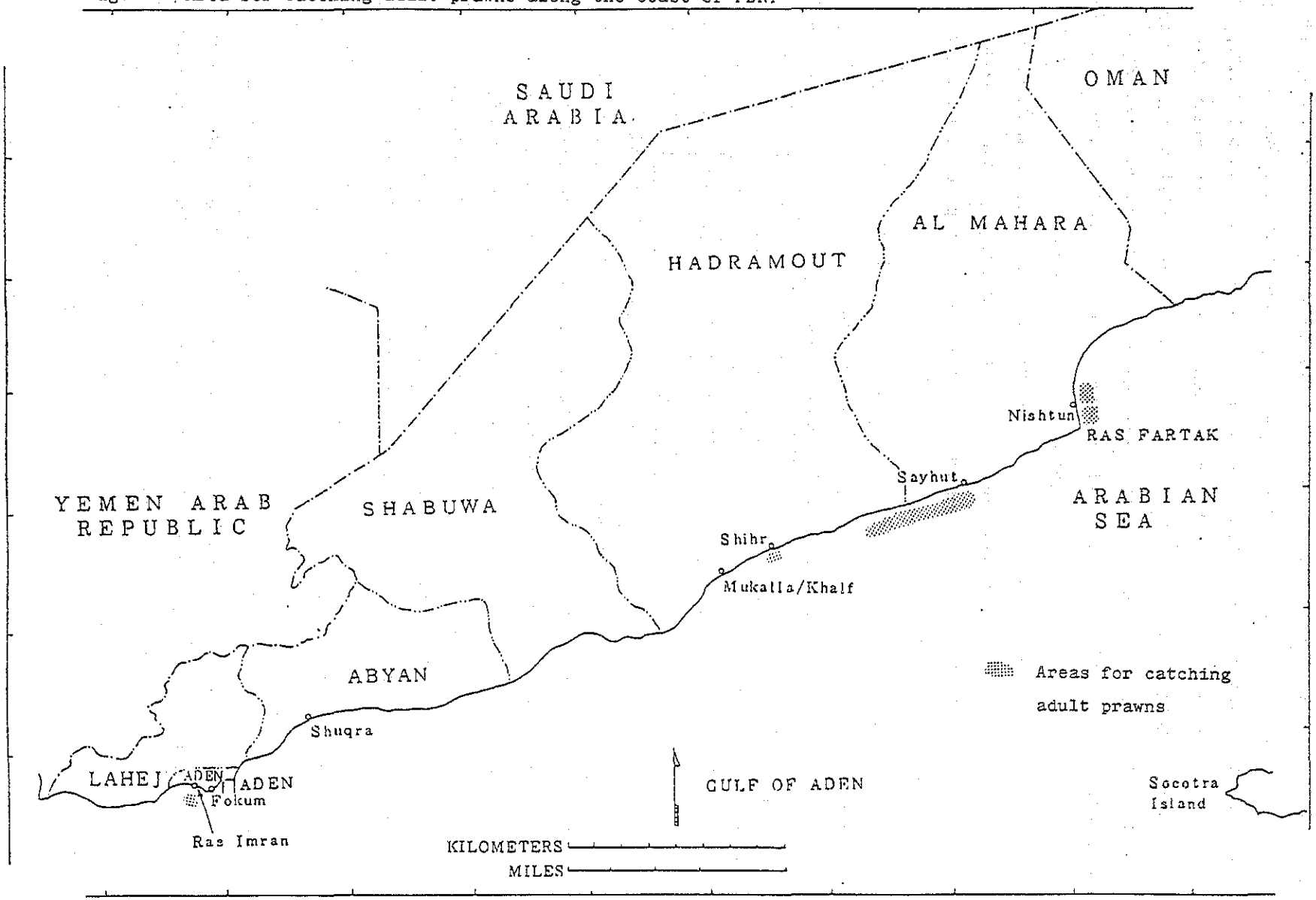
The western offshore of ASH SHIHR
The offshore of SAYHUT - RAS AKAB
The offshore of NISHTON - RAS FARTAK
The offshore of NISHTON - TABUT
The offshore of IMURAN

The fishing ground is 10 to 40 m deep and its bottom is covered with soft mud or sandy mud. The fishing season is from October to February and for the incubating adult prawns are in season from October to November. The prawn catch in the PDRY is small as shown in Table 4. Luckily, the adult prawn grounds are found in limited areas so that catches are relatively easy to accomplish. There will be no problem in obtaining adult prawns in order to put forward the present project and commercial aquacultural enterprises.

B. Cultured adult prawn

Seeds were successfully produced from cultured adult prawn in the existing prawn nursery for the first time at the end of 1979. Since then, seed production was practiced for six generations from cultured adult prawns as well as from natural adult prawns by means of compound eye cut.

Fig. 1 Area for Catching adult prawns along the coast of PDRY



Cultured adult prawns have an advantage of spawning the year round, but their disadvantage is that the amount of spawn per unit is small and not of so high quality. However, the utilization of cultured adult prawns makes possible the operation of aquaculture all the year round. Also the utilization of cultured adult prawns as well as natural ones will be an essential factor for the efficient use of the production facilities in this Center and the promotion of large-scale commercial aquaculture enterprises in the future.

For the present, it is necessary to improve the culturing environment, develop the feed for adult prawns and improve the spawning techniques (compound eye cut, processing by ultraviolet rays, etc.) in order to produce excellent cultured adult prawns in this Center.

Table 6 Comparison of spawning amount between natural adult prawn and cultured adult prawn

Class	Weight	Spawning	Remarks
Natural	50 - 60 g	200,000 to 400,000/pc	
Cultured	20 - 40 g	60,000 to 150,000/pc	9 to 10 months after hatching

C. Necessary amount of adult prawns

To carry out the present project, in the first stage, importance should be placed on securing the natural adult prawns which are easily obtainable and excellent in quality as well as quantity of spawn. The grounds of getting adult prawn are shown in Fig. 1. In the present project, the prawn ground off the coast of Imuran, which was found by a training boat granted by Japan during navigation training in the Fall of 1982, is the best because it is located at the short distance of about 50km from the Center site which is less than a 3 hour boat trip.

As far as the obtaining of adult prawn is concerned, it is the best policy to consolidate the means by trawlboats belonging to the Yemen Fishing Corporation, small fishing boats owned by the Coastal Fishing Corporation, and fishery training boats using trawl or prawn creels.

During the height of the fishing season the staff of this Center will embark the above-mentioned fishing boats and undertake the task of instruction in selecting incubating adult prawns and transporting prawns alive.

In consideration of the past results in the PDRY as well as the production standard including the effect of techniques introduced from Japan, the amount of spawns per unit was estimated at 200,000, the spawning rate of adult prawns at 20%, the survival rate up to p20 seed at 20%. The necessary amount of natural adult prawns in this project was calculated as follows:

(p20 seed)	(yield up to p20)	(amount of spawns)	(spawning rate)
one million ÷	20% ÷	200,000/prawn ÷	20% =125

Female penaeus semisulcatas usually copulate after casting off the skin and store spermatozoa received from male prawns in spermatheca until they deposit spawns. It is necessary to catch only female prawns which have copulatory organ with fully developed ovaries.

From the above calculation, 125 adult prawns should be secured. In consideration of the actual situation of the existing prawn culture station where 50 to 100 prawns/m^3 are left free, an approximately 2m^3 fish tank with appurtenances such as oxygen supplier is necessary in order to transport adult prawns. The tank should be demountable so that it can be transported both by sea and land.

② Seed production

Penaeus semisulcatas has the same life habit and cycle in the larval stage such as spawning, hatching and metamorphosing as penaeidae cultured in Japan. The PDRY was successful in seed production of penaeus semisulcatas and collection of spawns from cultured adult prawns on an experimental scale after trials and errors in the Prawn Aquaculture Laboratory established in 1978, and the Prawn Aquaculture Experiment Center which was completed in 1981 despite suffering from insufficient facilities.

In this project seed production of one million was planned as an immediate objective in order to lay the base for the commercialization of prawn aquaculture. The following production system, which matched the technical level

at present stage on the basis of the experiment results and experience in the PDRY, is considered to be optimal.

The obtained incubating adult prawns are put into the culture pond for adult prawn tank which contains filtered sea water. After selection on the basis of maturity of ovaries, they are transferred into the hatching tank. After transfer, they usually spawn and are fertilized at night within one or two days. All the filtered sea water in the feeding tank should be totally changed every day and adequate aeration is necessary until they spawn.

The fertilized spawns hatch out after about half a month and become Noprius larva. Feed is not necessary in the noprius stage. However, enriched diatoms which are pure-cultured in advance and nutritive salt should be added after the spawning is confirmed in preparation for the next stage. The change of feeding water is not necessary and 15% primary filtered seawater per day should be added.

Noprius larvae metamorphose into zoeal larvae one or two days after. In this zoeal stage 5 to 10% primary filtered sea water per day should be added in the same way. Diatoms which proliferate in the water tank constitute the main feed and from the latter zoeal period noprius larva of brine shrimp is also fed.

Zoeal larvae metamorphose into mysis larvae after passing through the 5 to 6 day in the zoeal stage. In the same way 10 to 15% primary filtered sea water per day should be added. The mainfeed should be noprius larvae of brine shrimp and the proliferation of diatoms should be continued.

After three days in the mysis stage, the larvae enter the post larval period, changing from a floating habit slowly into one of adhering to the bottom and walls of the water tank. At this stage, 10 to 60% water per day is changed and brine shrimp is fed for five days. Afterwards the feed is changed into live bait such as clam. Comparison will be made by using Japanese assorted feed experimentally. Prawn fry (P20) which passed 20 days in the post larval period are taken as seed for the next intermediary culture.

The feeding tank, considering the varied acquisition time for adult prawns, technical level in the PDRY, easiness of handling, easiness of various comparative tests and maintenance, is not a large one of the type used in the seed production of Japanese penaeidae, but is a relatively small sized 10m concrete one. This is considered optimum from the experiences.

Setting the present objective at 5,000 prawns per cubic meter, approximately one third of the results of Japanese cultured penaeidae, which exceeds the PDRY's results a little in terms of accomodation density of P20 seed, a total feeding tank capacity of $200m^3$ is required in order to produce one million P20 seeds for this project. Therefore, it is necessary to construct twenty $10m^3$ concrete tanks. Moreover, prawn seed production tanks should be installed indoors so that they can avoid various bad effects due to the sandstorms in the monsoon period and intense sunshine. Since the PDRY is located in a tropical zone, buildings for the purpose of seed production should be so designed that proper aeration is provided.

③ Intermediary culture

Small sized prawn fry (20mm long) such as P20 are not put in a large sized pond directly but in a manageable small sized intermediary culture pond for about 30days. The objectives of intermediary culture are to increase the yield, and to acquire the basic management techniques such as the checking of the total prawn stock in the pond and confirmation of growth.

After P20 seeds produced in the seed production building are taken out of the hatching tank and the round number of seeds are taken hold of, 200,000 to 250,000 seeds per ton of seawater are put into live fish transportation tanks and transported immediately to the intermediary culture pond.

In the intermediary culture pond accomodation density during the intermediary culture from P20 seed to 1gr prawn size should be 80 to 85 prawns per square meter, half the level in Japan, on the basis of the feeding results in the PDRY's prawn culture farm. Therefore, an $800m^2$ intermediary culture

pond is required to produce intermediary seeds for 66,000 prawns of this production plan. With regard to easiness of management, cleaning and taking out, there should be two 400m^2 intermediary culture ponds made of concrete which are 25m long, 16m wide and 1.3m deep. Accessories such as aeration pipes and water wheels should be provided so that homogeneous water and adequate oxygen supply can be assured.

In the intermediary culture pond, intensive control of such things as feeding, cleaning and water changing (one cycle per day) should be carried out for about 45 days. When the seeds grow into so called intermediary seeds weighing 1g, they should be taken out and transferred to the large culture pond for regular culturing.

④ Culturing

After seeds grown up to 1g prawns in the intermediary culture pond are taken out and rough number of the seeds are taken hold of, they should be transferred to the live fish transportation tank at the rate of 10,000 to 20,000 prawns per ton of sea water, or they should be sent from the intermediary culture pond to the culture pond proper through a temporarily installed a queduct.

Harmful fish should be exterminated from the culture pond and the culture pond should be properly cleaned before introducing prawns. When the culture pond is used more than twice, special care should be taken to dry the bottom of the pond, remove sludge and replace the old sand with fresh. Amount of everyday water change depends on the circumstances. Usually 10% water should be changed, which is considered to be a general standard. Also water wheels should be installed in the culture pond in order to homogenize the pond water and quicken the water flow. 4 water wheels in a 2,500m^2 pond can successfully cope with the future high density aquaculture experiment.

Experiment and study on feeding should be carried out, taking into account the availability in the PDRY and the optimum feed blend which is composed mainly of effective materials. Also attention should be paid to the appropriate amount of feed to be given every day. At the same time the ingestion conditions, appearance of prawn, dirt at the bottom of the pond should be checked

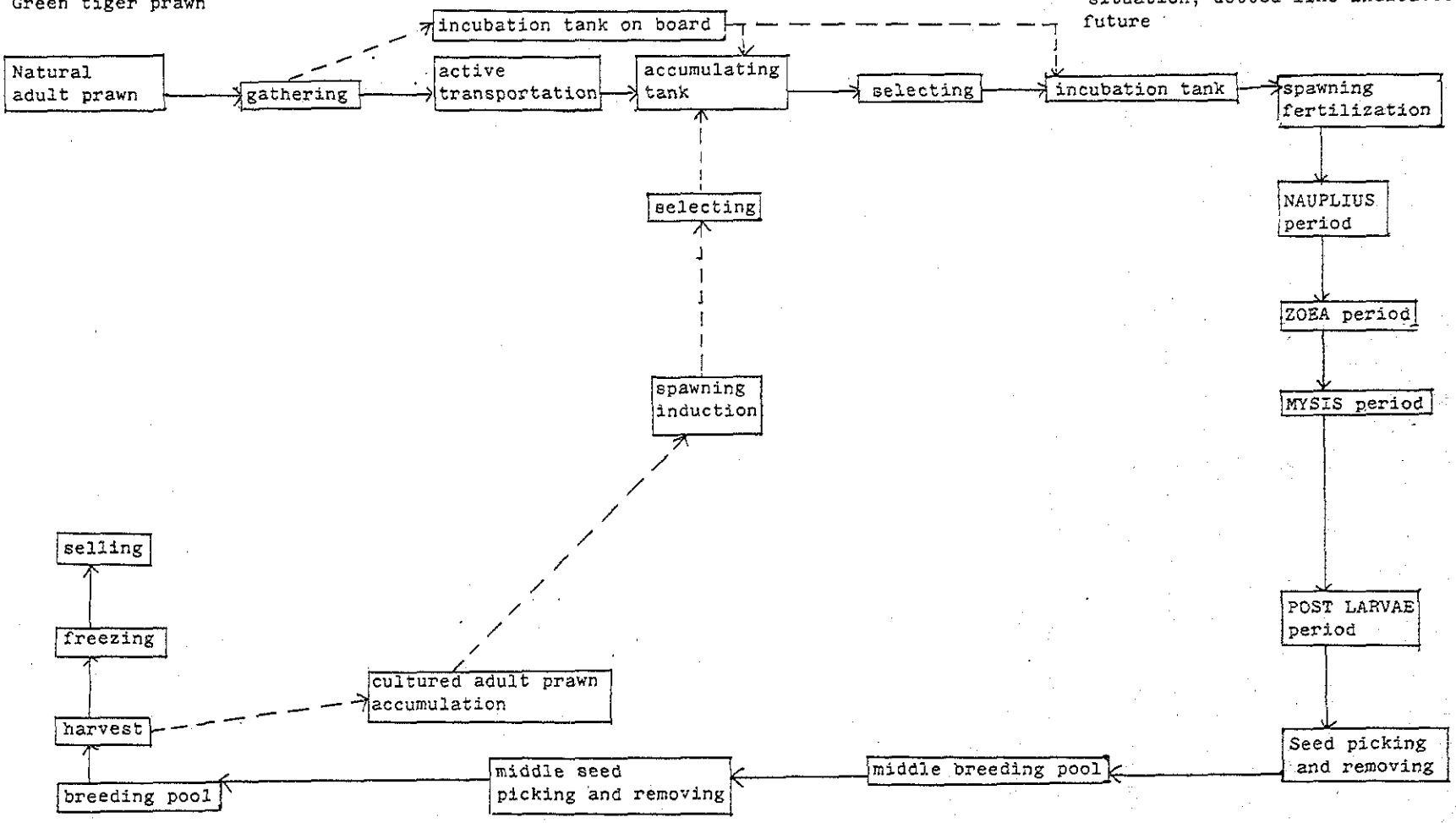
regularly by divers. Moreover, considering the availability of feeding materials in the PDRY, the optimal mini plant for feed preparation is necessary.

Under this feeding control, 1g seeds will grow into prawns with an average weight of 25g in half a year after they are introduced to the culture pond. Most prawns grown to the commercial size will be taken out with fishing gear such as prawn creel, electric net and fishing implements, and the rest will be immediately quick-frozen and processed into frozen products. Then they will be sold at fish markets and hotels in Aden on a trial basis which will provide basic data for earnings and expenses of a prawn aquaculture business, and will increase the demonstration effect on prawn aquaculture. Moreover, a part of the proceeds will be allocated as working expenses of this Center.

⑤ Process of seed production and culturing

Green tiger prawn

Note: full line indicates the current situation, dotted line indicates future



PLAN OF AQUACULTURE AND SEED PRODUCTION

Green tiger prawn

Columns	PLANS						Results in PDRY		Results in Japan with prawns	
	amount to culture	culturing period	Yield	Density	water required	rate of water exchange	Yield	Density	Yield	Density
Unit			%	10thou/m^3	m^3/day	%/day	%	10thou/m^3	%	10thou/m^3
Adult prawn (M)	125	1 - 5	20	2pcs/m^3	100					
						10tons x 20				
Fertilized egg	5 million	0.5	100				100		100	
Nauplius period		1.5		1.5 - 2	15	increased 15				2 - 6
Zoea period		4 - 5	40		17	increased 5 - 10	10-25		45-90	
Mysis period		3			37	increased 10 - 15				
P1 - P5	2 million	5			85	exchange 10 - 30				
-			50				40-50		50-90	
P6 - P20	1 million			0.5 - 1	169	exchange 30 - 60		0.1-0.4		0.5-2.0
Grand total up to P20			(20)				(4-13)		(23-80)	
middle breading (begin)	133,000				first day 1,040	exchange 100	800m^2 (depth 1.3m)			
(end) 1g	66,000	30	50	80-85 pcs/m^3	exchange 1,040				80	150pcs/m^3
Culturing (begin)	66,000				first day 6,500	exchange 20	5,000m^2 (depth 1.3m)			10 -
(end)	40,000	120 - 240	60	8pcs/m^3	exchange 1,300				80	30pcs/m^3

(2) Cuttle fish

① Collection of natural seeds

Natural seeding of cuttle fish was successfully carried out on trial twice in 1979 and 1981 in the shrimp station in the PDRY, but techniques of natural seeding in large quantity have not been established yet. However, the coastal zone in the PDRY is a good fishing ground for cuttle fish and the main fishing grounds are found in Hadramaut Province and Almahara Province. In addition, a large number of cuttle fish comesfloating in pairs to the coast along Aden Province mainly from August to November, and they spawn on coral reefs and shore reefs found in shallows along the coast and even on small rocks in the sea bottom so that the collection of natural seeds is quite easy.

In the past the shrimp station in the PDRY took the initiative in collecting natural seeds, using worn-out tires, ropes, semi-circular earthen pipes and brushwood or mass-like cuttle fish creels containing a thin rope. On the basis of these experiences the Center will carry out the collection of natural seeds by means of cuttle fish creels which showed the best results of all.

In October which is in the spawning season, cuttle fish creels will be installed 4 to 5m deep in the shallows and will be lifted up every day to be checked and creels to which enough spawns attach will be recovered on after the other. The spawns of cuttle fish are relatively resistant to the exposure to air and endure 2 to 3 hour transportation when enough humidity is provided. However, the best way to transport them is in live fish tanks taking care to avoid direct sunlight.

Cuttle fish creels are made of iron frame creels 50cm in diameter and 40cm high. 1,000 seeds can be collected per creel at one time. If a creel is placed 5 times per season, about 36 creels will be required to collect 178,500 seeds necessary for this production project. Including spares, 50 creels should be prepared. The main collection site of the natural seeds will be the seashore in front of this Center. A small FRP boat which can operate with a live fish tank aboard is necessary in order to collect seeds and transport them alive.

② Seed production method

The collected spawns will be put into the hatching creels immediately and creels will be set on the surface of the feeding water in the hatching tank. Aeration and water change once per day should be ensured. Hatching creels should be made of polyethylene which is 50cm wide, 50cm long and 20cm deep with 5mm mesh. Since a hatching creel can contain 2,000 spawns, 90 creels are required in order to hatch 178,500 spawns. However, one creel can be used more than twice. Therefore, 45 creels will be enough.

In this way, spawns put into the hatching tank will hatch out after about 15 to 20 days at the latest, depending on the growth rate of each spawn at the time of collection. The hatched cuttle fish fry begin eating soon. During this period they vigorously eat live bait such as adult artemia, mysid, small shrimps and fry.

The feeding water should be cycled once a day and aerated properly. The size of live bait should be altered according to the growth of cuttle fish fry. Care should be taken so as not to underfeed. After about one month feeding they will weigh 3g, at which point they will serve as seeds for stocking experiment.

In order to produce 50,000 seeds, the target figure of the production project in this Center, 178,500 natural seeds are necessary as described above, calculating the hatching rate of natural seeds at 70%, and the yield from a hatched larva to one month old 3g seed at 40%.

Various experiment data are available on the concrete of glass feeding tank or FRP feeding tank. From the actual results of the existing shrimp station, a circular rigid vinyl water tank is the most useful one for avoiding chafing of cuttle fish as they collide with the tanks walls.

The stocking density will be 200 per square meter in terms of 3g seed. Since one feeding period cycle will be about one and a half months from the collection of natural seeds, a biannual production cycle will be possible. Therefore, the required tank area will be as follows:

$50{,}000 \text{ seeds} \div 200 \text{ seeds/m}^2 \div 2(\text{cycles}) = 125\text{m}^2$

Also considering the manageability and feed ingestion range of cuttle fish, a 3 to 5m^2 water tank will be adequate.

In this Center, considering the common use of the water tank with other species, 24 tanks 2m in diameter and 10 tanks 2.5m in diameter will be prepared for cuttle fish seed production and they should be diverted for use with other species in the leisure season in order to utilize the facilities effectively.

③ Breeding

Full-scale aquacultural techniques for cuttle fish have not been established yet worldwidely actual results were found in the prawn culture farm in the PDRY where about 50 seeds were cultured and grown into 100 to 250g cuttle fish in 1979 and 1983. Synthesizing the whole situation along with the past feeding experiment results in Japan, it is too early to carry out large scale cuttle fish aquaculture. In this Center, basic aquacultural experiments will be carried out, with the aim of producing 500 adult cuttle fish by a part of produced seeds.

Seeds (1g) of one month after hatching should be taken out carefully by means of round net in order to avoid chafing and put them into the culture tank. Sand should be laid 5 to 10cm thick in the tank to make a culture floor for cuttle fish.

They prefer prawns as their feed. Since fish is excellent in feeding efficiency, frozen sardine and horse mackerel will mainly be used. Fresh small fish will be fed if available. Care should be taken to remove the leftovers. The ingestion conditions of the cuttle fish should be regarded closely.

Sea water is usually used as culturing water and 50% water should be changed a day. The water tank should be round and should be so designed that the water flow can take off the dirt in the tank. However, when given a strong shock, cuttle fish spurt ink and dirty the water. In this case a complete water change should be carried out.

It will take about half a year to grow from a 3g seed to a 500g adult. Growth rate is rapid and the cuttle fish have an excellent feeding efficiency which is about 30% in terms of live bait compared to that of 8% for prawns. However, their survival rate is extremely poor, which is 5% at most in the PDRY and only 5 to 15% even in Japan.

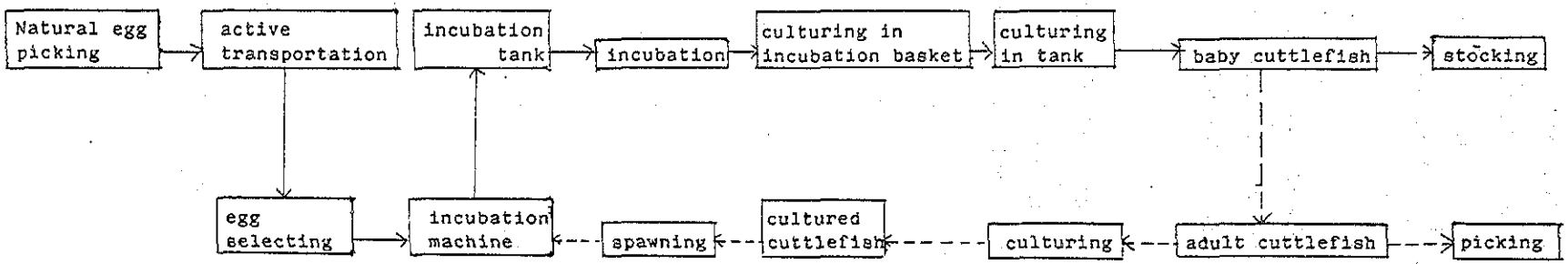
In the aquaculture project of this Center the survival rate is estimated at 10% for 3g seed to adult cuttle fish. Five thousand 3g seeds are required in order to attain the production project of 500 cuttle fishes. Stocking density is estimated at 2 per $2m^2$ in terms of 500g unit so that $250m^2$ culture water tank is necessary.

Since the small water tank to be installed indoors is appropriate for elaborate observation and study, the cuttle fish seed production tank 2m is diameter should be deployed for cultural use. Slightly large sized circular FRP water tank with 5m and 7m in diameter will be used outdoor.

The culture water tanks required in this project total $250m^2$, made up as follows: 24 indoor circular water tanks 2m in diameter (total $75m^2$), 5 outdoor circular FRP water tanks 5m in diameter (total $98m^2$) and 2 water tanks 7m in diameter (total $77m^2$).

⑤Process seed production and culturing

Cuttlefish



Note: Solid line indicates the current situation, dotted line indicates future.

Process of seed production and culturing

Cuttlefish

	PLAN							Results in PDRY		Results in Japan	
Column	Amount to Culture	Culturing Period	Yield	Density	Water Required	Rate of Water Exchange	Pool/Tank	Yield	Density	Yield	Density
Unit	pcs		%	pcs/m^2	m^3/day	%/day		%	pcs/m^2	%	pcs/m^2
Natural egg	178,500	7~20		2,000/ basket	45	exchange 100	basket 0.5m^2x45 depth 0.2m	100	2,000/ basket	100	2,000/ basket
			70								
spawned baby fish	125,000			500	first day 125	exchange 100	seed tank 125m^2 depth 0.5m		150	60-80	300
					exchange 125						
Baby fish		10									
Baby fish		20	40					30		50	
Baby fish (3g)	50,000	30		200					50-80		100
Baby fish (culturing test)	5,000										
Baby fish (culturing test)		40	10		first day 175	exchange 50	culturing pool 175m^2, depth 1m	5		5~15	
					exchange 88						
Adult fish 500g	500	120		3					2		5-10

3. Mullet

The coast along the PDRY abounds in mullet which is very popular among the people in the PDRY and ranks as the special grade fish. Domestic production of this species by aquaculture and supply to the market will be an epoch-making event for this country. However, integrated aquaculture techniques from culture seeding to cultivation have not been established so far. The following is the optimum method of mullet aquaculture in the PDRY for the present until the future cultural seed production technique is established, aiming at realizing the production project of this Center.

① Collection of natural mullet fry

In the area along the coast of Aden a large number of 2 to 3m long natural mullet fry come floating in shoals to the shallows along the coast. However, since it is difficult to produce natural seeds under the present conditions, these natural mullet fry should be used as culture seeds to begin with. The best collection sites of mullet fry in the coast of Aden are the Farisi inlet of Little Aden and the shallows of the inner part of the Gulf of Aden.

The mullet fry are collected by fishing gear suitable for the geographical features along the coast such as home-made fishing implements and round net. They are then transported little by little in live fish tanks on FRP boats or trucks. 10,000 mullet fry is the number aimed at in the seed production project of this Center and the yield in collection, transportation and selection is estimated at 65%. Therefore, the required natural fry will be 15,000.

② From seed production to culture

The collected fry will first be placed in the storage tank. The fry which are damaged during collection and transportation work or which differ greatly from average size are sorted and removed. Then, 10,000 fry are put in the intermediary culture pond. The water tank used temporarily to store the fry for selection and removal work should be shared with that for cuttle fish. Adequate accomodation density for natural fry will be about 1,000 per square

meter. Therefore, $15m^2$ is required in order to receive 15,000 fry before the selection, which accounts for 12% of the total water tank area for cuttle fish.

After selection the natural fry are allowed to settle for a while and then put in the intermediary culture pond. When fed for about 30 days in the intermediary culture pond, they will weigh 2g (about 5cm long). The yield during a one month period in the intermediary tank is set at 80%, and 8,000 fishes will be transferred to culture pond on full scale.

In regard to the intermediary culture pond, it will be a open round FRP water tank which has a volume of 40 m^2 for a density of 200 fishes of 2g size per square meter. Therefore, a FRP water tank of 7 m in diameter, 1.2 m in height (38.5 m^2) is suitable. Moreover, this water tank for intermediary culture will be commonly used for keeping adult fish in the future for artificial seed production.

Sea water is usuallly used as culturing water and 50% water should be changed a day. Fry grown up to 2g size will be collected by means of the specialized gill net carefull little by little and then put into the culture pond.

In the first stage of the culture in the culture pond, fry will be concentrated in a part of the pond for effective control over culturing activities. Then with growing up, they will be transferred gradually to different areas as all of culture pond is used. Growing up to 300g size after one year from stocking in the culture pond is aimed.

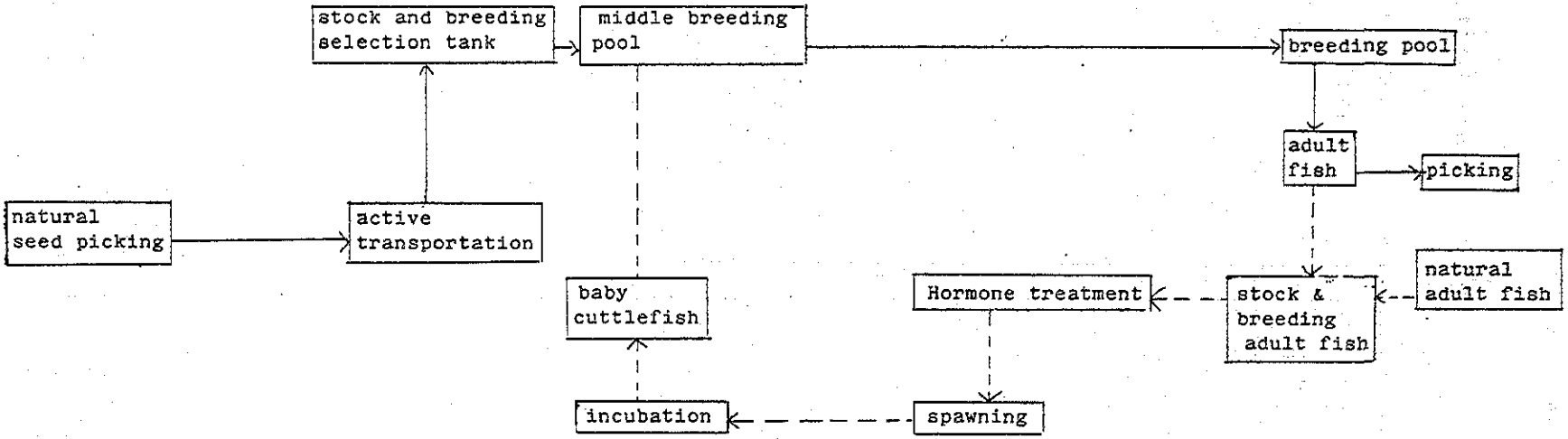
During the culturing period, the water change will be limited until 10% a day so that natural feed growing naturally in the pond is effectively used. Setting the yield in this period at 50%, the final catch will be 8,000 x 50% = 4,000.

The stocking density of 300g size mullet is estimated at 4 per square meter including the reserve. Therefore, $1,000m^2$ culture pond area will be

required (4,000 fry ÷ 4 fry/m^2). The culture pond should be constructed entirely of concrete, and there should be two 250m^2 ponds (10m wide, 25m long and 1.5m deep) and one 500m^2 (20m wide, 25m long, and 1.5m deep) in order to carry out various experimental cultures. Each pond should be equipped with a water wheel as well as aeration devices.

Process of seed producing and culturing

Mullet



Note: full line indicates the current situation, dotted line indicates future

4 Process of seed production and culturing

Mullet

Column	PLAN							
	amount to culture	culturing period	Yield	Density	water required	rate of water exchange	tank/pool	Note
Unit	pcs	days	%	pcs/m^2	m^3/day	%/day		
Natural seed picking	15,000			1,000				body length 2 - 3 cm
			65					
middle breeding (begin)	10,000			250	19.3	50	seawater pool 38.5m^2 depth 1m	2g
(end)	8,000	30	80	200				
culturing (begin)	8,000			8	100	10	seawater pool 1,000m^2 depth 1m	
(end)	4,000	360	50	4				300g

4-3-3 Acquiring and transporting plan of adult fish, fry and seed

(1) Plan policy

On the basis of the aquaculture project of this Center, adult fish, fry and seed inhabiting the coast of the PDRY will be collected by FRP boats belonging to the Center and small sized trawlboats owned by the fishing cooperative. Tilapia is obtained from neighbouring Arab countries. Live fish will be transported from the catchment area to the Center in live fish tanks, carried by FRP boats or trucks belonging to the Center. In addition, seed and fry produced in the Center will be transported from the Center to the culture pond by the same means in the future.

(2) contents of plan

Species	Acquiring area	Acquiring method	Transporting method	Necessary time
Adult fish	Aden Province Imuran off-shore Hadramaut off-shore Al Mahara offshore	Local small-sized trawler	FRP boat live fish tank Land live fish transport	3 hr 30 hr
Young prawn	Little Aden inlet	FRP boat (machiami) (tamoami)	FRP boat live tank or land live fish transport	30 min
Cuttle fish spawn	Near site	FRP boat cuttle fish creel	FRP boat live tank	30 min
Mullet fry	Aden coast	FRP boat (shiteami) (hikiami)	FRP boat live tank or land live fish transport	1 hr
Tilapia adult fish and fry	Neighbouring Arab countries	Purchase of cultured fish	Air cargo	10 hr

(3) FRP boat with outboard engine

As the conclusion of the basic design study, a small sized FRP boat with outboard engine is indispensable for live transportation of natural adult fish and fry. The objectives and operating schedule of that boat are as follows:

① Planned work and scale of boat

Main planned works of the above-mentioned boat are sea transportation of adult prawn, collection and transportation of natural cuttle fish spawn, collection and transportation of natural mullet fry and adult mullet, collection and transportation of other species for the present project (rabbit fish, grouper, milkfish, etc.), simple oceanographic observation in neighbouring sea, and plankton collection and experimental catch of feeding small fish in water close to coast.

Concerning the scale of boat, it will be small but assure a space as large as possible thereon for the above-mentioned works by being equipped with sectional bait tank. The boat will have a demountable small-sized davit for the purpose of collection of fry, adult fish and feeding small fish and simple oceanographic observation. The boat will be designed to accomodate generally three crewmen including a pilot.

② Yearly navigation schedule

The navigation schedule of the said FRP boat with outboard engine to be used for the present project is given in Table 8.

Table 7 FRP Boat service plan

month	Green tiger prawn	Cuttlefish	Mullet	Others	labour days
1			Catch test of natural adult fish - 4 days	Ocean observation, Plankton gathering - 3 days Catch test of small fish for feeding - 10 days	17
2			Catch test of natural adult fish - 4 days	Ocean observation Plankton gathering - 3 days Catch test of small fish for feeding - 10 days	17
3				Ocean observation, Plankton gathering- 3 days Catch test of small fish for feeding - 10 days	13
4			Catch test of natural adult fish - 4 days	Ocean observation, Plankton gathering- 3 days Catch test of small fish for feeding - 10 days	17
5			Catch test of natural adult fish - 4 days	Ocean observation Plankton gathering- 3 days Catch test of small fish for feeding - 10 days	17
6				Ocean observation, Plankton gathering- 3 days	3
7				Ocean observation, Plankton gathering- 3 days	3
8				Ocean observation, Plankton gathering- 3 days	3
9	Live transportation of natural adult prawns 3 - 6 days	Natural spawning 2 - 4 days		Ocean observation, Plankton gathering-3 days	8-13
10	Live transportation of natural adult prawn 3 - 6 days	Natural spawning 3 - 6 days		Ocean observation, Plankton gathering- 3 days	8-13

11	Stocking of baby prawns 2 - 4 days	stocking of baby cuttlefish 6 days		Ocean observation, Plankton gathering-3 days	11-13
12	Stocking of baby prawns 2 - 4 days			Catch test of small fish for feeding - 10 days	12-14
days	10-20	11-16	16	93	130-145

4-3-4 Feed Plan

(1) Feed for seed production

As for the feed for seed production of mullet and cuttle fish at this center, the same feed as the one for culturing is used. Here the feed for seed production of Penaeus semisulcatus is given.

Experiences up until the present in the PDRY has revealed that it is difficult to maintain a constant supply of diatoms needed as the early feed. That many early larvae in the Zoeal period did not survive, and this resulted in a lowering of general production standards. At this center, culturing lities for plant plankton will be completed for making preparatory assorted feeding of yeast from diatom, brine shrimps, and assorted feed. And first of all, the mass production of seeds will be realized with a simple feeding system without complicated labour or high level management capacity, technical capacity, though it might benefit from general Japanese feeding techniques.

Table 8 Details of feed for seed production of Penaeus semisulcatus

Kind of feed	per one million seeds of P20		Kind of feed for each stage of prawn larva				
	Necessary Q'ty	Remarks	N	Z	M	P1-P5	P6 - P20
Diatom	$15m^3$	200,000 cell/ml	----	----	----	------	----------
Sea yeast	40L	5×10^8 cell/ml		----			
Bread yeast	40g			----			
Artemia	10kg			----	----	-------	
Assorted feed	20kg			----	----	-------	----------

(2) Feed for culture

① Policy

According to Table 7, about 14 tons of feed are necessary a year for culture plan at the beginning of the operation of the Center. Setting the production level of Penaeus semisulcatus at the Japanese standards, about 50 tons of feed are necessary a year. It doesn't seem so difficult to obtain even under the present conditions.

However, for an aquaculture of Penaeus semisulcatus on a commercial scale in the future, a supply system of more than 2,000 tons feed will be necessary. Therefore, it is necessary to establish an optimum supply system of feeding materials making sure that unused protein which is easily obtained on the spot is utilized.

Prawn culture in the world can be grouped by feeding method as follows:

Culture method	Feeding system
Roughly leaving	Only fertilization of pond or completely no fertilization
Semi-concentrated	Not only fertilization of pond, but also feeding supplementarily
Concentrated	Feeding on a full scale

Present optimum culture methods in the PDRY are of the semi-intensive culture . That is, one which makes full use of the proper site, utilizes the natural productivity of the culture pond itself, and provides supplementary feed when necessary.

② Feed for culture

According to the findings, feeding materials in the country are as follows;

A. Materials for Feeding

Floating fish caught	Sardine, mackerel (frozen)
Materials caught by local fishermen and the center	Small fish (fresh fish)
Fishmeal from the Soviet vessels and tinning works in Mukara	
Wheat bran from milling factories	
Unstrained draff from breweries (containing yeast)	

B. Binder Materials

Wheat flour

C. Inducement materials

Mollusca	Cuttle fish, Shellfish, etc.
Crustacea	Prawn, Crabs, etc.
Flavour	import

At the beginning, the fish-catch will be used, but later, by-products such as tentacles, fins, internal organs, skins of cuttle fish, test of prawns/crabs from the processing factories will be used. And an out break of crustaceans in the coast of Aden State in the latter half of August (autumn mysid) will also be examined for use.

D. Nutrition Materials

Vitamins	import
Minerals	import

E. Feed for fry and cultured feeding materials

Fowl droppings	Dried from Chicken Production Corporation
Yeast	Beer yeast (Beer Public Corporation)
	Bread yeast (bakery)
Phosphate	import
Brine shrimps	import
(wamushi)	import
Assorted feed	import

③ Feed per year needed by the center

The necessary feed for the achievement of the production plan at this center and a sample of the constitution of the feed materials are given in

Tables 9 and 10. The monthly quantities of feed are given in Fig 2. However, it is calculated only supposing that the smooth supply of every material is assured. But under adverse supply condition, easily obtainable small fish at the site may be used. The monthly quantities of feed in the latter case are given in Fig 3.

Table 9 Annual necessary feed for cultivation

Unit: Kg

Species	Needed feed	Basis for calculation (Feed efficiency) x (Feed efficiency factor)
Prawn	5,976	996Kg x 6.0
Cuttle fish	750	250 x 3.0
Mullet	4,854	1,184 x 4.1
Total	11,580	

Table 10 Composition of feed for cultivation

Unit: Kg

Species	Total	Details					
		Fry	Fish meal	Flour	Wheat bran	Soybean meal	Others
Prawn	5,976	1,793 (30%)	896 (15%)	- -	2,092 (35%)	896 (15%)	299 (5%)
Cuttle fish	750	750 (100%)					
Mullet	4,854	971 (20%)	475 (10%)	1,699 (35%)	1,456 (30%)	- -	243 (5%)
Total	11,580	3,514	1,381	1,699	3,548	896	542

Numbers in parentheses are combination ratio.

Fig. 2 Amount of feed by species (home blend) per month

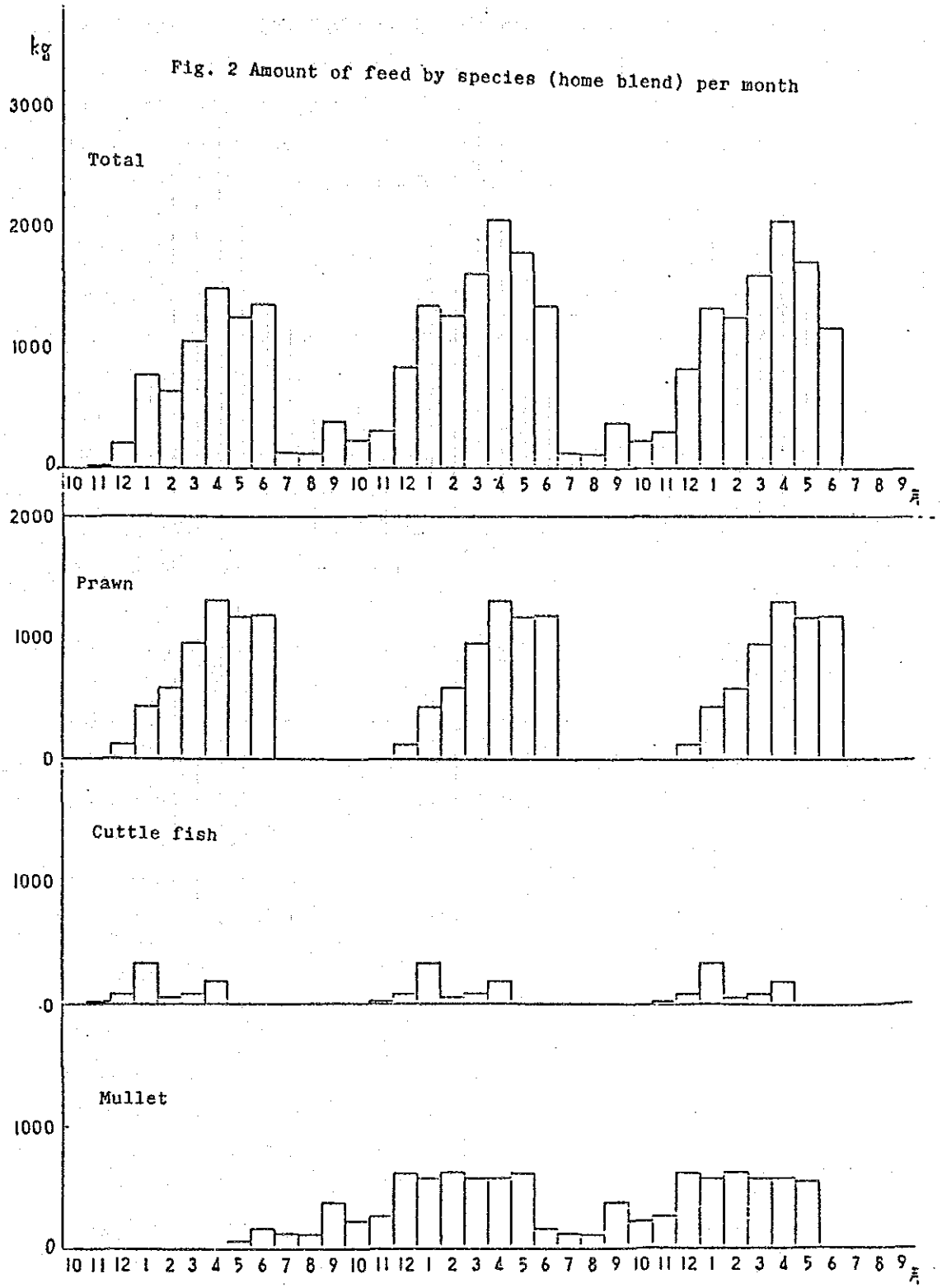
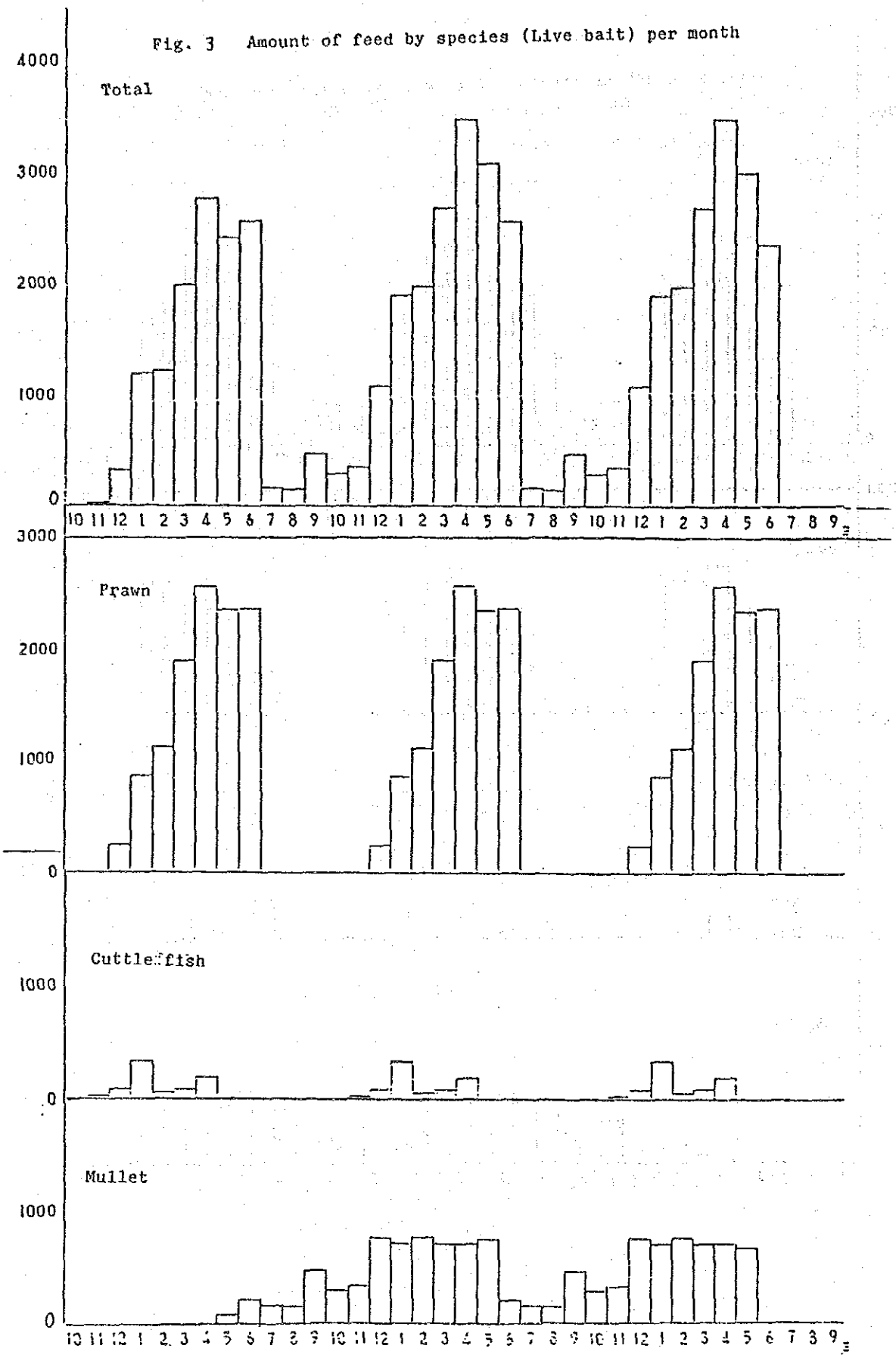


Fig. 3 Amount of feed by species (Live bait) per month



④ Cold Storage for Feeding

As for the feeding project at this center, cold storage is necessary especially for keeping fresh feed like small fish. To cope with the conditions as shortage in the capacity of cold storage in Aden and the climate very hot, the center will be equiped with small cold storages for feed.

The scale of the cold storage must be designed for providing against conditions where only fresh feed is available. According to Fig. 2 and 3, the monthly storage capacity for the first 2 or 3 years must be 3.5 tons if production plans are to be achieved.

But, 10 tons capacity prefabricated cold storage units will be needed when the facilities at this center are in full-operation due to development of the production techniques. By that time, the necessary quantity of raw feed per month will be 7 tons.

4-3-5 Training Plan

(1) Policy of Training Plan

There are no educational or training facilities and organizations for aquaculture in the PDRY. This center trains technical experts and aquacultural managers for the future development of aquaculture and is the only one of its kind in this country. For this purpose, training which combines of written and practical study will be carried out. And this center will provide aquacultural education to officers, fishermen and students through lecture classes and textes.

(2) Training Plan

① Applicants for Training

Fishermen from fishing cooperatives, officials from the Ministry of Fish Wealth, and the persons and students from the Marine Science and Resource Research Center, and the Fisheries Research and Training Center.

② Purpose and Contents of the Plan

A. Both practical and written study programs will be provided for proponents of aquaculture.

1 course-10 persons, 6 months training

B. Periodical lecture classes will be held for propagation of aquacultural know how.

3 times a year, one lecture class for about 10 persons.

C. Knowledge of aquaculture will be propagated through collection and regulation or documents and information about aquacultural technology in the world, and publication of pamphlets. This work will be done by the officers of the Center.

(3) Curriculum

A. As seeds production and aquaculture plan

B. training of members for propagation of aquaculture

Activities Months	1	2	3	4	5	6	7	8	9	10	11	12
Seminar	X						X					
Short course		X		X		X		X		X		X
Lecture meeting	X		X		X		X		X		X	
Experiment, practice	X	X	X	X	X	X	X	X	X	X	X	X

C. Institute

Participation in the above mentioned (B) short institute.

D. Collection of documents and information on aquaculture techniques and publication of pamphlets.

4-3-6 Investigation and research plan

(1) Policy of investigation and research plan

In order to promote the establishment of aquaculture in the PDRY, we need to not only develop aquaculture technology in a narrow sense, but also emphasize ecological study of cultured fish through means such as investigation and research of feeding, cultural environment, harmful fish, disease and culture ponds. Also investigation and research of aquacultural economy regarding distribution, processing, marketing, import, etc., are indispensable. The center will carry out these investigation and research on aquaculture and all that it entails.

(2) Contents of investigation and research

① Prawn aquaculture

A. Research for the establishment of prawn culture methods suitable in the PDRY

To establish seed production techniques adaptable to the PDRY based on the Japanese developed techniques with modifications where necessary to suit local conditions.

* Investigation of optimum period for catching parent prawn.
* Research & Development of early feeding.
* Investigation of optimum period, place and method for catching young prawn
* Research of cultivation of adult prawn for collecting seed.

B. Development of aquaculture techniques on a commercial basis.

* Research & Development of proper feeding.
* Research of the economical utility of water for culture.
* Research and investigation of improvement of out-door feeding density.
* Examination of the optimum method for aquaculture techniques transfer to private enterprises.

② Cuttle fish culture

Assuring natural seeds and hatching them can be easily accomplished.

However, culturing techniques of commercial size here are still lacking. It is expected that aquaculture is levelled up to a commercialization on the basis of investigation and research of every stage.

A. Research of hatching and culturing young cuttle fish

* Research & Development of hatching method
* Research & Development of the early feeding (from PL cultivation to assorted feeding)
* Research & Development of the structure of ponds and out-door feeding density.

B. Culture of adult cuttle fish

* Research & Development of feeding
* Research & Development of the structure of ponds and out-door feeding density.

C. Survey of inhabitable environment

* Survey of proper depth of water, quality of water, quality of bottom on every stage.
* Survey of feeding habits in natural environment.

D. Mullet Culture

Although the spawning ground and the life cycle of mullet has not yet been fully revealed, we can research and develop the proper culture method by catching them because there are many young mullet in the area.

* Research & Development of feeding
* Research & Development of the structure of ponds and out-door feeding density.
* Investigation of the seeds, hatching, and growth.

E. Other kinds of fish

Research and investigation of Tilapia Culture in seawater, which is already industrialized in every country, and the proper aquaculture method of rabbit fish and groupers and the like which are favoured by the Arabs and which are indigenous species.

F. Economical Survey of the Aquaculture Project

In order to promote the aquaculture industry, it is necessary to call the attention of all concerned to aquaculture and make it economically viable. Awareness of aquaculture can be inculcated upon the general public by the sale of cultured fish in the market place. For this purpose, we should investigate the proper methods of circulation, processing, marketing, import, etc., of cultured fish, and practice an economical survey on aquaculture.