BASIC DESIGN STUDY REPORT ON THE PROJECT FOR NATURAL WATER FISHERIES DEVELOPMENT IN THE KINGDOM OF NEPAL

JUNE 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from His Majesty's Government of Nepal, the Government of Japan has decided to conduct a Basic Design Study on the Project for Natural Water Fisheries Development and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Nepal a survey team headed by Mr. Naoyoshi Sasaki, Deputy Director of Fisheries Technical Cooperation Division, Forestry & Fisheries Development Cooperation Department, JICA from March 18 to April 6, 1990.

The team exchanged views with the officials concerned of His Majesty's Government of Nepal and conducted a field survey in Pokhara, Trisuli and Godawari. After the team returned to Japan, further studies were made and the present report was prepared.

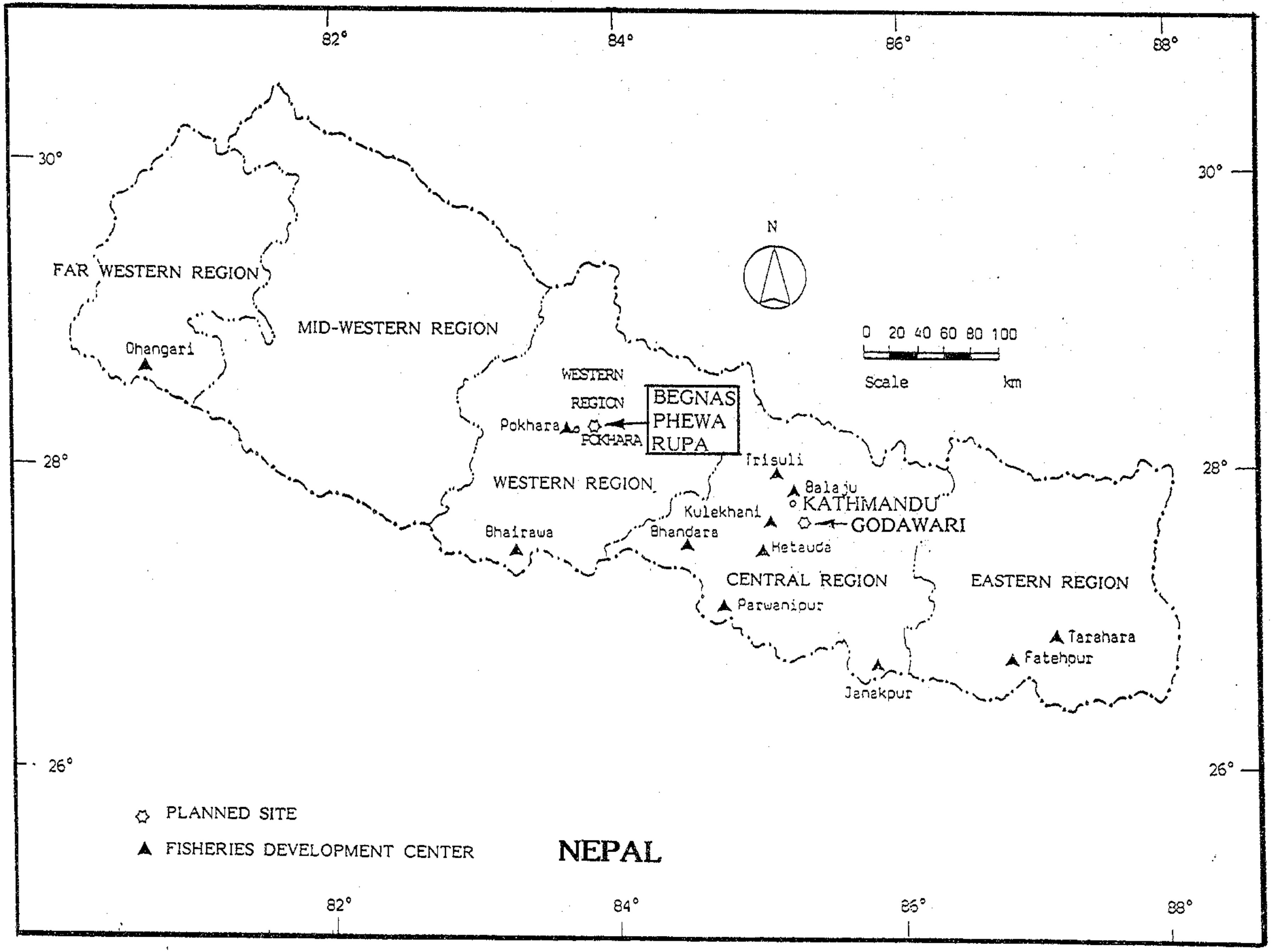
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of His Majesty's Government of Nepal for their close cooperation extended to the team.

June, 1990

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency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NEPAL

SUMMARY

The fisheries in the Kingdom of Nepal may be classified into two branches: captured fisheries, directed mainly at natural rivers and lakes; and aquaculture, centered around the production of Chinese and Indian Major carp. Whereas production by the captured fisheries has been static over the past decade, aquaculture has shown a major gain.

The impressive growth in aquaculture production in Nepal is attributable in large part to an expansion of production areas in the Terai region, which is highly suited to pond culture. However, the great bulk of the water area capable of being used for aquacultural production in this region are already being used for this purpose, meaning that any future increase in output will have to depend on productivity gains. Thus, aquaculture production in the Terai region based on the extensive culture method is approaching its natural limits.

On the other hand, since the preponderance of natural water bodies in the country, located in the Midland region, remain undeveloped, if their vast waters could be utilized for fishery purposes, it is believed that fish production would increase sharply.

The per-capita consumption of fish products in Nepal averaged 0.5 kg over the 1985-86 period, which is an exceptionally low level even in relation to the 8.1 kg average for less developed countries (LDCs). In order to improve the nutritional intake of the Nepalese people, His Majesty's Government of Nepal (HMG) is attempting to raise per-capita fish consumption to 1.2 kg by the final year of the 8th Development Plan.

HMG has formulated a policy governing the utilization of natural water bodies for fishery production which centers around the development of cage culture in lakes in the Pokhara Valley, along with the establishment of seed production and aquaculture technology for indigenous species. Effects are underway toward implementing these plans, with Pokhara positioned as the base for the former objective and Trisuli for the latter. A survey on the forms of riverine use, conducted principally at Trisuli, has been proceeding smoothly, aided by the findings of a mini-program for fisheries development inaugurated by the JOCV in 1987.

Cage culture in the Pokhara Valley has spread rapidly, thanks to technical cooperation from JOCV. As a result, seed production at the Fisheries Development Centers (FDC) in the Terai region has been totally unable to keep up with demand, resulting in a chronic shortage of seeds in the Pokhara Valley. The most important problem at present for Nepal's fishing industry is to expand the fish production of various species , and, to achieve this goal, there is a need to expand the area of pond culture and greatly increase the supply of seeds. The lack of facilities in the Pokhara Valley for seed production is, thus, a major bottleneck in the program to boost production volume.

In order to promote the use of natural water bodies for fish production, HMG has identified a need to consolidate the limnological research activity programs at Pokhara FDC and the riverine research activity programs at Trisuli FDC, which have thus far been operated independently, and develop an efficient level of technology. It has selected Godawari as the area best suited logistically for an organization to coordinate research activities in both FDCs, and Begnas as the site for a center designed to supply seeds to the Pokhara Valley and also play a central role in limnological research.

A "Project for Natural Water Fisheries Development" has been formulated to establish these two centers, and a request has been made to the Government of Japan for a grant aid to help implement this plan.

Upon receiving this request from HMG, the Japan International Cooperation Agency (JICA) dispatched a Project Formulation Team to Nepal to study the Project for Natural Water Fisheries Development (hereafter called "the Project") and determine the appropriateness of extending aid for this program.

Based on the report of this Project Formulation Team, the Government of Japan decided to conduct a Basic Design Study on the Project. To implement this survey, JICA dispatched a Basic Design Study Team to the Kingdom of Nepal from March 18 - April 6, 1990.

This Basic Design Study Team validated the contents of the Request with respect to the plan to develop Fisheries Development Centers at Pokhara and Godawari. For purposes of evaluating the suitability of the Project and the scope of the facilities and equipment plans, the Team conducted a field survey on the state of Nepal's aquaculture industry, activity patterns for similar facilities, and the plans for Project implementation and management. In addition, a topographical and geological survey was conducted at the proposed Plan sites for construction of the related facilities.

Based on the field survey and discussions with concerned officials of HMG, the Basic Design Study Team concluded that it would be appropriate, for purposes of increasing cage culture production in the Pokhara Valley and establishing seed production and aquaculture technology for indigenous species, to construct facilities and provide the required equipment for a Seed Production Center at Begnas, under control of the Pokhara Fisheries Development Center, a Fishermen Training Center at Phewa, a Fish Collection Shed at Rupa, and a facility to coordinate research on natural water bodies at the Godawari Fisheries Development Center.

Following further analysis and evaluation of the findings of the field survey, the Team prepared the following outline of the facilities deemed necessary and appropriate for implementation of the subject Project. Regarding with the equipment for laboratory, seed production, training and seed transport, since a Project-type Technical Cooperation Programme by JICA is anticipated in cordination with the subject Project, and the Team believes that it will be more effective to furnish the said equipment in accordance with the progress of the Technical Cooperation Programme, the Team centered the Basic Design Study on the buildings, the civil engineering work and the materials for aquaculture and fishery use.:

1. Begnas Seed Production Center:

(1) Construction program:

a) Administrative office	487.00 m^2
b) Hatchery for indigenous species	224.00 m^2
c) Hatchery for Chinese & Indian Major Carp	245.00 m^2
d) Feed production shed	72.00 m^2
e) Storage house	144.00 m^2
f) Night quarters	61.25 m^2

(2) Civil engineering work:

a) Brood ponds	50 x 40 m (x 4)
b) Nursery ponds	40 x 25 m (x 6)
	25 x 20 m (x 40)
c) Raceways	1 x 6 m (x 10)
	12.5 x 2.4 m (x 2)
d) Stocking ponds	2 x 3 m (x 10)
e) Water intake facility	
f) Filtration tank	
g) Water supply and drainage channels	
h) Road	6 m width;
	2,100 m length
i) Connecting bridge	6m width; 10 m
j) Dike	Crown height 3.0m
	Length 343 m

(3) Equipment and materials:

a) Ice making facility	500 kg/ 24 hours
b) Draft chambers	2 units
c) Emergency generator	35 KVA

2. Phewa Fishermen Training Center:

(1) Training building	264.0 m^2

3. Fish Collection Shed at Rupa:

(1) Fish Collection shed	32.0 m^2

4. Godawari Fisheries Development Center:

(1) Research & administration building	245.0 m^2
(2) Raceways	1 x 6 m (x 10)
	12.5 x 2.4 m (x 2)

5. Materials for Aquaculture and Fishery Use:

(1) Materials for cage culture	1 lot

(2) Materials for penculture 1 lot

(3) Materials for Gillnet 1 lot

The period of construction is expected to require a total of 15.0 months from the Consultant Contract between the HMG and a Japanese Consultant, comprising: 4.0 months for detailed designs, tenders, and contracts and 11 months (from the date of contract) for the first phase, and a total of 11.0 months from the Consultant Contract, comprising: 3.0 months for detailed designs, tenders, and contracts and 8 months (from the date of contract) for the second phase.

The Seed Production Center at Begnas, the Fishermen Training Center at Phewa, and the Fish Collection Shed at Rupa will all be under the supervision of the Pokhara Fisheries Development Center, while the Godawari facility will be under the control of the Godawari Fisheries Development Center, with overall responsibility for operation and maintenance of all facilities vested in the Fisheries Development Division (FDD) of the Department of Agriculture. Since the necessary expenses for facility operation have already been appropriated in the 8th 5-Year Plan, no problems are anticipated in this connection.

The equipment and materials for aquaculture and capture fisheries are to be sold to fishermen who have completed the training programs, and the revenues from these sales are to be placed in a special reserve fund for fishery development, which will be drawn on for the purchase of replacement purchases of aquaculture and fishery equipment, subject to the prior approval of the Government of Japan.

If the Project is implemented, resulting in the construction of a Seed Production Center at Pegnas, a Fishermen Training Center at Phewa, and a Fish Collection Shed at Rupa, an increase in seed production together with an improvement in aquaculture productivity can be expected in the Pokhara Valley, which, in turn, will lead to a growth in the supply of animal proteins for the Nepalese people.

The benefits resulting from seed production are expected to far outweigh the costs of operating the Pokhara Fisheries Development Center. In addition, the building of a coordinated research facility at the Godawari Fisheries Development Center for the development of production from natural water bodies will result in more effective diffusion of research findings at Trisuli and Pokhara, and this may be expected to contribute significantly to the expansion of production from both captured fisheries and aquaculture operations in natural water bodies. And, based on the equipment supply programs for both fishery sectors, which are to be simultaneously implemented, an increase in both production and fishermen's incomes can be anticipated.

Based on the above considerations, the Basic Design Study Team concludes that there will be major significance in implementing the subject Project on the basis of grant aid cooperation from the Government of Japan.

CONTENTS

CHAPTER ONE: INTRODUCTION

Freshwater aquaculture in Nepal have developed rapidly as a result of technical and funding support from the ADB, other international agencies, and various foreign countries, including Japan. In particular, the aquaculture industry, utilizing the village ponds of the Terai region, has expanded significantly, thanks to a rise in the levels of seed production technology and a diffusion of aquaculture techniques. As a result, 4,500 ha of the 5,000 ha of water areas capable of being used for aquaculture purposes in the Terai are already under cultivation, leaving very little room for new development in this region.

HMG has, therefore, decided to put major emphasis in its 8th 5-Year Plan (1990/91 - 1995/96) on the development of natural water bodies, which incorporate a much larger area than the village ponds of the Terai region, particularly the natural and artificial lakes and rivers of the Midland. In order to promote the utilization of fish resources in natural water bodies, the HMG has determined a need to unify the hitherto separate activities of the Trisuli Fisheries Development Center, which is oriented to research on seed production and aquaculture technology on indigenous species to encourage riverine development, and those of the Pokhara Fisheries Development Center for the promotion of cage culture in lakes as a means of improving the efficiency of technical development in these fields. The Godawari Fisheries Development Center has been selected as having the best logistics for coordinating research activities on natural water bodies in Pokhara and Trisuli, while the Pokhara Center has been chosen as most appropriate for seed production and supply to the Pokhara Valley as well as for playing a central role in limnological research as well as fishermen training programs. A "Project for Natural Water Fisheries Development" has been formulated to govern the development of these facilities, and the HMG has made a request to the Government of Japan for a grant-in-aid and technical cooperation to implement this Plan.

Upon receiving the request from HMG, the Japan International Cooperation Agency (JICA) dispatched a Project Formulation Team to Nepal from November 28 to December 10, 1989 to study the Project for Natural Water Fisheries Development (henceforth called "the Project").

This Project Formulation Team validated, through discussions with concerned officials, the present conditions in Nepal's aquaculture industry, the necessity of the Project in light of the national development objectives, as well as its background and objectives and also conducted a site survey. As a result of this survey, it became clear that the Project would contribute in a major way to the development of the country's aquaculture and to the riverine fisheries in general. The Team, accordingly, confirmed the appropriateness of extending cooperation for this Project.

Based on the report of the Project Formulation Team, the Government of Japan decided to carry out a Basic Design Study on the subject Project. For purposes of conducting this survey, JICA dispatched a Basic Design Study Team to Nepal from March 18 to April 6, 1990, led by Mr.Naoyoshi Sasaki, Deputy Head of the Fisheries Technical Cooperation Division, Division for Cooperation in Agriculture, Forestry, and Fishery Development, JICA.

This Basic Design Study Team validated the contents of the Request relative to the planned development of the Pokhara and Godawari Fisheries Development Centers and, in order to examine the appropriateness of the Project and the scale of facilities and equipment, undertook a field study on the present state of Nepal's aquaculture, activity patterns for similar facilities, and the implementation and operating structure for the Project. A topographical and geological survey was also conducted on the Plan sites for facility construction.

The basic understandings reached in the course of discussions between the Team and the HMG during the field survey were consolidated into a Minutes of Discussions, which was signed by both parties.

Upon returning to Japan, the Team analyzed and examined the survey findings and recognized that the Project would make an effective contribution to fisheries development in Nepal. The Team then prepared a Basic Design, which included suggestions on the optimum scale of the Project and the facilities and equipment to be provided as well as project costs, evaluation, and recommendations. This material is presented in this Report on the Basic Design Study.

Details on Team composition, discussants in HMG, the itinerary of the field survey, and the Minutes of Discussions are shown in the Appendix following the report.

CHAPTER TWO: BACKGROUND OF THE PLAN

2.1 Profile of the Kingdom of Nepal:

2.1.1 Geographical and Climate Characteristics

The Kingdom of Nepal is situated in the southern foothills of the Himalaya Range. It is a long, narrow country, extending, in an east-west direction, from 80° - 88° E longitude and from 27° - 30° N latitude. The area south of the Himalaya range is made up of a number of long, narrow ridge lines, followed by a central mountain region characterized by gentle slopes and altitudes of 600 - 2,000 m. But altitudes increase again in the rugged Midland, containing several peaks in the 3,000 m class, which runs in an east-west direction into the Mahabharat range and then into an alluvial plain of about 200 m elevation. Thus, over a short north-south distance of only 100-200 km, there is a variation of some 8,000 m in altitude.

Nepal is at about the same latitude as Amami Island (in Kagoshima Prefecture) and belongs to the sub-tropical zone but, owing to variations in altitude, there are major climatic differences. The country divides generally into 3 areas: the Himalayas, the Midland, and the Terai plains.

In the mountainous district, over 3,000 m high, the maximum summer temperature does not exceed 20° C, while minimum winter temperatures fall below - 10° C. The monsoons, which arrive between late May and early June, bring rainfall to the southern side of the main Himalayan ridges and dry winds to the northern side. Accordingly, total annual precipitation on the northern side of the Himalayas does not exceed 1,500 mm, while, in the Midland on the southern slopes, the average is about 3,000 mm, with Pokhara at the 4,000-4,5000 mm level.

The climate in the Midland is mild. For example, in Kathmandu, at 1,300 m elevation, average January temperatures run 0°C and those in July 25°C, evidencing a relatively gentle temperature curve. In the Terai, the climate closely resembles that of India, with maximum summer temperatures of over 40° C, with minimum winter readings never falling below 5° C. Average rainfall is 2,000 - 2,500 mm, of which 80% is concentrated during the monsoon season from June to September.

While the Terai plain is flat, its climate is quite unhealthy-- both torrid and humid. Formerly, the area was covered with dense forests, with malaria rampant. For this reason, despite the fact that 2/3 of Nepal's cultivable land is found on the Terai plain, until recent times, the bulk of the Nepalese population had been concentrated in the Midland. However, under the pressure of a 2.6% per annum population growth as well as a chronic food shortage, HMG has been attaching top priority to agricultural development in the Terai, which has huge leeway for growth.

Based on the government's policy of concentration on the agricultural development of the Terai region and its corollary resettlement program targeted at this region, 43.6% of the nation's total population now lives on the Terai plain, vs. 47.7% in the Midland hill area and the remaining 8.7% in the mountainous regions. About 10% of the Midland hill district is considered arable, while 40% of the Terai plain is already under cultivation.

2.1.2 The Economy

The major pillar of the Nepal economy is agriculture, which accounts for about 60% of GDP. However, while agricultural production increased slightly in 1987/88 and 1988/ 89, the real growth rate from 1981 to 1986 average only 3.5% per year, barely exceeding the 2.6% population growth.

From the standpoint of employment patterns as well, the country shows a major reliance on sell-sufficient agriculture. According to the 1981 Census, 91.1% of all workers (persons 10 years or older engaged in gainful pursuits) were engaged in the agriculture, forestry, and fisheries.

While the bulk of the population is highly dependent on agriculture, productivity in this sector is quite low, owing to the steep topography and the country's narrow configuration. In addition, under the relentless pressure of population growth, agriculture is spreading to marginal areas that are not necessarily suited to cultivation. And, as a result of indiscriminate logging, which has reduced the proportion of forest land to total area to a bare 0.6%, water retention of the land has fallen, while rain-induced erosion has become very acute, and haphazard, unplanned grazing has led to destruction of the land. All of these factors have produced a decline in agricultural production capacity per unit of area.

Under present conditions, where available land for agricultural expansion in the Terai has almost disappeared, a need has developed to tap the productivity of lands in other parts of the country, including the Midland, subject to a careful consideration of ecological factors.

2.1.3 Religion and Ethnic Groups

The Kingdom of Nepal is the only country in the world to have established Hindu as the nation's official religion. The caste system, which is inextricably linked to the Hindu religion, is an integral part of the nation's life and, even though prohibited by law, remains strongly imbedded as a social custom, creating numerous social problems, such as occupational patrimony and conflicts due to marriages between castes.

Nepal has a variety of races, ethnic groups, languages and cultures coexist within the country's small area. The ethnic groups can be classified into those of Tibetan-Nepalese extraction and Indo-Nepalese groups .

This minute ethnic pattern coincides also with linguistic areas. The Tibetan-Nepalese groups belong to the Tibetan and Burmese language groups, while the Indo-Nepalese speak a language derived from the Indo-Aryan tongues. These respective ethnic groups tend to live in areas of similar altitude.

2.2 State of the Nepalese Fishing Industry

2.2.1 The Position of the Fishing Industry:

The share of the fishing industry in Nepal's GDP is quite small relative to that of livestock raising and forestry. For the inhabitants of the Midland hill region, which is poorly endowed for agriculture, livestock has become a key source of both nutrition and income. The total number of livestock-- cows, water buffalo, goats, and sheep -- is said to be equal to the nation's human population. However, the pattern of livestock breeding is almost entirely extensive and dominated by small family units, resulting in low productivity, while the disorderly and indiscriminate grazing has caused serious damage to the natural environment. In addition, since cows may not be slaughtered, for religious reasons, they cannot, with few exceptions, be used as food, and so dairy products have become the nation's only major source of protein.

Although a landlocked country, Nepal contains many rivers, lakes, and reservoirs. While the volume of fishery production is not large, the country holds high expectations for the growth of its natural water fisheries and aquaculture. This is because these resources can be harvested without risk of environmental destruction and in full harmony with the ecology. Moreover, production costs for fishing activity are extremely low, while protein value is very high. Also, fishing provides employment and income opportunities to people of low social strata. In addition, fish, like lamb, is an animal protein that can be eaten by all castes.

The total water area of Nepal is 395,000 ha, of which natural lakes comprise 5,000 ha and reservoirs 332 ha. In addition, as a result of hydro-power and irrigation projects, a not inconsiderable water area is expected to be added in the future. Hydro-power projects, in particular, in a country with few other natural resources, are attracting major priority, in view of the abundant water and steep gradients throughout the country. HMG is, therefore, paying close attention to the possibility of using the reservoirs formed by newly constructed dams for fishery development purposes.

2.2.2 The Fisheries

The fisheries is divided into captured fisheries and aquaculture. While the former generally relies on fishing lines, nets, and fish traps, gillnets are also employed in lakes in the Pokhara Valley. In the Terai, the rivers are quite wide and gentle but, in the Midland hills, they are rapid and rocky. Also, during the rainy season, the extreme increase in water volume renders fishing activity impossible. Thus, the captured fisheries has not developed in such areas, with productivity low. Catches are being taken by means of dynamite and poison, which is leading to a contraction of the natural resources.

The volume of fish production from all sources in 1984/85 totaled approximately 5,000 tons, including 2,200 tons from captured fisheries and 2,500 tons from aquaculture.

2.2.3 Aquaculture

In contrast to the static pattern of fishery production for more than a decade, aquaculture output has shown steady growth, having increased five-fold from 500 tons in 1975 to 2,500 tons in 1985. The bulk of this growth has occurred in village ponds on the Terai; thus, past growth has been largely the result of an expansion of aquacultural pond area. But 4,500 ha of the 5,000 ha of water area available on the Terai for aquaculture use are believed to be already under cultivation and so, in terms of further production increases, there is a need to raise the productivity per unit of area and develop new cultivation areas.

HMG, while continuing to base the country's aquaculture production in the Terai region, has recognized the acute shortage of pond areas to support further aquaculture activity in this region. It has, therefore, for some time, had a plan to utilize large natural water bodies for fishery development and so has come to attach urgent priority to fishery development in the rivers, streams, lakes, and reservoirs of the Midland.

The important species for aquaculture are common carp, grass carp, silver carp, bighead carp, and Indian major carps known as rohu, catla, and mrigal (naini). Such cold water species as asala, katle, and sahar have been important in the captured fisheries, but, in recent years, with the increased interest in the development of natural water bodies, these species are also being carefully studied as candidates for aquaculture.

2.3 Projects for Fisheries development and Foreign Aid:

2.3.1 Technical Cooperation in the Initial Stage

Except for the USAID boat construction project, virtually all fishery-related projects carried out to date in Nepal have been targeted at aquaculture.

Modern aquaculture in this country got its start with the introduction of Indian major carp in 1945. But, properly speaking, full-scale development in this field did not start until 1962/63, with the construction of a hatchery at the Godawari Fish Farm, based on USAID assistance. Since then, government-run Aquaculture Seed Production Centers have been built in various parts of the country, primarily in the form of technical cooperation from the WFP and the FAO/UNDP. Research at these Centers has been conducted on artificial insemination and hatching technology, which have given a good base to the country's aquaculture. Japan too has provided technical assistance through the dispatch of JOCV teams, the donation of equipment and materials, and the training of Nepalese officials in Japan.

In 1975, under the "Integrated Fisheries and Fish Culture Project", implemented by UNDP/FAO, the effectiveness of pond culture integrated with agricultural production, for carp, ducks and hogs, was clearly established. Since that time, Nepal's aquaculture has split in two directions: polyculture in village ponds on the Terai and cage culture in natural lakes and reservoirs. JOCV extended technical cooperation in association with UNDP/FAO experts, in the conduct of basic research on natural water bodies (rivers, lakes, and reservoirs), the introduction of cages into natural lakes and reservoirs.

2.3.2 The "Aquaculture Development Project" of the ADB:

There are 5,000 ha of village ponds in the Terai region, of which the great bulk are suitable for aquaculture. In the ADB Sector Study focusing on this area, major potential was identified for expanding fish production via the development of village pond culture in Terai.

Under the "Aquaculture Development Project" of the ABD, in the public sector, a plan was developed for establishing facilities and strengthening the 5 existing Fishery Development Centers in the Terai plain of Central, Western and Mid-Western regions. In the private sector, the plan comprised the improvement of 2,000 ha of existing ponds and the construction of 800 ha of new ponds, through financing by the Nepal Agricultural Development Bank; the construction of 25 new seed production facilities; and the provision of credits to fishermen, with the Janakpur Fishery Development Center serving as the base for this activity.

Based on this Aquaculture Development Project, the technology established at the government's Fishery Development Centers has been diffused in the private sector, and this, combined with the supply of high quality seeds, has contributed to a spectacular increase in aquacultural production.

2.3.3 The 2nd ADB Aquaculture Development Project

Based on the success of the first Aquaculture Development Project, HMG, with further aid from ADB /UNDP, drafted a second Aquacultural Development Project in 1986, which is now being implemented. This Project is intended to expand fish production, increase employment opportunities and incomes among fishermen, improve the foreign exchange balance through fish exports, and promote aquaculture among small-scale farming households as a means of eradicating poverty in rural areas.

This 2nd Project aims, at the public level, at increasing seed production capacity, strengthening the 6 existing Fishery Development Centers in the Western, Central, and Eastern development regions, reconstructing existing Fishery Development Centers in the Far Western region, and constructing new Fishery Development Centers in the Mid-Western development region.

In the private sector, the Project calls for funding construction of 1,400 ha of new aquaculture ponds in Terai and improving fingerlings production and fish distribution facilities. It also incorporates research, public information services, and training programs with a view to expanding productivity and earning power within the capabilities of local fishermen.

2.4 The Fisheries Development Plan:

2.4.1 The 7th 5-Year Plan (1984/85-1989/90)

Under HMG'S 7th 5-Year Plan (1984/85-1989/90), with a view toward maximum utilization of the Terai village ponds, human resources and facilities were concentrated on a priority basis in this region, and a start was made on research and training programs geared to production. But the Plan also took note of the water resources of natural water bodies, with surveys on the riverine fisheries development potential of these bodies accorded high priority. As the central facility for aquacultural research and training for warm-water species in village ponds in the Terai region, an Aquaculture Center for Training and Allied Research (ACTAR) was established in Janakpur.

In comparison with the well-developed village ponds in Terai, aquacultural development in natural water bodies has lagged. The total water area of Nepal, as of 1986, was 735,000 ha, of which village ponds comprised 5,000 ha and irrigated rice fields 325,000 ha, with the remainder accounted for entirely by natural water bodies. In the future, another 78,000 ha of reservoirs are to be created through hydro-power and irrigation projects. And, even allowing for the planned 1,400 ha increase in pond areas in Terai under the 2nd Aquaculture Development Project, the vast undeveloped area of natural water bodies far exceeds the remaining pond areas in the Terai region.

2.4.2 Draft 8th 5-Year Plan (1990/91-1994/95):

The draft 8th 5-Year Plan (1990/91-1994/95), as priority policies in the fishery sector, continues to pursue expansion of aquacultural pond in Terai, while also coming to grips with full-scale fisheries development in natural water bodies.

In this 8th Plan, the following four areas have been given precedence in the utilization of natural water bodies for fish production:

1) Environmental protection and the implementation of fishery resource studies in natural water bodies.

2) Extension of cage and pen culture.

3) Utilization of commercially significant indigenous species -- asala, katle, and sahar -- for fisheries production.

4) Establishment, expansion, and equipping of a Fisheries Development Center at Godawari as the headquarters for natural water body study; having the Pokhara Fisheries Development Center take charge of limnological study and making the Trisuli Fisheries Development Center responsible for riverine study; strengthening the Inland Fisheries Development Office at Kulekhani to take charge of fisheries development in reservoirs.

The JOCV is currently engaged in a mini-program involving the dispatch of a team to the Trisuli Fisheries Development Center, and expansion and improvement of the Center with a view to strengthening its operations. JOCV has also been continuing a program to extension of pond culture and conduct basic research on the reproduction technology of cold-water species, artificial feed, and rivers.

The two main achievements to date in aquaculture development in Nepal's natural water bodies, mainly resulting from the JOCV programs, have been the following:

1) Although only on an experimental scale, success has been recorded in the artificial breeding of the main commercial cold-water species: asala, katle, and sahar.

2) Success has also been achieved in cage culture in lakes in the Pokhara Valley. This cage culture has been demonstrated to be of high profitability and has been diffused among private farmers, resulting in a present annual output of some 65 tons.

2.5 Background and Nature of the Request:

2.5.1 History of the Request

The rapid growth in aquaculture production in Nepal reflects the priority HMG has attached to development in the Terai region, which is endowed with many village ponds suitable for aquaculture. As a result of this policy, seed production technology has improved, while aquaculture technology has been smoothly transferred to the private sector. An even more direct stimulus has been the expansion of aquaculture pond areas on the Terai plain. However, the great bulk of the available water areas in Terai for aquaculture use are said to be already under cultivation, and this poses a major roadblock to further production increases in the region.

On the other hand, since the bulk of Nepal's natural water bodies remain undeveloped in the Midland hills, if these vast areas could be utilized for fishery purposes, a rapid increase could be expected in fish production. But the research required to this end has only just begun and, with the exception of Pokhara Valley, virtually none of these natural water bodies are yet being used for fishery purposes.

The Fisheries Development Division in Nepal's Ministry of Agriculture has drawn up plans relative to the fishery use of natural water bodies, geared to the promotion of cage culture in lakes and reservoirs and the establishment of aquaculture technology for indigenous species, with Pokhara positioned as the base for the former activity and Trisuli for the latter. Efforts to implement these projects are now underway.

Studies on usage patterns in river areas, focusing mainly on Trisuli, have been progressing smoothly, aided by the results of the mini-program for fishery development that has been carried out by the JOCV since 1987. Cage culture in Pokhara is also being rapidly diffused with technical cooperation from JOCV. However, in view of the lack of adequate seed production facilities in the Pokhara Valley, fingerling supply has become an acute bottleneck for the future expansion of fish production.

In order to promote the use of natural water bodies for fishery production, HMG has concluded that there is a need to improve the efficiency of technical development by coordinating the activities of the Pokhara and Trisuli Fisheries Development Centers, which have hitherto been operated independently. For this purpose, the Godawari Fisheries Development Center has been selected as the organization best equipped to coordinate research on natural water bodies at Pokhara and Trisuli, while the Pokhara Fisheries Development Center has been chosen as the site of a center for seed production and supply to the Pokhara Valley and as the organization to play a central role in limnological research and fishermen training. The Project for Natural Waters Fisheries Development has been designed to provide the above facilities, and a Request has been made to the Government of Japan for grant-in-aid cooperation to implement this Project.

2.5.2 Nature of the Request

The Basic Design Study Team conducted a survey on current conditions in the target Project areas, topography and geology, and the state of aquaculture in various parts of the country and collected relevant data and materials. The Team also reviewed the Request submitted by HMG along with the subject Project.

On the basis of these investigations and the discussions held with the Fishery Development Devision of the Ministry of Agriculture, the Team validated the Nepal Request. As validated and discussed with the officials concerned of HMG, the Request contained the following items, listed in order of priority:

1. Pokhara/Begnas:

1) Brood ponds/nursery ponds.
2) Hatchery for Chinese and Indian Major Carp.
3) Hatchery for indigenous fish species.
4) Laboratory.
5) Equipment for Laboratory.
6) Office cum meeting room
7) Protection dike.
8) Water supply and drainage canals.
9) Feed production shed.
10) Materials for cage fishculture and pen-culture.
11) Materials for captured fisheries.
12) FRP boats with outboard engine.
13) Vehicles with fish container.
14) Floating watch house.
15) Ice making facility.
16) Store room.
17) Net shed.

18)Motor cycles.
19)Garage.

2. Godawari

1) Laboratory.
2) Equipment for Laboratory.
3) Raceways.

3. Pokhara/Rupa

1)Small fish collection shed.
2)Equipment for above.

4. Pokhara/Phewa

1)Training facility for fish farmers.

At the discussion stage, it was decided to eliminate from the Request the request for a connection road from Lake Rupa, since a budget had not yet been secured to acquire the required land and, at least for the time being, primary consideration must be given to establishing a proper production structure.

Also, with regard to the training of fish farmers at the Pokhara Fisheries Development Center, the original plan was to locate this activity within the Seed Production Center to be newly built at Lake Begnas. However, since this site is distant from the city of Pokhara, which would entail transportation and lodging costs for the trainees, it was felt that it would be more convenient to establish the Training Center within the existing Center at Lake Phewa, and the Request was modified accordingly.

CHAPTER THREE: NATURE OF THE PLAN

3.1 Plan Objectives:

The objective of this Plan, based on the 8th 5-Year Development Plan of HMG, is to promote increased fish production and fishery development in natural water bodies in the lakes and reservoirs of the Midland.

The following facilities are to be provided, in accordance with the Plan objectives:

1) A Seed Production Center to eliminate fingerlings shortages in cageculture in the Pokhara Valley;

2) Basic research facilities for riverine and limnological studies as well as research on indigenous species;

3) A Training Center for fishfarmers within the Pokhala Fisheries Development Center;

4) Facilities and equipment to integrate research activities on natural water bodes at Pokhara and Trisuli, to be located within the Godawari Fisheries Development Center; and

5) A facility at Rupa to collect data of fish production.

3.2 Evaluation of the Request:

3.2.1 Justification of the Project

Per-capita fish consumption in Nepal, according to FAO data (1987 Yearbook) averaged only 0.5 kg/year during the 1984-86 period (supply: 7,793 tons; population 16,484,000). This level is extremely low relative to the global average for this period of 12.4 kg/year and even that for less developed countries (LDCs) alone: 8.1 kg.

HMG, with a view to improving the nutritional standards of the Nepalese people, seeks to increase per-capita fishery intake by the final year of the 8th Development Plan to 1.2 kg/year and deems it essential to this end to expand capture fisheries and aquaculture production in natural water bodies.

The present low levels of fish consumption may be attributed to inadequacies in absolute supply rather than to a lack of demand for fish products. To the contrary, except for committed vegetarians, fish has an important value, comparable to goat meat, as a source of animal protein, with no religious on its consumption. But, despite the deep-seated demand for fish products, owing to a lack of growth in capture fisheries production in natural water bodies, reflecting adverse natural conditions, the future increase in fish supply will have to rely on an expansion of aquaculture output. But the production of fish seed at Fisheries Development Centers around the nation has been unable to keep up with private demand, leading to chronic supply shortages.

For Nepal's fisheries, then, the most pressing matter at the present time is to increase fish production, and, to achieve this objection, there is a critical need to expand water surface areas for aquaculture and develop an ample volume of seed production.

3.2.2 Management Plan

The Seed Production Center to be established at Lake Begnas, the Fishermen Training Center to be located within the existing Fishery Development Center at Lake Phewa, and the Shipping Shed at Lake Rupo will all be attached to the Pokhara Fishery Development Center. The raceways and research facilities to be built within the Godawari Fishery Development Center will be attached to the latter Center.

The total present staff at the Pokhara Fishery Development Center is 59, comprising 48 technicians and 11 office workers, including 15 aquaculture specialists. The FDD plans to add 6 aquaculture technicians to the staff by the time the Project facilities are completed as well as 7 at the Begnas Seed Center, 2 at the Rupa Branch Center, and 14 at the Phewa headquarters of the Pokhara Fishery Development Center.

3.2.3 Similar Plans; Relationship to Other Aid Programs:

Aquaculture in Nepal has received aid from the ADB and other sources and has developed primarily in connection with warm-water species in the village ponds of the Terai region. However, for future growth, it is felt that the most important area of aquacultural development will be among cold-water species in the natural water bodies of the Midlands.

The ADB is currently implementing its 2nd Aquaculuture Development Project in the Terai region, but the main sources of assistance for aquacultural development in natural water bodies in the Midlands have been the JOCV (Japan) and IDRC (Canada). The contents of the subject Request from HMG incorporates: a request for a grant-in-aid for the development of natural water body fisheries, which is a priority goal of the 8th 5-Year Development Plan, covering new and expanded facilities for the Godawari Fisheries Development Center, which serves as control headquarters; the Pokhara Fisheries Development Center, which is to take charge of limnological development; and the Trisuli Fisheries Development Center for riverine development. The Request also covers technical cooperation in the field of aquaculture development, including the dispatch of experts.

Among the 3 facilities that are the subjects of the grant-in-aid request, the JOCV is already providing facilities under its Mini-program for the Trisuli Fisheries Development Center, and so no immediate need was identified in the report of the Project Formulation Team for expanding these facilities. Accordingly, this phase was not included in the Basic Design Study.

The HMG highly values the important work of JOCV to date in fisheries development in the Midland and, thus, has concluded that, if fisheries development were implemented in natural water bodies in the Midland, it would be most appropriate to seek cooperation from Japan, at both the technical and funding levels, resulting in the present Request.

3.2.4 Components of the Plan:

The subject Plan is composed of two elements: the construction of facilities and the provision of research equipment and materials.

The requested construction program is spread over four sites: Begnas, Phewa, Rupa (in the Pokhara Valley), and Godawari. The facilities at Begnas, Phewa, and Rupa will be attached to the Pokhara Fisheries Development Center, while those at Godawari are to be built on the premises of the Godawari Fisheries Development Center.

The facility requested at Begnas is a Seed Production Center, to comprise brood ponds, nursery ponds, hatchery for Chinese and Indian Major carp, water intake and drainage facilities, administration and research building, hatchery for indigenous species, warehouse, night quarters, raceways, stocking ponds, ice making facilities, dike, and connecting bridge. The above facilities are all required for the production of commercial species and for aquaculture technology research on indigenous species.

A Training Facility for fishefarmers has been requested at Phewa to provide training for new farmers and also upgrade technical levels among existing farmers. At Rupa, a request has been made for a Fish Collection Shed to collect fish production and other data on fish from Lake Rupa.

A request has also been made for a Research and Administration building and raceways at Godawari. Godawari has been positioned as the core research center for fishery development in natural water bodies, and these facilities are definitely required to carry out this function.

The equipment request covers such essential items as equipment for a hatchery, seed production, biological surveys, phsyiochemical experiments, feed production, seed transport, and cage and pen culture. However, in selection of equipment, consideration must be given to a parallel request for technical cooperation.

3.2.5 Evaluation of the Request Items:

(1) The Begnas Seed Production Center

1) Seed Production Center

a) Seed Production Ponds

The target species at the Begnas Seed Production Center will be Chinese, Indian major, and common carps. A brood pond and nursery pond will be needed of a scale sufficient to meet the planned production requirements.

There will also be a requirement, as an adjunct to the hatchery for research on indigenous species, a raceways, and also a small stocking pond for seed prior to shipment.

b) Hatchery

Since Chinese and Indian Major carp do not spawn naturally in ponds, a hatchery is required to induce spawning artificially. Required facilities at this hatchery are a conditioning tank to observe gonadal maturation of the breeders, a spawning tank with current of 0.2 - 0.3 m/sec which is effective for stimulating the parent fish spawn, incubation tanks for collecting and incubating fertilized eggs, and nursery tanks for the rearing of hatchlings until emergence to the water surface.

c) Water Intake Facilities

Since all water used in the facilities is to be drawn from Lake Begnas, water intake facilities will be required. As the site ground level is lower than water level of the lake, it will be possible to drawn in water via the siphon method, and so this method will be used in the interest of operating economy.

A well will also be required to draw in underground water for use as general-purpose water at the various facilities.

d) Filtration Tank

The lake water to be supplied to the hatchery will have to be filtered in order to secure normal hatching of fertilized eggs and to eliminate predatory fish.

e) Water supply and Draining Channel

Water supply and draining at the various facilities will be based on the open-channel method, utilizing water level differences, which will be easy to operate and maintain in Nepal.

2). Hatchery for indigenous species

The target species to be reared at this facility will include sahar (Tor Putitora) and katle (Tor Tor), indigenous species of the carp family with high market value. While research on sahar and katle is being conducted also at Trisuli, the activity at Trisuli is directed primarily at river fish, whereas the subject facility is designed to conduct research on lake fish.

3) Administration and Laboratory Building

The research objectives at this facility will be to collect and analyze basic limnological data, analyze the findings based on ecological research and lake stocking for various species, and conduct nutritional and food study. These activities will require various types of rooms, including a bio lab, chemical lab, and rooms for nutritional research and draft chambers.

Also, since the administrative functions of the Seed Production Center are to be located here, there will also be a need for a Director's office, room for experts, general office, staff room, library, and conference rooms.

4) Feed Production Shed

The feeds to be produced at this facility will be produced on a very small scale for use in seed production and for indigenous species. However, the development of feeds suitable for aquacultural use from under-utilized resources will be of considerable significance in terms of increasing fish production in natural water bodies, which is a prime goal of the FDD.

The functions required for the subject facility will include operation of a pulverizer, kneader, pelletizer, and other equipment; storage of materials and finished products; and space for outdoor (sun) drying of pellets.

5) Infrastructures

To facilitate operations at the above facilities, since an irrigation canal divides the site in two, a connecting bridge and road will be required to permit carrying seed with trucks. In addition, a dike will be mandatory to protect the facilities from damage during rainy season along the banks of the Khudi Khola.

6) Operating Facilities

For operating purposes, a warehouse, fishing gear storage and net repair area will be required. In addition, a small ice plant will be needed to make ice, as required for seed transport during the oppressively hot summer months. Also, during spawning and hatching periods, long spells of night duty will be required, creating a need for night quarters for technicians.

7) Equipment for the Research Laboratory and Seed Production Use

The required equipment and materials include scales for shipping and weighing fish, and a scoop nets.

The equipment needed for the hatchery, which is to be used to rear indigenous species, includes: incubation tanks, nursery tanks, rearing tanks, a blower for aeration, scales, and various types of instruments for analyzing water quality.

The equipment and materials for the administrative/research building will include microscopes for biological observations, sample collectors for gathering limnological data, various types of instruments for measuring water quality, analytical instruments for nutritional experiments, draft chambers, and general-purpose physiochemical equipment.

The equipment required in the feed production shed will include pulverizers, kneaders, and pelletizers.

When commencing full-scale lake stocking program, it will be necessary to monitor the effects of these programs in terms of determining the optimum number and species distribution of the stocked fish and increasing recapture ratios as a means of maximizing the use of lake surfaces for fish production. Gillnet materials will be provided for this purpose.

For purposes of distributing the seeds produced at the facility and providing technical guidance for aquaculture to private fish farmers, there is a requirement for a small truck for seed transport, motor cycles with small trailers for transporting seed to places inaccessible to trucks, and, in view of the poor road access to the opposite bank of the lake, an outboard skiff for use in seed transport, extension activities, and limnological surveys.

8) Materials for Aquaculture Use

In connection with increasing the volume of fish production in natural water bodies, the present problem areas revolve around a shortage of seed and cage materials. Accordingly, netting material will be provided for use in cage and pen culture, as required to disseminate cage culture techniques.

Under this Project, the FDD plans to sell netting directly to fishermen, with the proceeds from these sales to be invested in a revolving fund to replenish netting supplies. This is expect to result in an enlargement of cage capacity and a corresponding increase in aquaculture production.

(2) The Phewa Fishermen Training Center

As the base for fishery development in the Pokhara Valley, the Pokhara Fisheries Development Center / Phewa produce seed, edible fish, and ducks and also serve as the core organ for limnological research on indigenous species, extension of aquaculture among fishermen, and programs to promote fish production, along with administrative and management responsibilities in the fishery area.

Cage and pen culture are not necessarily familiar with every Nepalese fishermen. Thus, to expand aquaculture production, training of new entrants is indispensable. Training in more efficient aquacultural methods is also necessary for veteran fishermen as a means of raising productivity. This sort of fishermen training is to be strengthened at the Pokhara Fisheries Development Center under the 8th 5-Year Plan, and plans have been developed to stimulate fisheries by raising productivity per unit of area. However, there is no reserve capacity for conducting training programs at the existing facility. Accordingly, the subject facility is indispensable for cage culture area to develop fisheries in the future and achieving production goals as well as providing the above types of training to fishermen.

Lake Phewa is the largest lake in Pokhara, and so continuing limnological research here is of the greatest importance. The present quarters for this research are on the second floor of the administration building, where successive JOCV volunteers have carried out their work. But this area doubles as a biological laboratory and so is far too small to conduct comprehensive limnological research, including an evaluation of lake stocking programs.

In view of the confined space for future service as a limnological research facility and the lack of training rooms, it is vital that a new training facility be built.

(3) Fish Collection Shed at Rupa

While Lake Rupa is the most productive of the three Pokhara lakes, owing to the lack of an access road, it is very difficult to monitor the production and shipping volume of fish shipped from the southern tip of Lake Rupa.

When lake stocking program begin, more accurate catch surveys will be required to determine its effect. For this reason, it is essential that a fish collection shed be constructed to obtain data on shipping volume by species from the southern tip of Lake Rupa. Since the main activity at the facility will be to gather data on the volume of shipments and body lengths, the required equipment will include scales and instruments for body length measurement.

(4) Godawari Fisheries Development Center

The Godawari Fisheries Development Center had occupied a key position in the supply of seed to Terai but, as a result of improvements in seed production technology and the rapid growth in private seed production in Terai, the requisite seed volume has been largely secured. Thus, the seed distribution capability from the subject Center is no longer as important as in the past. In addition, the Plan is to have private producers provide 60% of total seed supply in the Terai region by 1994/95 and 100% by 2000/01. Thus, the seed supply function at the Godawari Center will become less and less important in future years.

On the other hand, the Godawari Fisheires Development Center, as an organization under the direct control of the FDD, is positioned as an all-around fisheries experimental station for the conduct of research and training programs related to fisheries development. But, based on its past concentration on the production of Chinese carp seed, the facilities and equipment are inadequate for rearing and experimenting with indigenous species, and so the Center has lagged in this field. Since the policy of HMG emphasizes future fishery development in natural water bodies, the subject Center, as a base for fisheries development in these bodies, is intended to unify the hitherto separate activities of the Trisuli and Pokhara Fisheries Development Centers, thereby improving the effectiveness of research and development programs.

In developing this Plan, basic experiments will be necessary, including biological and physiochemical programs in a number of research areas, which will create a need for various types of rooms and physiochemical equipment.

The subject Center is surrounded on three sides by mountains, and clear, cool water can be obtained throughout the year. Water flow during periods of heavy rainfall is 150-200 liters/second and, during dry seasons, about 60 liters, while water temperature is 18-20° C. With the use of proper grading on the site, raceways can be provided for use in conducting research on indigenous species.

3.2.6 Technical Cooperation:

The development of fisheries in natural water bodies is one of the key policies of the Fisheries Development Plan in Nepal's 8th Development Plan. The decision of HMG to request technical and financial assistance from Japan for this Project to develop fisheries in these natural water bodies evidences its regard for the work to date of JOCV, which has played a key role in cage culture development in natural water bodies in the Pokhara Valley and in the development of fisheries in the Midland through research programs on indigenous species and riverine studies at Trisuli.

Based on a grant-in-aid for the Project, a Seed Production Center will be provided to expand aquaculture production in the Midland along with other facilities to encourage research on the development of natural water bodies. In addition, in connection with the advancement of research in natural water bodies, the HMG also considers technical cooperation from Japan to be an indispensable part of the Project, incorporating both a continuation of JOCV activity and the dispatch of experts to solve technical problems.

In addition, during discussions with the Basic Design Survey Team, senior officials of the Ministry of Agriculture asked the Team to convey to the Government of Japan a request for assistance in the following specific areas:

a) As river system comprises majority of natural water bodies therefore it should not only be concentrated in Trisuli river but also include one or two other possible rivers under the project activities.

b) Ways and means of solving siltation problems in order to check decreasing depth of lakes, reservoirs, etc.

c) To suggest techniques of increasing natural food for fish in natural water bodies.

d) Provide appropriate design of fish ladder to be constructed in the dam.

3.2.7 Basic Policy on Extending Cooperation:

At the Plan site for the Seed Production Center in Begnas are an irrigation dam and canal, assuring an abundant supply of water, while infrastructure is also well developed. The Pokara Valley, including Begnas, is the focus of high expectations as the core region for stocking and aquaculture in natural water bodies, which is a key element in Nepal's fishery development program. We feel, therefore, that the area is quite appropriate as a location for seed production activity. The site is flat, and land has been secured with foundation conditions to support the various buildings, and the FDD is taking steps to obtain addition land bordering the north side of the site.

At Phewa, which is the planned site of the Training Facility for Fishermen, the Pokhara Fisheries Development Center is already in operation, and so the necessary infrastructure is already present. There should be no problems in connection with the construction program.

The Fish Collection Shed at Rupa will be a small-scale facility, requiring no power or water. The lakeside site is on government-owned land.

The Research and Administrative facility and raceways at Godawari are to be built within the Godawari Fisheries Development Center, and so power, water, and other infrastructure are available.

With respect to the operating structure, as mentioned in the Minutes of Discussion signed with the Project Formulation Team, it is planned to transfer technicians and officials from existing Fisheries Development Centers to the new facilities and also add new people. Since the operating budget has already been appropriated in the 8th 5-Year Plan, no problems are foreseen in this connection.

The Plan facilities are targeted primarily at fishery development for cold-water species in natural water bodies in the Midlands. Accordingly, there is, in our view, no likelihood that the subject Project will overlap with other aid or similar programs, such as the pond culture project for warm-water species being carried out by the ADB on the Terai or the Inland Fisheries Project for reservoirs in Kulekhani being implemented by IDRC.

As the Project Formulation Survey noted, the subject Project has evolved out of the foundation created by technical cooperation to date from JOCV. Based on this history, HMG has asked Japan to provide a grant-in-aid for facilities and equipment together with technical cooperation to further develop aquacultural research in natural water bodies and improve the efficiency of seed production.

With regard to technical cooperation, we feel that there is a need to continue JOCV programs and strengthen the cooperative structure through the dispatch of experts as well.

Based on a careful examination of the Request, no problems are foreseen with respect to Project implementation in terms of effectiveness, practicality, and the implementation capability of the beneficiary country. The Project is also fully in accord with Japan's system of grant-in-aid cooperation and so is deemed to be appropriate for such aid. Accordingly, we have proceeded with the Basic Design on the premise of a grant-in-aid from Japan for the subject Project.

3.3 Outline of the Plan

3.3.1 Implementation Organization and Management Plan:

(1) Implementation Organization

The Fisheries Development Division (FDD) of the Ministry of Agriculture will be responsible for Project implementation and for operation and maintenance of the facilities and equipment.

The FDD has technical responsibility for the fishery within the Ministry of Agriculture, which is in charge of agriculture development and production, and drafts plans for and oversees fisheries development. With regard to fisheries research as well, a National Agriculture Research & Service Center (NARSC) has been established within this Ministry to coordinate agricultural research.

Nepal, at present, has seven Fishery Development Centers across the country with responsibility for fisheries development, along with one Inland Fisheries Development Office and 5 Fisheries Development Centers oriented primarily to research activity. However, the Centers devoted to production activity are, for administrative reasons, placed under the Regional Agriculture Directorates located in each development region.

The only organizations under the direct control of the FDD are the Kulekani Inland Fisheries Development Office, which is receiving assistance from IDRC; the Balaji Fisheries Development Center on the outskirts of Kathmandu; and the Godawari Fishery Development Center. However, with regard to the 7 Fishery Development Centers located within the area of the ADB Aquaculture Development Project, project headquarters have been placed under the FDD for overall control and to facilitate coordination with the Agricultural Development Bank and other related agencies as well as between the various Centers. As a result, one might say that all of the Fisheries Development Centers are effectively under the control of the FDD.

(2) Management Structure

The Seed Production Center to be established at Lake Begnas, the Fishermen Training Center to be located within the existing Pokhara Fisheries Development Center at Lake Phewa, and the Fish Collection Shed at Lake Rupa will all be attached to the Pokhara Fisheries Development Center. The raceways and research facilities to be built within the Godawari Fishery Development Center will be attached to the latter Center.

The total present staff at the Pokhara Fisheries Development Center is 59, comprising 48 technical staffs and 11 office workers, including 7 Fisheries Development Officers. The FDD plans to add 5 Fisheries Development Officers to the staff by the time the Project facilities are completed as well as 4 at the Begnas Seed Production Center, 2 at the Rupa Branch Office, and 6 at the Phewa headquarters of the Pokhara Fisheries Development Center.

3.3.2 Operation Plan

(1) Seed Supply Targets

The lake stocking and aquaculture program in the Pokhara Valley under the 8th 5-Year Plan is as follows:

(Unit: tons)

Fiscal Year / Classification/Type of Fishery:	1990/91	1991/92	1992/92	1993/94	1994/95
Private Sector:					
1. Lake fisheries; Aquaculture					
(1) Cage and Pen Culture	60	85	109	147	160
(2) Recapture Fishery	61	64	67	74	83
Sub-total	121	149	176	221	243
2. Pond Culture	45	50	65	75	100
3. Paddy-cum-fish Culture	2.6	2.9	3.6	4.6	5.7
Public Sector:					
4. Cage Culture	9.0	9.2	9.7	10.1	10.3
TOTAL	177.6	211.1	254.3	310.7	359.0

In this Plan, the fish production target for 1994/95 is set at 359 tons, and the estimated seed production required to meet this goal will be as follows:

	Planned Production Targets (tons)	Size of Fish (kg/fish)	Necessary Survival Caught Rate (No. of Fish)	Seed Supply Volume* (No. of Fish)
Cage/Pen Culture	170	0.5 kg	340,000	720,000
Pond / Paddy-cum-fish Culture	106	0.5 kg	212,000	480,000
Recapture Fisheries	83	1.0 kg	83,000	830,000
Total	359			2,030,000

* Seed supply volume (in fry equivalents)

Cage/Pen Culture	340,000 / 0.5 / 0.95 =	720,000 fish
Pond / Paddy-cum-fish Culture	212,000 / 0.5 / 0.90 =	480,000 fish
Recapture Fisheries	83,000 / 0.5 / 0.20 =	830,000 fish

In Nepal, generally speaking, survival rates from the stage of fry (1-2g) to advanced fingerlings (10-25g) are in the order of 50%. The survival rate that can be expected from advanced fingerlings to harvesting is 95% in the case of cage and pen culture and 90% for pond and paddy-cum-fish culture. Productivity for lake fish, based on past experience, is 300 - 700g/fish, even without feeding, and average fish weights of 500 g can be expected. And, in pond and paddy-cum-fish culture, with proper rearing management, similar weights of 500 g can be anticipated.

On the other hand, with regard to the effects from lake stocking, there are many uncertain factors, so definite conclusions cannot be drawn, but, with a released seed size of 10-25g, it is felt that the decrease from predator fish is small. Thus, if escape from the lake can be prevented, recapture of a considerable number of fish is possible. During the 12 month period from July, 1988 to June, 1989, catch of silver and bighead carp in the lakes that were believed to have escaped from cages was established definitively at about 24 tons and so, if an adequate management of lake stocking is undertaken, the number of fish remaining in the lake is believed to be considerable, even under existing conditions. In addition, the total area of the 3 lakes at Phewa, Begnas, and Rupa, at about 900 ha, is not all that large, while depths are fairly shallow, at a maximum of just under 8m.

Thus, there are few problems in connection with recapture, and, depending on the fishing effort, a relatively high recovery rate may be expected. From the preceding, we have estimated a cumulative recapture rate of 20% and an average fish weight of about 1.0 kg.

From the above, if the seed production target is initially set at the lake stocking and aquaculture production volume for 1994/95, the last year of the 8th 5-Year Plan, the required seed supply becomes 2,030,000 seed, converted to a fry equivalent. Of this total, the planned seed supplies from the private sector (all fry-size) would be 246,000 fish (98,000 Chinese carp, 63,000 Indian Major carp, and 85,000 common carp). Accordingly, target seed volume for the Plan facilities would be:

2,030,000 - 246,000 = 1,784,000 seeds

Inasmuch as the existing seed production facility at the Pokhara Fishery Development Center, after the Plan facility comes on stream, is planned to be gradually diverted to training use, it will be reasonable to rely on the Begnas Seed Production Center for all of the planned seed supply.

Following is a breakdown of the various seed requirements:

SEED SUPPLY TARGETED BY THE PROJECT

(Unit: 000 seeds)

Species	Chinese Carp		Ind. Major Carp		Common Carp		Total	
Use / Seed Stage	Fry	A.F.	Fry	A.F.	Fry	A.F.	Fry	A.F.
Seed for: Cage culture	—	290	—	—	—	—	—	290
Pen culture	—	42	—	28	—	—	—	70
Recapture fishery	—	208	—	207	—	—	—	415
Pond culture	175	—	70	—	105	—	350	—
Paddy-cum-fish culture	—	—	—	—	130	—	130	—
Seed production in the Pokhara area	175	540	70	235	235	0	480	775
Private fry supply	98	—	63	—	85	—	246	—
Seed production targets under this Plan	77	540	7	235	150	0	234	775
(in fry equivalent)	1,157		477		150		1,784	

NOTE: As the method for size classification of the seeds, we shall use the following terms, for reasons of convenience:

Hatchling	larval fish just hatched from eggs
Fry	fish seed with a size of 1-2g
Advance fingerlings	fish seed with a size of 10-25g

Also, the references in the text to Chinese carp, Indian Major carp, and common carp include the following species:

Chinese carp:	Silver carp (Hypophthalmichthys molitrix), Bighead carp (Aristichthysnobilis), and Grass Carp (Ctenopharyndodon idellus)
Indian Major carp:	Rohu (Labeo rohita), Catla (Catla catla), and Mrigal (Chirrina mrigala)
Common Carp:	Common carp (Cyprinus carpio)

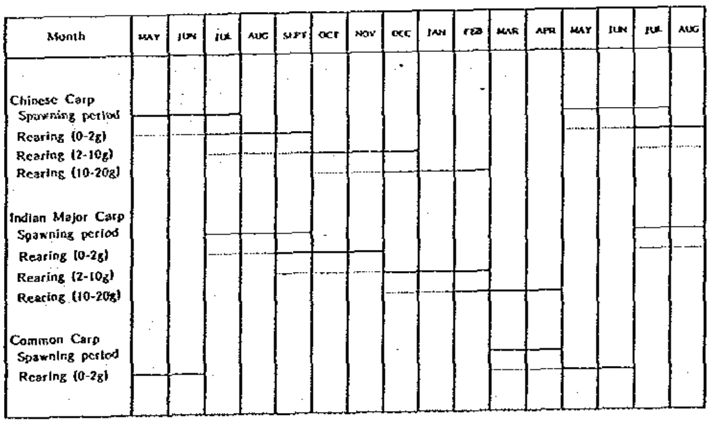
(2) Outline of Seed Production

Seed production at the Pokhara Fisheries Development Center is generally based on a method using fertilization and feeding. However, while fertilizer is supplied mainly from excrement derived from duck raising, the use of waste from other livestock or of chemical fertilizers is quite small, and so productivity cannot be said to be at adequate levels. As initial feed during the first week, chicken eggs are given, followed by a shift mainly to soybean through the eighth week. However, from a nutritional standpoint, this diet is not necessarily sufficient. As a result, present culturing operations are close to extensive culture, which relies to a large extent on natural productivity. During the early stages after pond construction, the productivity of pond is particularly low, but, with each passing year, the subsoil becomes increasingly fertile, leading to a rise in productivity. However, taking the above factors into consideration, we feel it would be proper to set the scale of the Plan facility on the basis of a productivity of 2 tons per hectare.

In addition, since , in the light of the limited area of usable land and the above productivity factor, it would be difficult to set the size of all advanced fingerlings for distribution at 15-20g or more, the scale of the Project for the Basic Design has been set on the basis of a 10g size for the advanced fingerlings to be produced at the Plan facility.

1) Nursery Ponds

The spawning seasons for the various target species in the Pokhara Valley are, for the most part: common carp, March - April; Chinese carp, May - July, and Indian Major carp, July - September. The time required to grow these species is about 2 months from hatchlings to fry, 1g to 2g, 3 months from fry to 10g size and 2 months from 10g to 20g size. The annual production cycle may be charted as shown below:



a) Seed production for Chinese carp

The spawning period for Chinese carp runs from May to July, with a peak in June. Since the rearing period from hatchling to fry is about 2 months, the planned 1-2g fry size will be reached between July and September. The fry production target is 1,157,000; figuring an average fry weight of 1.5g within 2 months after hatching, the pond area required to rear 1,735.5 kg of fry becomes:

1,157,000 fry x 1.5 g = 1,735.5 kg (1)

Of the fry produced, 77,000 will be reared to between 3g to 5g, for shipping as seed for pond culture, while the remainder will be reared further into advanced fingerlings.

In the case of Nepal, some 3 months are required to grow seeds from a 1g or 2g to a 10g size, which means that this size will be reached between October and December. Since the survival rate during this period will be about 50%, the rearing pond area must be able to accommodate production of 540,000 seed, with a total weight of 5,400 kg.

(1,157,000 - 77,000) seed x 0.5 = 540,000 seed (production target)

540,000 seed x 10g = 5,400 kg (2)

b) Indian Major carp

The spawning season for Indian Major carp runs from July to September, with a peak in August. The aquaculture methods are the same as for Chinese carp; during the first two months after spawning (September - November), the fry grow to a size of 1-2g. The fry production target is 477,000 and, based on an average weight of 1.5g within 2 months after hatching, the pond area must be sufficient to rear 715.5 kg of fry.

477,000 fry x 1.5g = 715.5 kg (3)

7,000 of the fry produced will be shipped for use in pond culture at weights of 3-5g, with the remainder to be raised to the advanced fingerling stage. The rearing period from 1-2g to 10g fry is about 3 months and so the latter size will be attained between December and February. Since the survival rate during this period is approximately 50%, the rearing pond area must be able to accommodate production of 235,000 seeds, with a total weight of 2,350 kg.

(477,000 - 7,000) seeds x 0.5g = 235,000 seeds (production target)

235,000 seeds x 10g = 2,350 kg (4)

c) Common carp

Spawning of common carp occurs between March and April. Since the production target is limited only to fry of 1-2g, the rearing period is 2 months. Thus, hatchlings hatched in March will be shipped in May, and those hatched in April in June. Since the planned production is 150,000 seeds, based on a 1.5g average size at time of harvesting, the rearing ponds will have to produced a total of 225 kg.

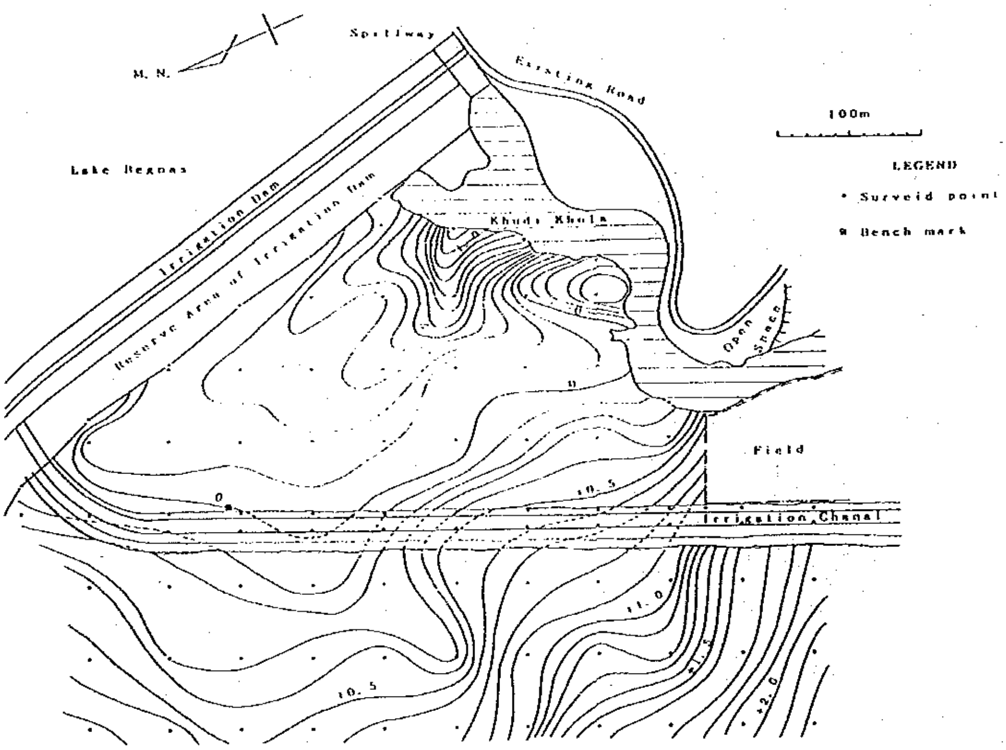
150,000 seeds x 1.5g = 225 kg (5)

3.3.3 Site Conditions

(1) Conditions at the Plan Sites

1) Lake Begnas

Lake Begnas, which forms part of the Khudi Khola basin, is located about 10 km east-north-east of Pokhara city. An irrigation dam was completed here in 1988, with a dam length of 540 m, a lake area of 300 ha, a lake live storage head of 3.6 m, and an irrigated area of 500 ha. The site for the Plan facilities is downstream from the dam; it is bordered on both sides by rice paddies and divided by an irrigation canal. Although the site is almost totally flat, there is a slight rise to the west - northwest, while the land flattens toward the east - southeast Along the banks of the Khudi khola, the land tends to rise in a downstream direction, and it may be surmised from this fact that, at some time in the past, Lake Begnas extended farther downstream than at present. A topographical sketch of the site is given below.



As a result of boring tests in the area, it has been determined that the surface level is an humus solid layer laying about 30-50 cm. Below this is a 0.2 - 4.5 m layer of ash-colored silty sand (composed of gravelly sand and silty sand with gravel), followed by a dark gray layer of sandy gravel (made up of sandy gravel, gravel sand, and silty sand with gravel). The former layer is believed to have developed from silting on the bottom of the old Lake Begnas and shows low N values of 6-13, while the latter is river bed accumulation (Pokhara Formation, Yamanaka et. al., 1982). The gravel in the sandy-gravel layer tends to become larger with depth. Gravel diameter is almost entirely 50 mm or less, and the stones are round and polished. N values were found to be high, at 18 - over 50.
Appendix V-1 contains a chart of the positions used in the soil survey, while boring logs are shown in Appendix V-2.

On the basis of in-situ permeability tests, the permeability of the soil was found to be 10^{-3}-- 10^{-4} cm/sec, so that adequate water proof treatment will be necessary for construction of ponds. The ground-water level was 1 m or less below ground surface at points in the vicinity of the dam but rather deep (1.4 m) in the downstream portion of Khudi Kohla of relatively high elevation. This situation must be carefully considered in implementing the construction program.

During 1988/89, 1.6 ha were procured by the Pokhara Fisheries Development Center, while the budget for another 3.4 ha has been included in the 1989/90 budget. Next year, budgetary provisions are planned for an additional 5 ha.

2) Lake Phewa

This facility faces Lake Phewa and situated in Pokhara city. The total area is fairly confined--only 1.3 ha (comprising a 0.3 ha pond area, 0-.3 ha for buildings, and 0.7 ha for roads and garage).
However, since the immediate area is designated as an environmental preserve, it will not be possible to expand the site. The Fishermen's Training Facility is to be located on the site of the present garage, and power and water are already available. The site, therefore, presents no problems.

3) Lake Rupa

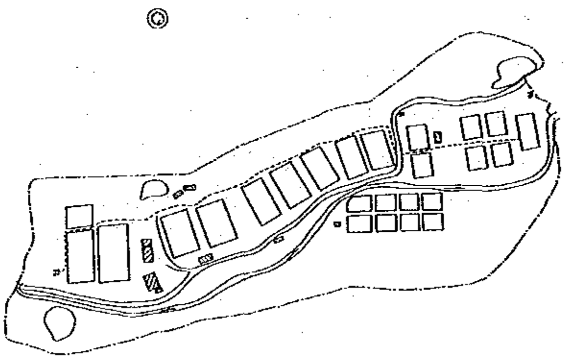
Lake Rupa is separated by a mountain from Lake Begnas but, owing to access problems, due to the lack of a road to the lake shore, the Rupa branch of the Pokhara Fisheries Development Center is situated on the mountain between Lakes Begnas and Rupa. The planned Fish Collection Shed is to be built on the flat area at the southern tip of Lake Rupa. Although the area lacks infrastructure, such as power and water, these facilities are not required for the time being at the Fish Collection Shed, and so no problems exist at the proposed site.

4) Godawari

The Godawari Fisheries Development Center is located at the southeastern edge of the Kathmandu Basin in a ravine some 15 km from Kathmandu. The Center area is approximately 3 ha, with the mountains surrounding the basin encroaching on the rear of the facility. As a result, there is a gradual upward slope from the gate to the interior of the facility. In addition, while water volume is about 60 liters/second during periods of minimum dryness, with summer temperatures sometimes in excess of 20°C, the springs originating in the mountains to the rear of the site, with normal water temperatures of 18-20°C, do not trace their origin to glaciers and so remain crystal clear throughout the year. The area is thus highly amenable to raceway aquaculture, while conditions are also good for rearing experiments on indigenous species as a core facility for research on natural water bodies in the Midland highlands.

Power and water are available, and so no problems will be encountered in this respect.

Following is a topographical chart for the Godari Fisheries Development Center:



(2) Social Infrastructure:

1) Power

Power supply in Nepal is provided by the Nepal Electricity Authority (NEA). There is a brewery near Godawari which uses the rich water resources of the area, and power conditions are generally good.

At Begnas and Phewa, a start has been made during the past few years toward developing hydro-electric stations and a power transmission grid, while power conditions in the Pokhara district are also improving. When the irrigation dam was built at Begnas, a high-voltage line was brought into the nearest bus station some 300 m from the boundary of the Plan site.
At Phewa, a power line has already been brought into the Plan site. No power is required at the Rupa facility.

The voltages used at the various Plan sites are as follows:

High voltage	11 KV	50 Hz 3-phase, 3 line
Low voltage	400 V	50 Hz 3-phase, 3 line
	220 V	50 Hz single-phase

2) Water supply

At the Godawari Fisheries Development Center, there is presently an abundant supply of spring water for both drinking and other uses. Conditions are the same at the planned Administration/Research facility, and so no problems are anticipated.

Municipal water services are available in Pokhara city, while water is also available at the Phewa Fisheries Development Center. At Begnas, while there are no water mains, springs provide water for drinking and general purposes at the Begnas Branch Center nearby.

At the Begnas Seed Production Center, it will be necessary to dig a well to tap supplies of underground water for general purposes.

3) Sewage

Except for certain parts of Kathmandu, there are no municipal sewage facilities anywhere in the country. Accordingly, septic tank will have to be provided at each Plan facility for treatment.

4) Gas

There is no municipal gas in Nepal, and supplies of LPG have been quite unstable. Thus, individual gas cylinders will be provided, as necessary to meet the needs of the research facilities, but electricity will have to be used as the primary heating source.

3.3.4 Outline of Facilities and Equipment to be provided

As a result of analysis and evaluation of the findings of the field survey, the Team believe the following facilities deemed necessary and appropriate for implementation of the subject Project. The Team also believe the equipment for laboratory, seed production, training and seed transport are imperative for the Project, though, as a Project-type Technical Cooperation Programme by JICA is expected to start in harmony with the subject Project, the said equipment could be furnished under the Technical Cooperation Program. The Team centered the Basic Design Study on the buildings, the civil engineering work and the materials for aquaculture and fishery use.:

1. Begnas Seed Production Center:

FACILITIES	FUNCTIONS
(1) Construction program:	
a) Administrative office	For Management of the Seed Production Center
b) Hatchery for indigenous species	For experiment of indigenous species culture
c) Hatchery for Chinese & Indian Major Carp	Hatching for commercial species
d) Feed production shed	Seed production experiment
e) Storage house	Ware, Net store, Ice making
f) Night quarters	Accomodation in night shifts

(2) Civil engineering work:

a) Brood ponds	For stock of parent fish
b) Nursery ponds	For seed productioN
c) Raceways	Culture for indigenous species
d) Stocking ponds	Stock seed prior to shipment
e) Water intake facility	Lake water intake
f) Filtration tank	Eliminate predatory fish
g) Water supply and drainage channels	Supply of water to ponds
h) Road	Transport within the Center
i) Connecting bridge	Access to the main road
j) Dike	Protection from flood

(3) Equipment and materials:

a) Ice making facility	For transport in hot season
b) Draft chambers	For safety
c) Emergency generator	For emergency

2. Phewa Fishermen Training Center:

(1) Training building	For training fish farmers

3. Fish Collection Shed at Rupa:

(1) Fish Collection shed	For fish production data

4. Godawari Fisheries Development Center:

(1) Research & administration building	For integrating research activities
(2) Raceways	For study of indigenous species

5. Materials for Aquaculture and Fishery Use:

(1) Materials for cage culture	For promotion of fish production

(2) Materials for penculture	For fish production
(3) Materials for Gillnet	For promotion of capture fisheries

3.3.5 Operating and Maintenance Plan

(1) Personnel Plan:

Project implementation will involve a relatively sophisticated operation, including the large-volume production of seeds for aquaculture use, rearing experiments for indigenous species, research and development of suitable feed materials, limnological research, and training and extension activities.

To this end, the Project Formulation Team felt that it would be appropriate to implement a Project-type Technical Cooperation Program. HMG has also confirmed a need to increase the number of fisheries development officers and technicians at the following Fisheries Development Centers.

Planned Staff Increases in Connection with Project Implementation vs. Present Size of the Technical Staff

	Begnas	Phewa	Rupa	Godawari
Fishery Development Officers (2nd Class)	1 (0)	1 (1)	0 (0)	2 (1)
Fishery Development Officers (3rd Class)	3 (1)	5 (4)	2 (0)	2 (2)
JT	2 (1)	4 (4)	0 (0)	2 (2)
JTA	2 (1)	4 (4)	0 (0)	4 (4)
Total	8 (3)	14 (13)	2 (1)	10 (9)

Figures in (   ) = the present size of the technical staff.

1) Begnas Seed Production Center:

Personnel requirements at this facility will include technical staff involved with seed production and research on indigenous species along with administrative staff.

Overall operations will be under the direction of Fisheries Development Officers, Junior Technician (JT) and Junior Technical Assistant (JTA). In addition, there will be a requirement for 2 driver/mechanics and 12 field technicians. The field staff will be divided into 2 teams of 6 persons each, with one team to be involved with selection and seed transport operations and the other with hatchery and feed production operations. Office staff will include an accountant and a secretary/typist plus 2 guards and 2 general workers.

	No. of Persons
Technical Staff:	
Fisheries Development Officer (Director)	1
Fisheries Development Officers	3
JT (Junior Technician)	2
JTA (Junior Technical Assistant)	2
Driver/mechanics	2
Foreman	2
Field workers	10
Office/Administrative Staff:	
Accounting Officer	1
Secretary/typist	1
Guards	2
Peons	2
Total	28

2) Phewa Fishery Training Center; Rupa Fish Collection Shed:

Staff at these two facilities will be built up, in tandem with Plan implementation, to a complement of 2 Fisheries Development Officers (3rd Class), with one assigned to each location. At Rupa, 2 persons will have to be provided to conduct data collection.

3) Godawari Fisheries Development Center:

Planned personnel additions at this Center will include a Fisheries Development Officer (2nd Class) plus a staff of 10 JTs and JTAs for research and administrative operations.

(2) Operating Costs:

(1) Begnas Seed Production Center

If this project is implemented, the main categories of operating costs at the Begnas Seed Production Center will be feed, power, fuel, and labor costs.

Based on a production of 1,786,000 seeds, the annual operating costs for this facility may be estimated as follows:

(a) Feed costs:

1)	1st week (7 days)	
	Chicken eggs	125 eggs/day x 7 days x 2 Rs = 1,750 Rs
2)	2nd week (7 days)	
	Fine soybean powder	75 kg x 20 Rs/kg = 1,500 Rs
3)	3rd to 8th Week (42 days)	
	Soybean	9,300 kg x 7 Rs/kg =65,100Rs
4)	3 months from the 9th week (90 days)	
	Feed	24,600 kg x 5.5 Rs/kg=135,300 Rs
	Total	203,650 Rs

In actuality, seed production will take the form of polyculture, involving the rearing of ducks, but the required feed costs for the ducks will be offset by sales of ducks and so do not have to be appropriated in the Project budget.

b) Power costs:

Power consumption by the various items of equipment have been set on the basis of the following conditions:

(a) Intake pump

The power costs for pumping operations, based on the siphon method, have been based on the assumption that the water level in Lake Begnas will be below that of the Plan site on 20 days each year, with pumping required on those days.

(b) Filtered water intake pump

Water will be used in the hatchery from May to September. The number of spawnings per month will be:

	May	June	July	August	September	Total
					(No. of Spawnings)	
Chinese carp	2	3	2	-	-	7
Indian Major carp	-	-	2	3	2	7
Total	2	3	4	3	2	14

The number of tanks used per spawning will be 3 in the case of Chinese carp and 2 for Indian Major carp, while the water requirement per spawning will be 30 liters/minute in both the conditioning and spawning tanks and 20 liters/minute in the incubation and nursery tanks. Thus, the total volume of water to be pumped becomes:

Conditioning tanks: 30 liters/min. x 1,440 min./spawning x 14 spawnings
= 605 tons

Spawning tanks: 30 lit./min. x 1,440 min./spawning x 14 spawnings
= 605 tons

Incubation Tanks: 20 liters/min. x 1,440 min./spawning/tank x 70 spawnings
= 2,016 tons

Nursery tanks: 20 liters/min. x 1,440 min./spawning/tank x 105 spawnings
= 3,024 tons

Total 6,250 tons

In addition, the water required for the Hatchery for indigenous species will total:

432 tons/day x 365 days = 157,680 tons,

resulting in a total water requirement of:

6,250 tons + 157,680 tons= 163,930 tons

c) Feed Production Equipment:

The volume of feed to be produced at this facility has been set at 24,600 kg/year.

d) Blower:

Blowing will be required on 100 days a year for 25% of the 35 ton tank capacity used in the Hatchery for indigenous species.

e) Test equipment:

Total rated power of the test equipment is about 10 KW, and it is assumed that this equipment will be operated 240 days per year. At peak operating times, equipment utilization has been set at 50% of capacity for 6 hours/day over a period of 60 days. On the other 180 days, the equipment will be operated at 20% of capacity for 2 hours/day.

f) Ice-maker:

Ice will be required to transport seed from May to September. It is assumed that shipments will be made on 30 days during this period.

g) Pump for general water:

We have assumed that the pump will be in use 240 days/year, with a daily requirement for 13.12 tons of general water.

h) Indoor and outdoor lighting:

The power requirements for lighting have been set on the basis of the following:

	Capacity	Number	Load	Hours	Days	Total
Indoor Lighting:						
Hatchery	0.06KW	x 14	x 0.2	x 2	x 150	= 50 KW
Hatchery for indigenous species	0.06KW	x 14	x 0.2	x 2	x 240	= 81 KW
Administration /Research Building	0.06KW	x 40	x 0.2	x 2	x 240	= 230 KW
Other Structures	0.06KW	x 40	x 0.2	x 1	x 240	= 58 KW
Outdoor lighting:	0.06KW	x 15	x 1.0	x 1	x 365	= 2628 KW
Ceiling Fans	0.40KW	x 30	x 0.2	x 4	x 120	= 1152 KW
Other equipment	10 KW x		0.1	x 2	x 240	= 480 KW
Annual Total						4679 KW/Year

The power consumption, calculated on the above assumptions, is summarized below:

Equipment to be Used	Power Rating (KW)	Demand Load	Cumlative Operating Hours (Hours)	No. of Operating Days/Year (Days)	Total (KWH)
a) Water intake pump	3.7	1.0	24	20	1,776
b) Filtered water intake pump	3.7	—	2,732	—	10,108
c) Feed production equipment					
Pulverizer	2.2	—	246	—	541
Kneader	2.2	—	62	—	136
Pelletizer	5.5	—	246	—	1,353
d) Blower	0.5	—	24	100	1,200
e) Test equipment					
at Normal load	10.0	0.2	2	180	720
at Peak load	10.0	0.5	6	60	1,800
f) Ice-making equipment	3.7	—	24	60	5,328
g) Lifintg pump for general water	0.75	—	1.1	240	198
h) Indoor/outdoor lighting, etc.	—	—	—	—	4,679
Total					27,839

Power rates run 1.8 Rs per KW, with a basic rate of 100 Rs/month. Thus, total power costs per annum may be estimated at:

27,839 KW x 1.8 Rs / 100 Rs x 12 months = 51,310 Rs/yr.

(c) Fuel Costs:

a) Trucks:

Fuel economy for the trucks is expected to run about 7 km/liter, with an average daily movement of 40 km. Based on 2 vehicles operating 150 days/year, annual diesel fuel requirements will be:

5.7 liters/day x 150 days x 2 vehicles = 1,710 liters

b) Outboard motors and vehicles for seed transport:

Gasoline consumption by the 15 ps outboard motors will run about 18 liters/hour at full throttle. Figuring 2 hours of operation per day at 60% of rated capacity, and assuming they will be utilized 50 days/year, the total annual fuel requirement becomes:

18 liters/hour x 0.6 x 2 hrs./day x 50 days = 1,080 lit.

The fuel consumption of the 125 cc motor cycle for seed transport can be estimated at about 40 km/liter. Based on a daily operating distance of 20 km/vehicle and assuming the motor cycles are operated 100 days/year, the annual fuel consumption for 4 vehicles works out to:

0.5 lit./day x 100 days x 4 vehicles = 200 liters.

Accordingly, total gasoline consumption for the outboard motors and motor cycles may be estimated at:

1,080 +200 = 1,280 liters/year.

Fuel costs for the trucks (a) and the outboards and motor cycles (b) would be:

Diesel consumption	1,710 l. x 10 Rs	=	17,100 Rs
Gasoline "	1,280 l x 20 Rs	=	25,600
Total			42,700 Rs

(d) Labor Costs:

Job Classification	No. of Persons	Monthly Wages(Rs)	Total (Rs)
Fisheries Development Officer 2nd Class (Director)	1	3900	46,800
Fisheries Development Officers(3rd Class)	3	3400	122,400
JT (Junior Technician)	2	2000	48,000
JTA (Junior Technical Assistant)	2	1800	43,200
Driver/mechanics	2	1800	43,200
Foreman	2	1300	31,200
Field workers	10	1000	120,000
Accountant	1	1700	20,400
Secretary/typist	1	1200	14,400
Guards	2	1000	24,000
Peons	2	1000	24,000
Total	28		537,600

Based on the above, the main operating costs at the Begnas Seed Production Center may be summarized as follows:

1)	Feed costs	203,650 Rs
2)	Power costs	51,310
3)	Fuel costs	42,700
4)	Labor costs	537,600
	Total	835,260 Rs

2) Fishermen's Training Facility

Only power costs have been included in this Plan, based on the following assumptions:

(a) Exibition tank:

Rated capacity will be 6 KW, with the average demand load at about 30%.

(b) Lighting:

	Capacity	Units	Load	Hours	Days		Total
Electric lights (Training Building)	0.06 KW x	40 x	0.2 x	2 hr x	240	=	230 KW
Ceiling fans	0.4 KW x	30 x	0.2 x	4 hr x	90	=	864 KW
Other equipment	2.0 KW x		0.1 x	1 hr x	240	=	48 KW
Annual Total							1,142 KW

Accordingly, the total power requirement becomes:

Equipment to be Used	Power Rating (KW)	Demand Load	Cumlative Operating Hours (Hours)	No. of Operating Days/Year (Days)	Total (KWH).
a) Observation tank	6.0	0.3	24	365	15,768
b) Lighting, etc.	—	—	—	—	1,142
Total					16,910

Power rates run 1.8 Rs per KWH, with a basic monthly rate of 100 Rs. Thus,

16,910 KW x 1.8 Rs / 100 Rs x 12 months = 31,638 Rs/year

3) Rupa Fish Collection Shed:

Labor will be the only operating cost at this facility. Figuring 2 employees, the required personnel budget is:

Job Classification	No. of Persons	Monthly Wage	Total
Manager	1	1,300 Rs	15,600 Rs
General worker	1	1,000	12,000
Total			27,600 Rs

4) Godawari Fisheries Development Center:

Calculations have been made only on power costs for facility operation. The assumed conditions are as follows:

a) Laboratory equipment:

Total power consumption for this equipment will run about 5 KW, with 240 operating days per year. Peak loads are estimated at 6 hours per day, with a 50% load on 60 days per year. For the other 180 days, a 20% utilization rate is projected, with the equipment to be used 2 hours per day.

b) Pump for general water:

Calculation have assumed 6.9 tons/day of general water consumption and 240 operating days per year.

c) Other items:

	Capacity	No.	Load	Hours	Days	Total
Electric lights (Laboratory Building)	0.06 KW	x 20	x 0.9	x 2 hr	x 240	= 115 KW
Ceiling fans	0.4 KW	x 15	x 0.2	x 4 hr	x 90	= 432 KW
Other equipment	2.0 KW	x	0.1	x 1 hr	x 240	= 48 KW
Annual Total						595 KW

Summarizing the above, we have:

Equipment to be Used	Power Rating (KW)	Demand Load	Cumlative Operating Hours (Hours)	No. of Operating Days/Year (Days)	Total (KWH)
a) Lab. equipment					
at Normal load	5.0	0.2	2	180	360
at Peak load	5.0	0.5	6	60	900
b) Lifting pump for general water	0.75	—	0.6	240	108
c) Other items	—	—	—	—	595
Total					1,963

Applying power rates of 1.8 Rs per KWH and a basic charge of 100 Rs/month,
1,963 KWH x 1.8 Rs + 100 Rs x 12 mos. = 4,733 Rs/year

(3) Operating and Maintenance Plan:

In order to maintain satisfactory levels of efficiency in facility operations under the Plan, proper handling and maintenance are vital. Without diligent daily care, buildings and facilities will deteriorate rapidly, with a commensurate loss in functional capacity. Maintenance involves mainly cleaning, replacement, or repair of worn out or broken items. Interior and exterior finishes should also be renewed every 3 years.

In the case of the generators, ice-making equipment, pumps, outboard motors, and vehicles, there is a particular need for daily equipment checks and servicing and for major inspections and overhauls at regular intervals. The durability and rate of breakdowns of the facilities will depend on the quality of these maintenance programs. Even if with proper inspections and servicing, it will still be necessary to replace the outboard engines after about 2,000 hours of operation and the generators, ice-maker,and pumps after about 8 years. And, with respect to the research equipment, it is vital that it be given daily care and regular inspections, as prescribed in the respective manuals.

3.4 Technical Cooperation:

Following are the areas of technical cooperation that are required in connection with this project:

(1) Seed production, cage culture, and pen culture of Chinese carp and Indian Major carp.

   a) Cooperation in achieving the production target of approximately 2,000,000 seeds via utilization of the Seed Production Center.

   b) Making technical improvements in cage and pen culture and promoting extension of this technology in association with JOCV.

(2) Feed development; raceway culture

   a) In order to develop feeds that meet Nepal's economic conditions in the face of the present bottlenecks in the development of such indigenous cold-water species as asala and sahar, research is required on the production of feeds using locally available ingredients, including surveys on the extent of these resources.

   b) Technical development of raceway culture compatible with economic conditions in Nepal.

(3) Limnological research and research on fishery resources.

a) To develop and provide guidance in appropriate fishing and aquaculture technology to help maximize the natural productivity of lakes for fish production, via limnological research programs in the Pokhara Valley.

b). On the basis of surveys and research on riverine fishery resources, to gain knowledge on the effects of riverine stocking programs and clarify the utilization limits of riverine fish resources.

CHAPTER FOUR BASIC DESIGN

4.1 Basic Policy:

Aquaculture in Nepal has shown steady growth, with the development of seed production facilities in cooperation with ADB, FAO, and other international organizations as well as financial assistance from individual countries. At this stage, the technical capabilities of technicians and engineers in the FDD are steadily improving, and effort is being put into the construction of facilities conforming to local conditions and requirements. For example, the Trisuli Fisheries Development Center was originally built as a trout farm, using water from reservoirs and power generating plants, but the trout operation was a failure, and so the facility was converted to the seed production of carp, as a mini-program of JOCV, making considerable use of local materials and contractors, and was reborn as a Fisheries Development Center for riverine research, breeding, and rearing and research on cold-water indigenous species, such as asala, katle, and sahar.

The facilities incorporated in this Basic Design Survey have been designed in harmony with the existing Fisheries Development Centers, with ample consideration being given to the use of construction methods incorporating large amounts of local materials and building methods.

The major obstacle to the use of local construction methods is that of construction time. In implementing previous projects in Nepal, the main criticisms have related to delays in Plan implementation. The principal reasons for these delays are said to be the complexity of procedures and a lack of technical and management mampowers in the area of construction. An additional factor has been that, owing to the country's geography and topography, such as its landlocked and mountainous character, considerable time is required for transport of materials.

The problems relating to administrative procedures is one which HMG is taking steps to solve, but those relating to construction must be fully considered at the Basic Design stage. Realistic progress plans, personnel plans, and procurement plans must be prepared with due regard to the technical and construction capabilities of local contractors, while maintaining proper conformance with Japan's grant-aid system.

The following natural and social conditions should be borne in mind in formulating the construction plan:

-- There is a sharp division between rainy and dry seasons. During the height of the rainy season, a large amount of precipitation is concentrated in a very limited period.

-- There are definite limits on the variety and quantity of building materials that can be procured within Nepal.

-- Since Nepal is a land-locked nation, overland transport distance for imported materials can be as much as 1,000 km, resulting in relatively high transit costs and long transit times.

-- Building contractors in the vicinity of the Plan site are all of small size and so incapable of handling sudden large orders for materials and labor.

-- The construction season is limited.

The construction plan has been formulated with due regard to the above conditions.

Considering that the Plan is to be implemented on the basis of a grant-aid from Japan, the basic policy has been developed along the following lines:

Construction program:

1) Buildings will be built to be safe and sturdy.

2) Construction methods and materials will be selected in accordance with construction conditions in Nepal.

3) Operating and maintenance costs following completion of the facilities are to be kept low.

4) Materials will be selected on the basis of the present level of construction techniques in the country.

5) Items will be selected for which replacement parts will be obtainable when the need arises.

Equipment program:

1) Equipment will be selected with reference to the specifications of equipment used in comparable existing facilities.

2) Since Project-Type Technical Cooperation is expected from Japan, the subject grant-aid program will be limited to essential equipment.

4.2 Design Conditions:

4.2.1 Natural Conditions:

(1) Meteorological Conditions

The Plan site at Godawari is located in the Kathmandu basin at an altitude of about 1,300 m. The climate is somewhat cooler than in the city, owing to its higher elevation.

Begnas, Phewa, and Rupa are all in the Pokhara area. Elevation at Begnas is about 650 m, so that temperatures are higher than at Kathmandu. The major climatic feature of the Pokhara Valley is its conspicuously heavy rainfall, even by Nepal standards, with annual precipitation in excess of 4,000 m not unusual.

The predominant characteristic of Nepal's climate is the clear-cut demarcation between rainy and dry seasons. Some 80% of annual rainfall falls during the height of the rainy season (June - September), but much of this occurs at night; continuous rainfall during daylight hours is rather rare.

The weather is quite unstable during April and May, which mark the transition from the dry to rainy season. In the Pokhara Valley, perhaps because of its proximity to Annapurna and other parts of the Himalayas, fist-sized hail sometimes falls, and it was necessary to bear this point in mind in the facility design.

(2) Seismic conditions

In the Pokhara Valley, there are a number of faults running parallel to the thrust fault on the large northern slope, known as the MCT (Main Central Thrust). Since the possibility of an active fault remains in a portion of them, while earthquakes of Magnitude 5.0 - 6.0 have been recorded, careful consideration shall be given to earthquake precautions in the facility design.

4.2.2 Applicable Standards:

Nepal has no construction standards, laws, or ordinances, but Indian standards are followed to some extent. In aid projects, the donor nations tend to apply their own respective standards.

In this Basic Design, Japanese standards will be applied to the construction phases, while area and spacing will be adjusted to local conditions.

4.3 The Basic Plan

4.3.1 Layout Plan for the Begnas Seed Production Center

The subject facility incorporates seed production ponds for Chinese and Indian Major carp, including brood ponds and a hatchery; and water distribution facilities therefor. In addition, stocking ponds will be included as a preserve for fish awaiting shipment.

The size of the Plan facilities will be sufficient to permit the production of 1,784,000 seed, the quantity necessary to fulfill the production targets of the 8th Plan. However, since the FDD has set a production target of 3,720,000 seeds for production and distribution in the Pokhara Valley by 1994/95, the Project has been structured from the outset on a scale that will accommodate future plans for expansion of the hatchery and water intake facilities, so as to avoid imposing a heavy future burden on the Nepal government.

The Plan facilities at Begnas Seed Production Center (SPC) have been considered as follows;

The Plan facilities at the Begnas Seed Production Center include not only those to be provided under the current grant-aid but also future facilities. The layout plan has thus been designed to allow for this future development.

The layout composition for this facility is as shown below:

Buildings

- Hatchery
- Feed Production Shed
- Hatchery for indigenous species
- Administration/Research Building
- Storage House
- Night Quarters

Seed Production/Experimental Ponds

- Brood ponds
- Nursery ponds
- Raceways
- Stocking ponds
- Water intake facilities
- Filtration tank
- Connecting bridge
- Water supply and drainage channels
- Road
- Dike

The Plan site is located in the Khudi Kohla basin, about 10 km east - northeast of Pokhara city, in an area of rice paddies extending along the west bank, downstream from the Begnas Irrigation Dam. The total area will be approximately 10 ha, divided in the middle by an irrigation canal, but, in the present Plan, the facilities are to be deployed in the 6.5 ha portion on the southern side of the irrigation canal.

The layout plan gives priority to the placement of water intake facilities, which constitute the core facility in this project, with the raceways, filtration tanks, seed production ponds, and brood ponds to be attached to these intake facilities. The Administration Building will be positioned at the entrance on the west side of the site to provide ready access from outside and prevent fish epidemics.

The average size of a brood pond in Nepal is 50 x 40m; for a large nursery pond, 40 x 25m; and, for a small nursery pond, 25 x 20 m.
The proper scale of the ponds will be calculated on the basis of a determination as to functional size, and they will be arranged in modular fashion.

After the water for rearing purposes has been brought in from Lake Begnas, it will pass through the raceways and be branched and distributed to the seed production ponds placed to the south of the irrigation canal.

An intake location on the lake side would not be appropriate, in view of the danger of damage to intake pipes from driftwood and the like in the vicinity of the spillway. In other places, no particular problems are anticipated.

The water intake facilities for this project are to be installed at a place adjacent to the existing intake facility for irrigation use, which is felt to be the most advantageous location for branching and distributing water on both sides of the site.

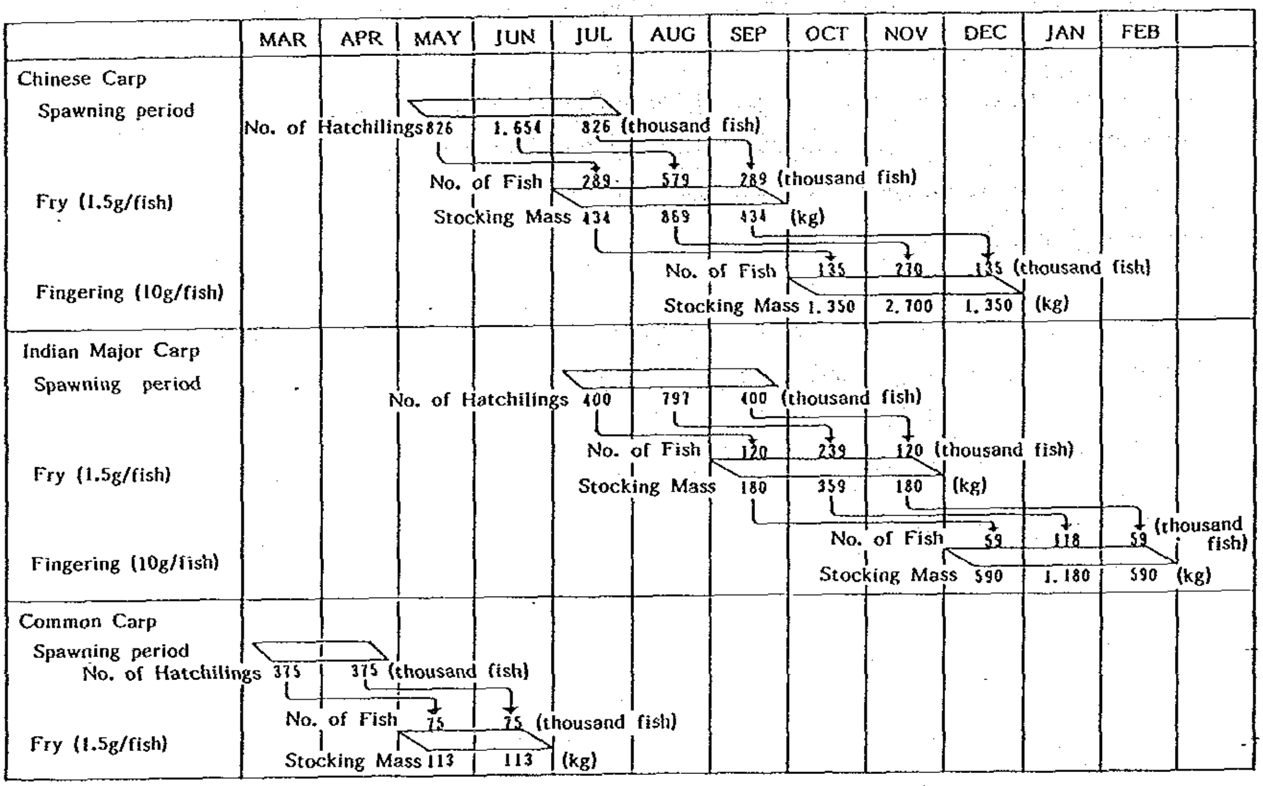
The intake facilities are to be composed of intake pipes and intake pits and will adjoin the raceway and filtration facilities.

4.3.2 Facility Plan

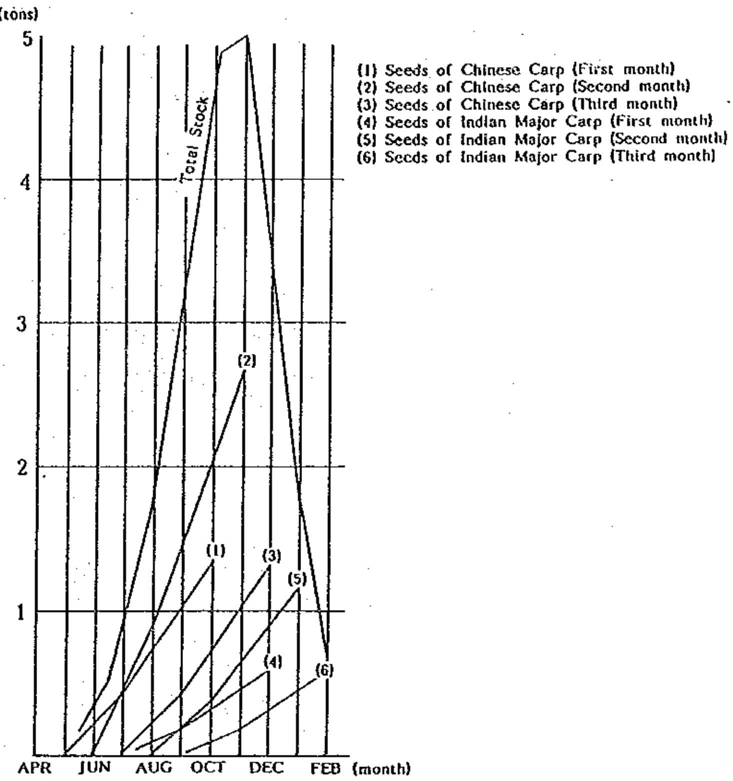
(1) Scale of the Seed Production Ponds

Spawning season, depending on the species, runs 2-3 months-- 3 months in the case of Chinese and Indian Major carp and 2 months for common carp. In the case of Chinese and Indian Major carp, the spawning period is divided into: first month, 2nd month, and 3rd month. Since June is the most active month for Chinese carp and August for Indian Major carp, 50% of seed production will occur in those months, with 25% each in the preceding and following months. In the case of common carp, as the spawning period is only 2 months, the first month is termed the early period and the second the late period, with production to be divided equally between the two periods.

Values (1) - (5), as shown above, are summarized in the following figure:



The growth curve of these stage of young fish should be shown as secondary curves but, in this figure, we have simply joined the points with a straight line. The sum total of the contained weight is shown in the following figure:



Based on the above findings, the total weight of seed stocked at the time of maximum confinement, can be estimated at about 5 tons. Figuring a productivity of 2 tons/ha, the required size of the nursery ponds becomes 2.5 ha.

(2) Brood Ponds

Based on production experience in Nepal, the survival rates at each stage for Chinese carp, Indian Major carp, and common carp are as shown below:

	Chinese carp	Indian Major carp	Common carp
Insemination rate	70 % (←)	80 % (←)	60 % (←)
Hatching rate	70 % (50 %)	70 % (55 %)	60 % (35 %)
Survival rate for hatchlings	75 % (35 %)	75 % (40 %)	100 % (35 %)
Survival rate for fry	35 % (13 %)	30 % (13 %)	20 % (7 %)
Survival rate eggs to fry	12.9 %	12.6 %	7.2 %

The planned seed production at this facility, in fry equivalents, comprises: 1,157,000 seeds for Chinese carp, 477,000 for Indian Major carp, and 150,000 for common carp. Accordingly, the number of eggs required to attain these targets will be:

Chinese carp:	1,157,000 seeds	/ 0.129	=	8,968,992 eggs
Indian Major carp:	477,000	/ 0.126	=	3,785,714 eggs
Common carp:	150,000	/ 0.072	=	2,083,333 eggs

While there are differences in the fecundity, depending on the species, as well as major variations in individuals, the averages, as used in Nepal, are 90,000 eggs/kg for Chinese carp, 30,000 for Indian Major carp, and 80,000 for common carp. Accordingly, the weight of the brood (females) required to produce these quantities becomes:

Chinese carp:	8,969,992 eggs	/ 90,000 eggs/kg	=	100 kg
Indian Major carp:	3,785,714	/ 30,000	=	127 kg
Common carp:	2,083,333	/ 80,000	=	26 kg
Required total brood weight (females)			=	253 kg

Total weight of males required to fertilize egg is 1.5 to 2 times of the total weight of females. Thus, in the subject Project as well, if 1.5-2.0 males are provided for each female, the required weight of breeders, as shown below, will be 1,018 - 1,271 kg. And, assuming an 80% spawning success ratio, based on this method, 1,272 - 1,590 kg of broodstock will have to be provided.

Required Weight of Broodstock

	Female	Male	Total
Chinese carp	100 kg	150 ~ 200kg	250 ~ 300kg
Ind. Major carp	127 kg	190 ~ 254kg	317 ~ 381kg
Common carp	26 kg	39 ~ 52kg	65 ~ 78kg
Sub-total	509 kg	509 ~ 763kg	632 ~ 759kg
Total	spawning success ratio 80%		790 ~ 949kg

To obtain high quality eggs, the broodstock should be reared in less stocking density. In Nepal, the standard stocking density for broodstock is 900 kg/ha. Thus, in order to secure 790 - 949 kg of broodstock, the required brood pond area will be in the order of:

790 - 949 kg / 900 kg/ha = 0.8 - 1.0 ha

Since it will be possible, depending on requirements, to set up cages in Lake Begnas for broodstock cultivation, after carefully considering the site configuration as well as the layout of the various ponds and facilities, we have set the scale of the brood ponds at 0.8 ha, the minimum requirement for purposes of this Plan.

(3) Layout Plan for the Seed Production Ponds:

The site is divided by the irrigation canal into north and south sections, with the southern section containing about 6 ha and the northern about 4 ha, for a combined total area of 10 ha. The ponds will function mainly as brood ponds and nursery ponds. In the layout plan, it was necessary to consider a layout that would include not only the portion planned under the present Basic Design but accommodating future requirements as well.

The volume of seed distribution in the Pokhara Valley, as presently planned by the FDD, is 3,720, 000 seeds (in fry equivalents). After subtracting the amount to be supply by private sources, the production capacity of the subject Center has been set at 3,474,000 seeds, broken down as follows:

(Unit: 000 seeds)

Species	Chinese Carp		Ind. Major Carp		Common Carp		Total	
Use / Seed Stage	Fry	A. F.	Fry	A. F.	Fry	A. F.	Fry	A. F.
Seed for:								
Cage culture	—	500	—	—	—	—	—	500
Pen culture	—	72	—	48	—	—	—	120
Recapture fishery	—	500	—	500	—	—	—	1000
Pond culture	175	—	70	—	105	—	350	—
Paddy-cum-fish culture	—	—	—	—	130	—	130	—
Seed production in the Pokhara area	175	1072	70	548	235	0	480	1620
(in fry equivalent)	2,319		1,166		235		3,720	
Private fry supply	98	—	63	—	85	—	246	—
Seed production targets under this Plan	77	1072	7	548	150	0	234	1620
(in fry equivalent)	2,221		1,103		150		3,474	

In calculating pond size, based on a consideration of future plans and assuming a 10 g size for advanced fingerlings, the maximum stocking weight will be 10 tons. Thus, the estimated requirement is for a nursery pond area of about 5 ha and a brood pond area of at least 1.4 ha.

In general, sizes of the nursery ponds in the Nepal are either 25 x 20m ($500m^2$) or 40 x 25m ($1,000m^2$). In order to produce the target seed volume of 3,474,000, 40 small nursery ponds (2 ha) and 30 large ponds (3 ha) would be appropriate. And, since a number of brood ponds of 50 x 40m ($2,000m^2$) will also be used, with 7 such ponds (1.4 ha), the target number of seeds can be achieved.

The ponds required under the Basic Design will include 2.5 ha of nursery ponds and 0.8 ha of brood ponds, for a total of 3.3 ha in all, but this total will be almost equal to the combined area of the small nursery and brood ponds required to meet future Plan targets. Considering the advantages of functionally integrating the ponds and the fact that it will be possible to use the western portion of the site to provide 3 ha of $1,000^2m$ nursery ponds, we feel that, as seed production ponds to be built under this Project, it would be appropriate to construct 40 nursery ponds of 0.05 ha, 4 brood ponds of 0.2 ha and 6 nursery ponds of 0.1 ha that will allow conversion to brood ponds in the future on the basis of a plan. Summarizing the above, we have the following:

Size of Ponds to be Built Under This Plan

Pond Type	Length x Width	Area per Pond	No. of Ponds	Total Area
Brood ponds	50 × 40m	0.2 ha	4	0.8 ha
Nursery ponds (large)	40 × 25m	0.1 ha	6	0.6 ha
Nursery ponds (small)	25 × 20m	0.05ha	40	2.0 ha
Total			77	3.4 ha

4.3.3 Construction Plan:

(1) Construction Facilities for Seed Production:

1) Seed Production Ponds

These facilities will comprise brood ponds and nursery ponds in 3 sizes: 25 x 20 m, 25 x 40 m, and 40 x 50 m. The depth of all size ponds will be 0.9 m, with 1.15 m from pond bottom to bank crown.

A. Dike construction

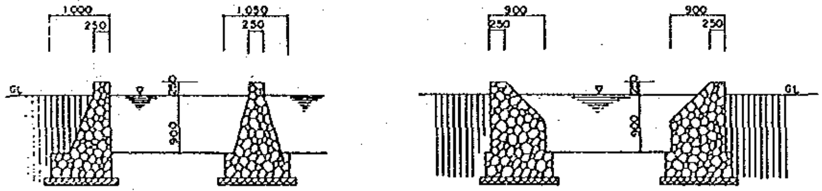
The dikes for the existing aquaculture and seed production ponds at Phewa, Godawari, and Trisuli, as observed during the field survey, use a variety of construction methods, include earthen, masonry, and concrete. In the case of earthen construction, it was pointed out that, owing to a need to maintain a directional gradient, a large pond area is required, increasing maintenance and operating costs, while the carp, which is the target species, tend to peck at the earth as they feed, causing damage to the dike.

In the case of masonry and concrete, however, we were told that, since the finish extends to the areas around the pond, operating efficiency is good, facilitating maintenance and administration, though construction costs are higher for concrete and masonry --in that order-- than for earthen construction.

In this Plan, considering the feeding habits of the target species, ease of facility management, and construction cost, we have decided on masonry construction for the dikes.

In the case of the nursery ponds, in the interest of operating efficiency, vertical dikes have been specified, while, in the case of the brood ponds, construction will be slightly graded to prevent the fish from jumping out of the pond.

Following is a standard sectional plan for the various dike structures:



NURSERY POND BROOD POND

B. Pond bottom construction

Aquacultural methods involve a non-feeding culture, whereby the pond water is enriched via fertilizers and feed is provided by the plankton resulting from this enrichment. This method, thus, depends heavily on natural production. Accordingly, it is essential that the ponds be left completely in a still water condition to prevent the introduction of unnecessary water or drainage and maintain a water quality suitable to propagation of the plankton feed. To this end, special care must be given in pond design to water retention properties.

As confirmed in the soil surveys, including boring surveys, which were conducted during the Basic Design Survey, the soil composition of the Plan site for the seed production ponds contains a sandy clay layer from the surface to a depth of 30 cm to 1.0 m and a silty sand layer from 1.0 -2.0 m, followed by one of gravelly sand and sandy gravel.

In addition, based on the results of the in-situ permeability tests, pearmeability of the target area were estimated as follows:

	(in cm/sec)
Sandy clay layer	10^{-5} -- 10^{-6}
Silty sand, gravelly sand layer	10^{-4} -- 10^{-5}
Sandy gravel layer	10^{-3} -- 10^{-4}

The permeability of the sand-gravel layer, forming the base of the target ponds, tends to be lower than that generally found in such layers in Japan. This is attributable to the mixture of clay in the substrate.

The coefficient limit which can be used as the bottom layer for the pond facilities is about 10^{-5} cm/sec. In the case of the Plan facilities, considering the fact that the pond bottom lies on a silty sand layer, while the fry are to be reared as much as possible in a still water condition in order to propagate phytoplankton for use as feed, while minimizing the supply of supplemental water, it is been determined that proper water proof treatment will be mandatory at these facilities.

Soil surveys were conducted in the site vicinity to evaluate possible water proof methods. There are 2 borrow pits on the southern side of the Begnas Dam but, on the basis of the soil tests, it was found that the pit on the south side was not suitable as a source of bottom layer. The soil on the north side is clay, which can be employed as a water interception material, but houses are built above the pit, and so we concluded that it would not be possible to secure sufficient soil material without adverse impact on these houses.

Accordingly, we have decided to use the membrane waterproofing method for water proof treatment in this project.

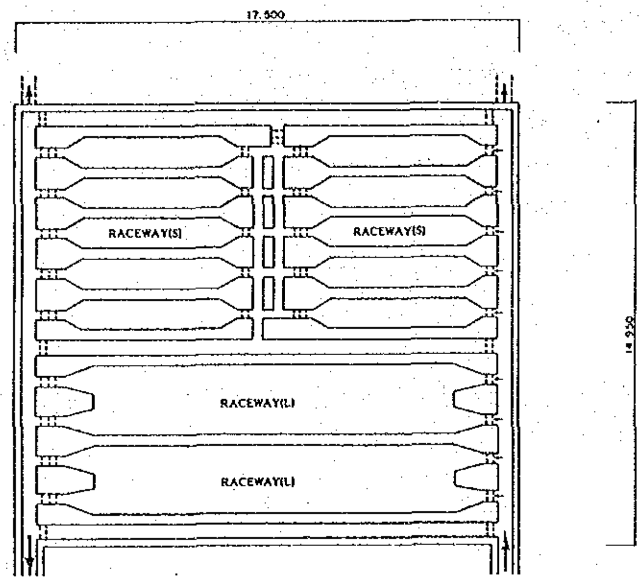
(5) Raceways:

The raceway facility is intended to have a pilot function, such as to clarify rearing conditions, in advance of the propagation program for sahar incorporated in the 8th Development Plan, and will also be used for various kinds of outdoor rearing experiments. The raceways constructed in Trisuli FDC can be cited as comparable facilities, and the 1m x 6m rearing ponds can be considered an appropriate size for an experimental pond. Five experimental groups are to be established to meet the requirement for changes in test conditions by group, such as stocking density, volume of water flow , and feed. Since this experiment will be of a long-term nature, lasting 2-6 months or more, the minimum scale of the raceway facilities should, we feel, be sufficient to permit the conduct of two concurrent experiments. We have, accordingly, provided for a total of 10 experimental ponds, arranged in 2 rows of 5 ponds each.

Two stocking ponds are to be provided for the rearing of adult fish and broodstock, respectively. These ponds will generally be 50-100 m^2 in size but, in view of the fact that the Plan facilities are being introduced on an experimental basis, we have set pond size at only $30m^2$.

After considering the layout of the incidental facilities, such as the intake and drainage channels, the stocking ponds have been set at 12.5m x 2.4m.

The layout plan is as shown below:



Since the rearing water is in a flow condition and it is desirable that, in constructing the ponds, both side walls and batholiths use materials that will minimize water loss due to erosion, the comparable facilities in Trisuli use masonry construction with a mortar finish.

In the subject Plan, we will use masonry material for the side walls and batholiths, as this material is cheaper than concrete and is the most widely used in the area.

The surfaces will be mortar-finished to facilitate rearing management.

(6) Intake and Filtration Facilities:

The water to be used for seed production and fish rearing and research will all be drawn from Lake Begnas. Since the surface of this lake is higher than that of the Plan ponds and the head differential of about 3.7 m is within tolerable limits, intake via the siphon method will be quite feasible. Based on this method, the power costs for water supply can be greatly reduced, with obvious benefits in terms of operations and maintenance; thus, the siphon method will be employed in this Project.
The intake valve will respond to changes in the level of Lake Begnas, which will make it possible to draw water from the surface, middle, and bottom layers of the lake so as to obtain optimum water quality.

The intake water volume under the Plan must be sufficient to accommodate a future planned seed production of 3,474,000 seed, and so the applicable facilities will be as follows:

Seed production pond--

Brood ponds	2,000 m^2	7 ponds (lake water -- using drainage from the raceways)
Nursery ponds (small)	500 m^2	40 ponds (lake water -- using drainage from the raceways)
Nursery ponds (large)	1,000 m^2	30 ponds (lake water-- using drainage from the raceways)
Raceways	120 m^2	Lake water
Hatchery		Filtered water
Rearing shed		Filtered water

(1) Seed production pond:

The water required for the seed production pond will include water filled prior to the stocking of the hatchlings, replacement of water in case the rearing water turns bad, and replenishment of water lost through evaporation.

A. Water--

Water filling prior to stocking usually takes place about one week before the start of seed production. The number of ponds to be filled has been calculated on the basis of the approximate seed production plan.

Month	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
B	–	–	1	1	2	2	1	–	–	–	–	–
N S	–	–	6	12	10	8	4	–	–	–	–	–
N L	1	1	–	12	6	9	3	–	–	–	–	–

B: Brood ponds

NS: Nursery ponds (small)

NL: Nursery ponds (large)

B. Exchange water--

The purpose of changing pond water is to maintain a certain desirable level of water quality. An appropriate volume of exchange water is supplied when water quality becomes too fertile, hard-to-digest phytoplankton becomes dominant, or the level of dissolved oxygen has fallen. This exchange operation is normally done 1-3 times per month, with about 1/4 - 1/5 of the pond water renewed each time.

Some 20-75% of the total volume of pond water will be exchanged. Since the total pond surface area in the Plan will be 64,000 m^2, with a depth of 0.9 m, the total water volume will be 57,600 tons. Accordingly, the exchange volume per month becomes 11,520 - 43,200 tons.

However, when water has just been put into the pond, no exchange is necessary. Thus, subtracting the originally filled volume from total pond volume, the replacement requirement (at a frequency of twice/month, with a 20% exchange each time) becomes 40% of this adjusted water volume.

When there is ample pond capacity, seed production may exceed 10g per seed, permitting the rearing of advanced-size seed. Thus, excluding periods when the pond is drained to permit sterilization and extermination of predator fish, the ponds should be usable year-round.

The number of ponds to be used per month will be as follows:

Month	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
B	7	7	7	7	7	7	7	7	7	7	7	7
N S	20	0	6	18	28	36	40	40	40	40	40	40
N L	29	30	30	12	18	27	30	30	30	30	30	28

B: Brood ponds NS: Nursery ponds (small)

NL: Nursery ponds (large)

The number of ponds targeted for water exchange, after deducting the number of ponds receiving newly supplied water in a particular month from the total number of ponds in use, will be as follows:

Month	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
B	7	7	6	6	5	5	6	7	7	7	7	7
N S	20	0	0	6	18	28	36	40	40	40	40	40
N L	28	29	30	0	12	18	27	30	30	30	30	28

B: Brood ponds NS: Nursery ponds (small)

NL: Nursery ponds (large)

C. Balance between Evaporation and Rainfall:

The following table shows average monthly rainfall in the Pokhara area over the 1971-82 period.

The annual average in the area is 3,891 mm, while daily evaporation, using the Terai district as an example, runs 7-8 mm during the dry season. If we presume evaporation levels to be similar in Pokhara, with comparable evaporation levels during the rainy season, monthly evaporation can be set at

8 mm x 30 days = 240 mm / month.

On this basis, the balance between evaporation and rainfall would be as shown in the following table:

(in mm)

Month	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
Rainfall	61	139	367	673	889	858	587	221	29	14	24	33
Evaporation	240	240	240	240	240	240	240	240	240	240	240	240
Balance (Residual)	-179	-101	127	433	649	618	347	- 19	-211	-226	-216	-207

Based on the above, the monthly water requirements become as follows:

Volume of Water Required for Seed Production Ponds

(in tons)

	Water Injected *1	Water Exchange *2	Evaporation *3	Required Water Volume (per day) *4
JAN	0	23,040	13,824	36,864 (1,229)
FEB	0	23,040	12,834	35,874 (1,196)
MAR	900	18,720	9,487	29,107 (970)
APR	900	15,480	4,444	20,824 (694)
MAY	4,500	15,120	0	19,620 (654)
JUN	18,000	5,400	0	23,400 (780)
JUL	13,500	11,160	0	24,660 (822)
AUG	15,300	15,120	0	30,420 (1,014)
SEP	6,300	20,520	0	26,820 (894)
OCT	0	23,040	1,216	24,256 (809)
NOV	0	23,040	13,504	36,544 (1,218)
DEC	0	23,040	14,464	37,504 (1,250)

*1: Number of injection ponds x pond capacity

Brood ponds 2,000 m^2 (1800 tons)

Nursery ponds (small) 500 m^2 (450 tons)

Nursery ponds (large) 1,000 m^2 (900 tons)

*2: Number of ponds targeted for water exchange x pond area

*3: Number of ponds to be used x pond area x evaporation/rainfall balance x 0.001

(However, this value is "0" when rainfall exceeds evaporation)

*4: ( ) = total water requirements for the month / 30 days

2) Hatchery:

The volume of water required for the conditioning and spawning tanks in Nepal has been established at 30 liters/minute each, for a total of 30+30 +

60 liters. In the case of the incubation tanks, based on local experience, we have used a figure of about 20 liters/minute per tank, for a total of 120 liters/minute for all 6 units. The water requirement for the nursery tanks has also been set at 20 liters/minute, for a total of 180 liters/minute for the 9 tanks.

Accordingly, the total water requirements for the above facilities, at peak operation, will be 360 liters/minute, or 518 tons per day. This peak level will occur during the 5-month spawning season from May to September.

Conditioning / spawning tanks	60 liters/minute
Incubation tanks	120
Nursery tanks	180
Total	360 liters/minute
	518 tons/day

3) Hatchery for indigenous fish species:

The following table summarizes the types and capacities of the tanks to be used for rearing purposes:

Type of Tank	Capacity (liters)	No.	Total Capacity (cu.m)
Incubation Tanks	200	5	1.0
Nursery Tanks	400	5	2.0
Rearing Tanks (square)	800	10	8.0
Rearing Tanks (circular)	1,000	10	10.0
Stocking Tanks	1,700	10	17.0
Food Plankton Rearing Tanks	100	3	0.3
Small Experimental Tanks	30	15	0.5

The tanks for this facility are to be used essentially in the running water rearing method. While the desirable water exchange rate is generally 0.5 -

0.67 or more, given the experimental nature of this facility, the exchange water rate may be set at the minimum level of 0.5.

The target tanks for water exchange will be the rearing, stocking, and small experimental tanks. These tanks have a combined capacity of 35.5 tons, and so the volume of water exchange will be 35.5 x 0.5 = 18 tons/hour. When the incubation and nursery tanks are in use, it may be presumed that the rate of utilization of the above tanks will be at a low level. Thus, at the Plan water volume of 18 tons/hour, the daily water requirement comes to 432 tons.

4) Raceways:

The water intake requirements for the raceways is determined primarily in relation to the exchange water rate. Generally speaking, it is desirable that the water in the ponds be replaced every 1-2 hours. On this basis, with a pond area of 120 m^2 and an average depth of 0.8 m, for a total of $96m^3$, the exchange water requirement at 1.5 -2 hour intervals becomes:

$96m^3$ / 1.5 - 2 hours = 48 - 64 m^3/hour

The main purpose of this facility will be rearing experiments. Considering the experimental nature of the operations, we have set the water requirement at 48 m^3/hour, which would allow for a 50% exchange water rate. On this basis, the daily requirement becomes 1,152 tons.

In this project, the only facilities requiring water throughout the year are the rearing tanks and raceways. The water supply for the seed production ponds can be recycled from the raceways. In addition, water will be required for the hatchery only during the May - September spawning season.

From the above, the final daily water requirement per month may be compiled as follows:

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
A	970	694	654	780	822	1014	894	809	1218	1250	1229	1196
B	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152	1152
C	432	432	432	432	432	432	432	432	432	432	432	432
D	0	0	518	518	518	518	518	0	0	0	0	0
E	1584	1584	2102	2102	2102	2102	2102	1584	1650	1682	1661	1628

A: Seed production ponds

B: Raceways

C: Rearing tanks

D: Hatchery

E: Required water intake volume: A or B (whichever is higher) + C + D

Accordingly, the maximum daily requirement will be 2,102 tons. Allowing an extra 15% margin for water loss due to pipe rust and adhesion of biological matter, the Plan intake volume can be set at 2,400 tons/day.

(7) Wells:

Based on the geological survey and secondary materials, it is believed that, at a water intake depth of about 10 m for the Plan wells, it should be possible to secure the target intake volume if 19 tons/day. The wells will be shallow type directed at free underground water. Well construction will be tubular, since the water-bearing layer is good-quality sandy gravel and this type of construction is economical and poses no programs in terms of construction technology. A 2-3 inch intake pipe will be driven into the water-bearing layer, and the water will be drawn directly therefrom.

(8) Filtration tank:

The filtered water requirement for the Plan is 950 tons/day.

The purpose of filtration treatment in this project is to remove dirt, organic sections, predator fish, and plankton. The filtration method will be via a gravity-feed sand filtration tank. This method is widely used in aquaculture, seed production, and research facilities in both fresh and seawater.

This filtration method has been incorporated also into the Janakpur Fisheries Development Center, which can be considered a comparable facility, and the sand used as the filtration material is easily obtainable in the vicinity. Possible structural methods for the filtration tank, in the case of pressurized rapid filtration suitable for large-volume processing, include steel and FRP. However, with the gravity feed type, concrete is generally used, owing to its durability, ease of maintenance, and relatively low construction cost.

In the present Plan, the structure of the filtration tank is to be concrete, based on maintenance and operating considerations and the fact that all of the materials for this type are locally available.
The filtration tank should be set high enough to generate adequate water pressure for the hatchery.

(9) Water supply and drainage channels:

These channels are to be used for the supply and drainage of water for the Plan ponds at the Begnas Seed Production Center, with a maximum Plan flow volume of 2,000 tons/day. The standard sections will be 50 x 40 cm for the supply channel and 100 x 115 cm for the drainage channel. Channel construction, as in the case of the raceways, will use materials on side walls and batholiths that will inhibit water loss from erosion and simplify maintenance and operation. On the basis of these considerations, the construction method will be masonry with mortar finish.

(10) Dike facilities:

The Begnas Dam has been designed so that, during periods of rising water, when water levels exceed fixed norms, the overflow is eliminated by an overflow dike in order to protect the dam structure. For this reason, a dike will be necessary to prevent the influx of river water into the central site area along the right bank of the Khudi Kohla, which receives the overflow. This dike is to have a total length of 343 m and will be built at the downstream border of the site.

Taking into consideration the extent of possible damage in the event that the river water were to inundate the Plan facilities, it is vital that the dike be of solid construction. Its structure will essentially be banking construction but, with regard to the direction of contact with the raceways, the dike will be of covered gabion construction. This type of construction is relatively resistant to friction abrasion, works like a scrubbing brush, and allows partial repairs using locally available materials.

(11) Connecting bridge:

The present access to the Plan site is by crossing the Khudi Kohla, but, considering the future plan to use the area on the south side of the irrigation channel and build an approach to the main highway, it is felt that an approach road of 6 m from the road side, bordering the present irrigation channel, would be ideal. To accomplish this, a connecting bridge will be necessary linking the north and south sides of the site. The width of this bridge should be the same as that of the road -- i.e., a single lane of 3 m-- to permit passage of work trucks.

Possible structural methods for this bridge include wood, steel, and concrete. But, since wood and steel would pose problems in terms of local procurement and maintenance, it has been decided to use concrete in this Plan, which has also been used for the existing connecting bridge. The girders will be the same as those used in the present bridge spanning the irrigation canal.

(12) On-premise Road

This road will be used to move work materials around the site, principally people and light materials. While the frequency of vehicle use will be low, since countermeasures will be required against muddy spots and slippage during the rainy season, from the standpoint of operating efficiency, we have specified a gravel surface -- the simplest type of surfacing. Road width is to be single- lane 3 m to permit the passage of work trucks. So that at least one pond of each type will front on the road, its total length has been set at 2,100 m.

(13) Raceways at Godawari:

At Godawari, a constant supply of fresh, clear water at temperatures of 18-20°C can be obtained throughout the year. The area is, thus, actually better endowed than Trisuli or Begnas for rearing experiments, using the raceway method, on the principal indigenous species. Since these ponds are intended for rearing experiments, the test fish capacity will generally be 10 - 50 kg / test area. It will, therefore, be advantageous to keep pond scale small and establish a large number of test areas.

Since it is anticipated that the requisite number of ponds will eventually be built on the basis of a technical cooperation program, we have limited the number in this Plan to immediate requirements, specifying the same scale as the raceways at Begnas.

4.3.4 Building Plan

(1) Plan of the Facilities

1) Hatchery

A. Scale of the Required Water Tanks

This facility is to be used to spawn Chinese and Indian Major carps, and we feel it will be proper in this Plan to follow the Chinese system, not only because this is the method that has produced the best results in Nepal but also because technicians are familiar with the operation of this kind of system. In determining the size, number, and shapes of the various tanks. we will adopt the Chinese system, with which Nepal has had the most experience, and develop the necessary scale and deployment plans on this basis.

A general explanation is given below:

Type of Tank	*No. of Days required in Tank*
Conditioning Tank	1 to a few days
Spawning Tank	Half to 1 day
Incubation Tank	1-2 days
Nursery Tank	2-3 days

Conditioning Tank:
This tank is used to stock broodfish selected from brood ponds, appropriately attained sexual maturity and to accelerate spawning by dosage of the first hormone injection.

Spawning Tank:
The broodfish which have been dosed the second hormone injections are collected in this tank and allowed to spawn freely. If all goes smoothly, the spawning should be completed within 6-12 hours after the second dose in the tank. The eggs stripped and fertilized flow down together with the water and are placed in the incubation tank, while the broodfish, after spawning, are released again into the brood pond.

Incubation Tank:
The fertilized eggs are gathered in this tank and incubated while floating in running water. Since 1~2 days are needed for hatching, we have set the required number on the basis of a 2-day cycle.

Nursery Tank:
The hatchlings hatched in the incubation tank are collected in the nursery tank after eliminating dead fish and trash. Since the hatchlings lie on the bottom of the tank in layers, forming clusters, while great care must be taken in this stage. The period until the larvae emerge to the water surface is 2-3 days, and our design has been based on a 3-day cycle. After emergence to the water surface, the larvae are moved to the nursery pond.

We have calculated the scale and number of the various tanks, as follows, with reference to comparable facilities in Nepal.

a) Conditioning and Spawning Tanks

One tank of each type will be required, of a size that is standard in Nepal, with due consideration to ease of operations and impact on the spawners. The standard size of the conditioning tank will be 2.5 x 4m, while the spawning tank will be 4m in diameter.

The conditioning tank, in our judgment, should be sufficiently large to hold both 10-20 females (weighing 4 kg) and 20-30 males (4 kg) and to fully handle requirements at peak breeding season, while being easy to operate.

The size of the spawning tank should be sufficient to permit spawning of 5-6 female broodstock at a time. This scale will be proper, since it has been set on the basis of results achieved to date in spawning activities and takes into account the influence of broodfish on spawning behavior.

Accordingly, the Plan scale will be as follows:

Conditioning tank:	2.5 x 4m (1)
Spawning tank:	4m diameter (1)

b) Incubation Tank

The incubation tank will have a diameter of 1.5m. Since the total number of eggs to be incubated in this tank will be about 0.5 to 1 million, in the case of Chinese carp, where fecundity is large, the average number of eggs expected per spawning will be:

90,000 eggs/kg x 4 kg x 4 female = 1,440,000 eggs

Thus, 1.5 to 3 incubation tanks will be required. Even with breeders of the same size, fecundity will vary considerably on the basis of individual variations, while individual differences will also be seen in the weight of spawning breeders. Thus, considering the possibility of increasing production in the future, the Plan scale of the incubation tanks has been established as 3 tanks per breeding.

Since eggs will be held inside the incubation tank for two days, the incubation tanks will have to be able to accommodate two breedings. Accordingly, the Plan scale of the incubation tanks will be:

3 tanks/breeding x 2 breeding = 6 tanks

c) Nursery Tanks:

The most commonly used nursery tanks are 1.5 x 2m in size, with a capacity of about 250,000 larvae. The average number of eggs obtained per breeding is 1,440,000, with 72,000 hatchlings to be stocked, based on a 50% hatching ratio. Accordingly, there is a requirement for:

1,440,000 eggs x 50% / 250,000 laevae/tank = 2.9, or 3 tanks

The hatchlings will be kept in the nursery tanks for 3 days and so, in order to permit continuous operations, these tanks will have to accommodate 3 breedings.

Thus, the Plan scale of the nursery tanks has been set at:

3 tanks accommodating x 3 breedings = 9 tanks

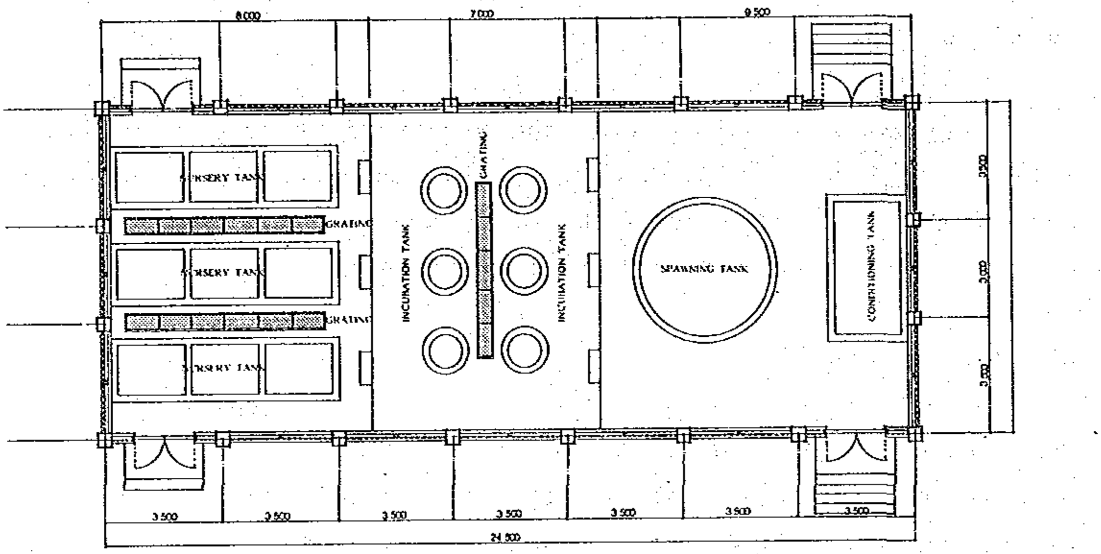
B. Layout Plan:

Consolidating the sizes and number of the various tanks, we have the following:

Type	Size	No. of Tanks
Conditioning tank	2.5 x 4m	1
Spawning tank	4m diameter	1
Incubation tank	1.5m diameter	6
Nursery tank	1.5 x 2m	9

With a suitable allowance for working space, the required floor area for this layout plan will be 250 m^2.

The final layout plan is shown below:



2) Feed Production Shed

The target items of equipment include a pulverizer for pulverizing raw material, a kneader to mix the various pulverized materials, and a pelletizer for converting material into pellet form.

Except for the early stage of feeding, the feed is ordinarily set, as a rule of thumb, at about 3% of total weight and is made mainly from rice bran, corn, and oil cake. The maximum planned stock is 12 tons, comprising approximately 10 tons for seed, 1 ton for broodstock, and 1 ton for other indigenous species. 3% of this 12-ton total is 360 kg, which has been set as the daily production capacity of the Feed Production Shed. The plant will operate 7 hours per day, but, allowing 2 hours for preparations, cleaning up, and other maintenances, the entire operation is to be completed in about 5 hours.

a) Pulverizer:

Based on a 3-hour operation to pulverize 360 kg, the capacity of the pulverized must be about 120 kg per hour.

b) Kneader:

Since the kneading operation can be conducted in parallel with pulverizing, in order to complete the former in 4 stages, a 100 kg capacity will be required.

c) Pelletizer:

The pelletizing operation can be conducted in parallel with pulverizing and kneading. Allowing about 3 hours for this operation, the pelletizer capacity has been set at about 130 kg.

3) Hatchery for Indigenous Species:

The major target species for experimental rearing will be sahar, while research will also be done on the rearing of rewa (Chagunius Chagunio) and katle (Acrossocheilus Hexagonolepsis), which are commonly found in lakes and rivers in the Pokhara Valley and have traditionally been important as food fish. The research programs will be comprehensive in nature, centering on basic data collection to clarify ecological and growing conditions, establish reproductive technology, and develop suitable feeds as well. In carrying out this research, 3-5 experimental groups will normally be established, with varying conditions, depending on the nature and objective of the program. Considering that these experiments and research facilities are to be developed largely through technical cooperation programs, in order to obtain results during identical periods, it will be proper to create an efficient research environment, based on these 5 experimental groups.
Since this facility will be a wet lab, it will require water supply and floor drainage as well as aeration ducts so as to permit continuous rearing experiments under identical conditions.

A. Equipment scale

The required items of equipment will be an incubation tank, nursery tank, rearing tank, stocking tank, water tank for small- scale experiments, and a culture tank for food plankton. The functions of the various tanks, with specific reference to conditions in Trisuli, will be as set forth below:

a) Incubation Tanks

The incubation tank will contain the fertilized eggs and will incubate through the eye stage, or hatching, and various types can be considered. Since the sahar eggs, the main target species, are a free demersal egg, a vertical type and an Atkins-type incubator will be suitable. 6 vertical type incubators (both new and old) are presently in use in Trisuli. As a result, the vertical type incubator has been adopted for this project, with 5 units initially planned.

b) Nursery Tanks

A nursery tank will be provided for the rearing of hatchlings, and such tanks (old and new) are presently being used in Trisuli. They are intended for both nursery and experimental purposes, with 5 units planned.

c) Rearing Tanks

Two types of rearing tanks are used in Trisuli, each with a capacity of around 1,000 liters: an FRP square type and a poly-carbonate circular type. 6 units of each type will be provided for rearing and experiments. The main characteristics of the square tank will be the ability to employ floor area effectively, while the circular type, by directing the water flow in a particular direction, will permit rearing by the raceway method. The two types will be combined in this Plan to take advantage of their respective merits.

The basic research themes at this facility will be submitted in connection with the implementation of technical cooperation but, if, as a minimum, 2 sets of experimental groups are provided for experiments on feed and growth and another two for accumulating data on basic rearing conditions, such as to set up suitable stock density and water supply, etc., there should be no problems in accommodating immediate requirements. Thus, if 5 experimental groups for an experiment areestablished, a total of 20 tanks will be required, and we have, therefore, designated 10 square units of 800 liter capacity and 10 circular units of 1,000 liter.

d) Stocking Tanks

There will also be a requirement for tanks to stock the test fish. Considering the fact that these tanks will have to be deployed on the basis of growth stage, species, and sampling place of the test fish, and in order to permit indoor rearing experiments on large fish as well, 10 tanks of 1,700 liters each will be provided for this Plan.

e) Culturing Tanks for Food Plankton

The major problem in research on the rearing of indigenous species is the development of the incipient feed. At Trisuli, artemia are being hatched experimentally as an incipient feed. But artemia, of course, is not indigenous to Nepal and so cannot be used in the future for cost reasons. Accordingly, equipment should be provided under this Plan for the development of substitute feed organisms.

Considering the experimental nature of the culturing tanks, their capacity has been set at a minimum of 100 liters. A total of 3 tanks will be provided: one for artemia use, a second for the culture of diatoms and other phytoplanktons, and a third for the culture of such zooplanktons as water fleas.

f) Small Experimental Tanks

This facility is intended to conduct experiments on the physiological needs of fry and their reaction to physical conditions at the various growth stages. While the number of test areas will vary also with the objectives of the experiment, we have identified a need for 5 locations, including a comparison area, to create various sets of conditions (environments). In Trisuli, tests are presently being conducted using 10 tanks but, since test periods under this Project may run several months, we have decided to provide a total of 15 tanks, which will permit 3 testing programs to be run concurrently as a means of increasing their effectiveness.

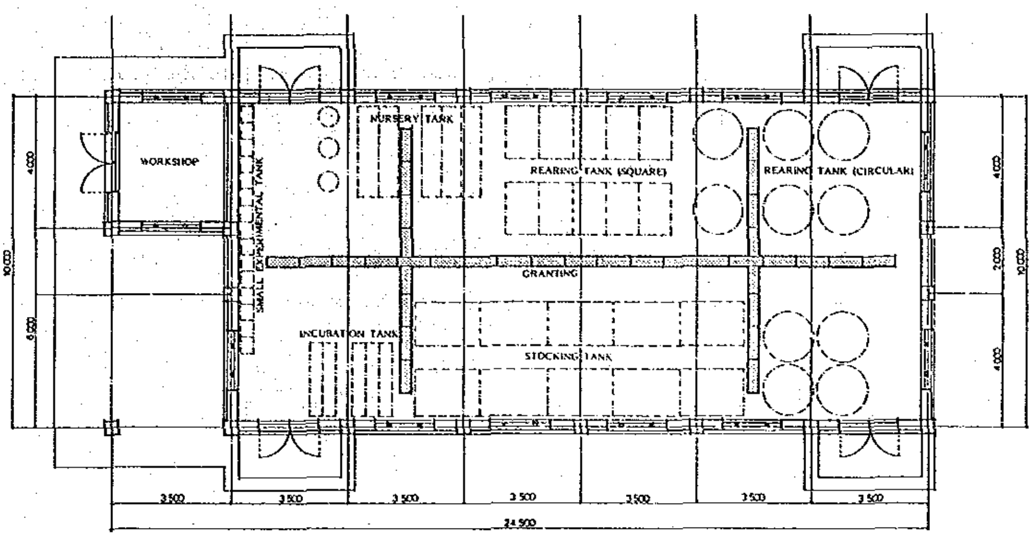
Assuming that the test fish will all be fry, we have specified a small tank with a capacity of about 30 liters.

B. Layout Plan:

Summarizing the tank requirements outlined above:

Type of Tank	Capacity (liters)	Material	Approximate Dimensions	No.
Incubation Tanks	200	FRP	400 × 2,200 mm	5
Nursery Tanks	400	FRP	600 × 2,700 mm	5
Rearing Tanks (square)	800	FRP	1,000 × 1,600 mm	10
Rearing Tanks (circular)	1,000	Poly-carbonate	1,500 mm diam.	10
Stocking Tanks	1,700	FRP	1,400 × 2,200 mm	10
Food Plankton Rearing Tanks	100	Poly-carbonate	550 mm diam.	3
Small Experimental Tanks	30	Acrylic	450 × 300 mm	15

Allowing space for work tables and storage and working areas, the total floor space requirement has been calculated at 200 m2. The floor plan is as shown below:



4) Administration/Research Building:

This building forms the core of operations at the Begnas Seed Center. Space requirements include the office, administrative, research, and experimental functions.

Personnel:

Administrative (10 persons)	Director, experts, accountant, typist, 6 technicians (2 3rd class, 2 JT, 2 JTA; 1 for feeds, 1 for aquaculture, and 4 for seed production)
Using Conference Rooms (20)	7 staff members; 1 expert; visitors-- e.g.,.FDD and provincial officials and fishermen (12)
Using night quarters (3)	3 technicians during night operations in connection with incubation

Space Requirements for the Various Rooms:

In calculating the space requirements for the rooms, we considered basically the types of persons using the room, layout of furniture and fixtures, and allowances for working space, with reference to the size of existing facilities in Nepal. A general floor plan was developed on the basis of the configuration and size of the various rooms, including an allowance for the entrance hall, stairway, and corridors.

Based on the above considerations, the space requirements for the Administration/Research building have been established as follows:

Room Designation	Area (m^2)
Laboratories	60.0
Biological Testing Lab	36.0
Chemical Storage	13.0
Draft Chamber room	13.0
Fishery resource Lab	24.0
Director's office	24.0
Room for scientists	24.0
Accountant room	10.0
Utility room	8.0
Toilets	28.0 (8.0 for men's room, 6.0 for ladies' room) x 2
Office	26.0
Conference room	60.0
Library	26.0
Staff room	16.0
Storage	8.0
Corridors, stairway, Entrance hall	111.0
Total	487.0 m^2

5) Warehouse:

This area will be used to store cage and pen materials, fishing gear, and materials for seed productive use and to provide space for net making operations and the ice-making plant.

The ice plant is needed to lower water temperatures during summer fry shipments to prevent the fish from weakening from high water temperatures. At the peak of fry shipments, the daily volume of water and fry combined will come to 1,350 Kg.

The ideal temperature for shipping carp is $18^{\circ}C$, but, during summer, water temperatures rise to $25^{\circ}C$ or more. However, it is considered undesirable for the difference from water temperature prior to shipment to exceed $5^{\circ}C$, and so the fry will be shipped with ice to cool temperatures by $5^{\circ}C$.

The volume of ice need to cool water temperatures $5^{\circ}C$ during shipment is:

V = weight x specific heat x specific gravity x difference in water temperature x 1.3 / 80.

Accordingly, 1,350 kg x 4.2 x 1 x 5 x 1.3 / 80 = 460.6878 kg.

The additional volume of ice needed to prevent a rise in temperature during shipment becomes:

V = heat transmission area x transit time (hours) x coefficient of overall heat transmission x temperature differential x 1.3 / 80.

Thus, $16.2m^2$ x 2h x 10 $kcal/m^{2}{}^{\circ}Ch$ x 5 x 1.3 / 80 = 26.325 kg.

Combining the above values, the total ice requirement works out to 487 kg/day.

Accordingly, the ice-maker and ice chest should have a capacity of 500 kg/24 hour period.

Allowing for installation and working space for the above equipment, the total required area becomes $36.0m^2$ for the warehouse, 36.0m2 for the fishing gear shed, $36.0m^2$ for the ice plant, and $36.0m^2$ for the net-making area, for a total of $144.0m^2$ in all.

6) Night quarters

During spawning and hatching periods, 6 staff members will be on night duty, 3 of whom will stay overnight. This facility will provide night workers with rest, mess, and sleeping quarters.
Allowing for the layout of furnishings and adequate working space, the required areas for this facility become: 14.0 m^2 for the mess hall, 6.25 m^2 for the kitchen, 5.0 m^2 for the toilet, and 16.0 m^2 and 14.0 m^2 for 2 bedrooms, and 6.0 m^2 for corridors, for a total of 61.25 m^2.

The total area of buildings and facilities at the Begnas Seed Center is as shown below:

Type of Building or Facility	Building Area (m^2)
Hatchery	245.0
Feed Production Shed	72.0
Rearing Shed	224.0
Administration/Research Building	487.0
Warehouse	44.0
Night Quarters	61.25
Total	1,282.25 m^2

7) Phewa Fishermen's Training Center

Since functions relating to the seed production are to be carried out at the Begnas Seed Production Center, the main activities planned at the subject location will center around extension services, training to fish farmers, and limnological research.

This facility will comprise various functions relating to the training of fish farmers, display of research findings, and limnological research.

Personnel:

Administrative (4)	4 officials (3rd class) [2 for limnological research, 1 for ecology, 1 for training]
No.of persons using the training room (20)	20 fishermen, or 20 employees from Begnas, Phewa, and Rupa
Workers (6)	

The calculation of space requirements for the various rooms has, in principle, been based on a layout plan for persons using the facilities and related furnishings, including a suitable allowance for working space. In preparing this plan, reference has been made to the size of existing facilities in Nepal.

We have developed a full floor plan, based on the above data and the configuration and size of the various component areas, including entrance hall, stairs, and corridors, plus a suitable allowance for working space.

The scale of the Training Center, based on the above considerations, is shown below:

Type of Room	Room Area (m^2)
Biological experimental and training room	67.5
Limnological lab	22.5
Specimen storage room	15.0
Office	22.5
Training room	45.0
Utility room	6.0
Toilet/washrooms	12.0 (men's room 6.0, (ladies' room 6. 0)
Staff room	9.0
Storage	9.0
Corridors, stairs, entrance hall	55.5
Total	264.0 m^2

8) Rupa Fish Collection Shed

This facility is designed to collect weights and size data on fish taken from Lake Rupa.

Allowing for the required furnishings and adequate work space, the total required area comes to 32.0 m^2, comprising 16.0 m^2 for the weighing room and 16.0 m^2 for the office.

9) Research Building /Godawari Fisheries Development Center:

The Godawari Fisheries Development Center will comprise administrative functions, fishery experimental and research functions, and material storage functions.

Personnel:

Administrative (7)	3 experts 2 officers (2nd class) 2 officers (3rd class) 2 specialists in ecology; 2 in resource study]
No. of persons using conference room (20)	20 employees from Pokhara, Trisuli, and Godawari
Workers (5)	

Calculation of the space requirements for each room has been based on a layout plan for persons using the facility, including related furnishings and an allowance for working space, which has taken into consideration the size of existing facilities in the country. The space has been determined on the basis of the configuration and size of the various rooms, including entrance hall and corridors and a suitable allowance for working space.

The scale of the research building, based on the above calculations, is shown below:

Type of Room	Room Area (m^2)
Conference Room	60.0
Chemical Lab	36.0
Biological Lab	22.0
Room for Specialist	24.0
Office	22.0
Utility room	8.0
Toilet/washrooms	14.0 (men's room 8.0, (ladies' room 6. 0)
Staff room	12.0
Storage	10.0
Corridors, stairs, entrance hall	37.5
Total	245.0 m^2

(2) Structural Plan:

The target facilities for the Plan are the seed production and research operations. The structure and methods have been determined, as outlined below, with due regard for the planned use, scale, material procurement during the construction stage, and ease of maintenance of the respective facilities.

1) Construction Methods:

From the standpoint of usage and scale of the subject facilities, possible construction methods include wood, brick, concrete and steel frame. The most prevalent methods in Nepal are reinforced concrete for pillars and beams, brick for walls, or masonary structure using stone. For roof truss, the most common method is steel trusses in small sections., which is the method that has been used at the existing research facility in Trisuli. In the case of facilities requiring wide spans, steel trusses and concrete beams are utilized. This technique makes it easy to obtain spacious areas, as opposed to the other construction methods, and the method tends to be used because it shortens construction time, owing to the ease of achieving quality and accuracy in the structural components. However, all of the steel materials must be imported.

Wood construction is relatively expensive and so, with the exception of small-scale facilities, is not used very much for structural components.

In this project, reinforced concrete has been specified for the mainstructures in the Administration/Research and Training structures, which constitute the core facilities under the Plan, while rigid frame construction will be employed in the general construction program. In the small-scale facilities, considering the intended use and plane scale, masonry will be used as appropriate. In the roofs, steel trusses will, in principle, be utilized on the basis of existing construction practices and span widths in the Plan areas.

2) Basic Structure:

The soil composition at the Begnas Plan site was confirmed by the soil analysis, including boring surveys, conducted during the field study as comprising a surface layer of sandy clay, a layer of silty sand and gravelly sand, and a sandy gravel layer, in that order. The soil layer is composed of sandy soil, and a long-term allowable soil bearing capacity of about 6 tons can be expected in the foundation structure.

The Plan facilities will be relatively light-weight, low-rise 2-story structures, and so it has been determined that the foundations are suitable for supporting the direct basic structure. The building facilities at Phewa and Godawari, like those at Begnas, will be relatively light-weight, 1-2 story structures. Comparable scale facilities have already been built in areas adjacent to both Plan sites, and we learned in the field discussions that the areas have been used for many years as building sites. We have, therefore, concluded that adequate soil bearing capacity can be anticipated at these Plan sites.

In the case of Rupa, site of the Fish Collection Shed, the building will be small and light-weight. Although no reference structures exist in the vicinity, we have confirmed visually that the area should be fully able to support the intended facility.

The basic structure for the Plan facilities will utilize a direct- bearing, single footing foundation, which is the most commonly found method in existing structures in the subject areas.

3) Sectional Plan:

The sectional plan is closely related to ventilation, lighting, and insulation of the various rooms. Adequate ventilation and light must be provided in the Administration/Research and Trainingstructures.

Eaves will be widely used in this Plan, as they are highly effective as a means of controlling rainfall invasion and luminous intensity, keeping out strong sunlight, and preventing direct glare on desk surfaces.

With regard to ceiling heights, high ceilings are a generally accepted technique in the Plan areas for providing proper ventilation and, particularly, for alleviating the oppressive heat just prior to the rainy season. Ceiling heights in comparable structure were generally found to be 2.5 - 3.5 m in small rooms and 3.6 - 6.0 m in medium-sized space.

4) Structural Component Plan:

The following conditions were kept in mind in developing the component plan for the building facilities:

-- Climatic conditions:
  High rainfall concentrated in a brief period of time.
-- Only a few building components can be sourced locally.

The component selections have been keyed to the above conditions.

Unless otherwise specified, all components shown in this section are common to all Plan structures.

A. Exterior finish

(a) Roofing

Not only in comparable structures, but in the Plan areas generally, slanted (pitched) gable, hip, and flat roofs are widely used, depending on the particular structure. Slanted roofs are effective in radiating indoor heat as well as in handling large amounts of rainfall. They can, therefore, be said to be the most suitable roof type for the natural conditions in the area. In the case of slanted roofs, regardless of size, the most common roofing materials are slate, tile, and corrugated galvanized steel sheets. In the case of flat roof structures, frequent use is made of concrete slab water-proofed.

In this Plan, we have specified slanted roofs as being most appropriate for the natural conditions. Roofing material will be slate roofing, which are the most widely used type in the area and also easy to maintain.

(b) Exterior Walls

The wall materials most commonly used in low-rise buildings in the subject areas are natural stone, common brick, and hollow concrete block. These are traditional building materials in Nepal and, along with slate tile, are the easiest and cheapest to procure. In this Plan, natural stone and concrete block will be used in Begnas, Phewa, and Rupa, which have abundant supplies of natural stone, since these materials are easy to obtain and use. In Godawari, common brick will be used.

(c) Building Openings

Wooden doors are primarily used for normal-sized openings, while steel doors are generally used for larger openings in factories and comparable structures.

In the present Plan, wooden doors have been specified for normal size openings in research areas and offices.

For windows in the general-purpose rooms, we shall use wooden fittings, which are most prevalent in the area.

B. Interior Finishes:

(a) Floors

We have standardized slab-on-earth concrete floors with mortar finish in the general rooms, incubation rooms, and research areas. The main section of the Phewa Training Center will extend from the entrance area to the biological laboratories on the 2nd floor, and terrazzo finish has been specified for these areas, since this material can be sourced locally and is durable and easy to maintain.

Toilets and washrooms will be given vitreous tile floors for sanitary reasons.

(b) Ceiling and Wall Finishes

The following materials will be used, as appropriate, as finish on ceilings and interior walls:

Ceilings: Strips, acoustical panel, veneers, watertight board with paint finish

Walls: Mortar with paint finish, cloth finish, veneer plank finish

(3) Facilities:

1) Power Facilities

Power supply to the various Plan facilities, in the case of the Begnas Seed Production Center, will be drawn from an 11,000 V overhead trunk line running to a point about 500 m from the southern border of the property. In Phewa and Godawari, power is already available from trunk lines that have been brought into the facility areas.
Power brought to the main switchboard of the Plan facility will then be distributed to branch distribution lines at each location. Rupa has been eliminated from this discussion, since no power consumption is planned there.
The trunk intake lines into each facility will, in principle, be distributed through underground lines via PVC conduit pipes.

In planning the power facilities, we have purposely avoided items which would be complicated to handle or service, specifying simple yet effective facilities. From a maintenance standpoint, the equipment materials will be products of standard local specifications which are easy to procure.

The electrical system may be classified into lighting outlets and powered facilities.

A. Lighting outlets

The lighting fixtures that are generally used in the Plan areas include both fluorescent and incandescent types, with all products imported. The items to be utilized in the Plan will basically be of Japanese origin, owing to their competitive prices, stability of supply, and quality and reliability.

The luminous intensity in the Plan rooms has been set as follows, in accordance with local conditions:

Main rooms (offices, research areas, conference rooms, library, laboratories)	300 luces
Incubation room and feed production shed, and hatcheries	150
Warehouses, corridors, toilets and washrooms	100
Outdoor lighting	10

Two types of outlet will be used: a general purpose outlet for the library and offices and specialized sockets for the research and aquacultural equipment and tools installed in the research areas, laboratories, and feed production shed. Load voltage will be 220V, 50HZ for the general purpose outlets and either single-phase 220 V or 3-phase 400V, depending on the equipment item, for the specialty sockets.

B. Powered Facilities

The powered facilities, mainly at the Begnas Seed Production Center, will include lifting pumps for use in water intake operations and with overhead tanks, air blowers in the feed production shed. Load voltage will be 400 V, 50 Hz.

C. Lightning Rods

Lightning is frequently observed in the Pokhara area, and lightning rods are found on facilities that have been built in the Plan areas with grant-aids. Rods will be installed on major structures provided in this project.

D. Phones

Telephone lines will be set in the main facility sites, excluding Rupa, and telephones will be installed. The securing of telephone lines from outside is to be the responsibility of HMG.

E. Fire-prevention Equipment

There are no local fire laws or ordinances. In this project, therefore, we have not given particular consideration to this subject.

F. Generating Facilities

Generating facilities will be installed at the Begnas Seed Production Center as a standby power source for the lift pump, laboratory refrigerators, precision instruments, and air blowers in the hatchery for the indigenous species.

G. Ice-making Equipment

An ice-making unit and an ice storage chest will be installed at the Begnas Seed Production Center for use in transporting the fry produced at this facility. The ice-maker will be plate type for ease of maintenance and service.

2) Facilities for Water Supply, Drainage, and Sanitation:

A. Water Supply:

a) Begnas Seed Production Center

The water used at this facility will be divided into 3 categories: (1) that used in connection with the seed production operations; (2) that used in research and laboratory work; and (3) general and miscellaneous water.

Category (1) and (2) water will be sourced mainly from Lake Begnas, which adjoins the east side of the Plan site. As to the general water supply, since there are no municipal water services in the area, this water will have to be obtained from wells dug at each site. The plan is to use water from newly drilled wells in the Plan area.

Considering the logistics of the Plan area and the fact that ground elevation is normally lower than that of Lake Begnas, we have concluded that a siphon pipe intake system would be optimal. Based on water level data for the past 18 months at this lake, the water level will normally be adequate to permit intake via this method. However, considering the fact that water intake is the most important function at the Plan facility, the siphon method can be expected to cover intake requirements only for water levels up to 0.5 m below minimum observed levels during abnormally dry periods. For levels 1.0 m or more below this minimum, an intake pump facility will have to be installed.

The materials used for siphon pipes may be either PVC or steel. However, based on the intended functions at the Plan facility, the material should be strong enough to withstand damage from a small external impact. In the case of PVC, there is a danger of sudden damage from external impact as well as concern about a decline in strength in exposed sectors , based on changes over time. Accordingly, in this Plan, we have specified the use of steel pipe for the siphon pipe, as in comparable facilities in Japan. For anti-corrosion purposes, PVC coating has been specified inside the pipe.

The water supply method within the facility will bring in water via the siphon pipe to a reservoir pit and distribute it to the various seed production ponds through water supply channels, using a gravity method.

At the rearing shed and hatchery, which require filtered water, after treatment in the filtration tank, the water will be pumped up to the overhead tank and then distributed to the various seed production facilities, again via the gravity method.

General-purpose water will be pumped up from the well to the overhead tank and then distributed to the various facilities via a gravity system. The supply pipes will be PVC, the most commonly used material in the area.

The anticipated daily requirement for general water at the Begnas Seed Production Center will be 16-18 m^3.

b) Phewa Training Center:

Water for this facility will be of two types: (1) that for research and experimental use; and (2) general and miscellaneous water. The water source for both categories will be via branch pipes from the main water pipe brought into the Plan site.

The supply method at this facility for both classes of water will be to pump the water first into the overhead tank and then distribute it to the various rooms via a gravity system.

The water pipes will be made of PVC, which, as noted above, is the most commonly used material in the Plan area.

The anticipated daily water consumption at the Phewa Training Center is 9.60 m^3.

c) Godawari Research Building:

The water supply system at this site will comprise: (1) water for raceway experiments; (2) water for research and laboratory use; and (3) general and miscellaneous water.

The water for the raceway experiments will be drawn directly from the water supply channel adjacent to the Plan site. Water for research and experiments as well as general water will be taken in through branch pipes from the main water supply pipe to be brought into the site.

The water supply system within the facility for research, laboratory, and general purposes will first be pumped to the overhead tank and then distributed to the various rooms via the gravity method.

Water supply will be via PVC pipes, which is the most commonly used material in the area. Daily water consumption at the Godawari research facilities, excluding the raceways, is estimated at 9.48 m3.

d) Rupa:

Since the Fish Collection Shed will be a very small structure, no consideration has been given to water supply facilities at this location.

B. Drainage Facilities:

In principle, water used for seed production will be treated and discharged directly into the connecting drainage channel.
Drainage from the laboratories and research facilities, containing highly concentrated chemicals and heavy metals, will be routed to a chemical tank and treated and recycled at regular intervals.

Sewage will be treated in a septic tank and then seeped into the ground.

Other waste water will be trap-treated, then permeated in the ground via a seepage pit.

3) Ventilating Facilities:

Draft Chambers will be installed in the Research/Administration Building at Begnas for chemical analysis of dangerous substances used at that facility.

Ceiling fans will be installed in the research areas, laboratories, offices, conference and other general-purpose rooms.
Exhaust fans will be installed in the toilet/washrooms, research areas, and laboratories.