AQUACULTURE (INDIA):
AN EVALUATION

Phase I - 3-P-73-0065
Phase II - 3-P-77-0077 (Proposed)

RECIPIENT INSTITUTION: Indian Council of Agricultural Research
New Delhi 1, India

DURATION: Phase I - Nov. 1974 to Nov. 1977
Phase II - proposed

IDRC CONTRIBUTION: Phase I - $324,000
Phase II - proposed

October 1978

1. THE RESEARCH PROBLEM

Aquaculture is the practice of farming aquatic plants and animals in water under varying degrees of control. The potential of aquaculture, sometimes called fish farming, for increasing edible protein and the income of rural communities has been emphasized at many scientific meetings including those of the Technical Advisory Committee (TAC) to the Consultative Group on International Agricultural Research (CGIAR). A seminar on aquaculture in Asia was sponsored by IDRC during April 1973 and attended by aquaculturalists from eleven Asian nations who defined several specific problems related to aquaculture as traditionally practised and proposed research projects to improve aquaculture technologies. The productivity of freshwater and brackish (slightly salty) water ponds is considered to be considerably below their potential and there are large bodies of water still unutilized for any food productivity purpose.

1.1 Background

In India there exist about 1.6 million hectares of cultivable fresh water, of which 0.6 million hectares (38 per cent) are currently being utilized for fish culture. Of the remaining 62 per cent, approximately 0.4 million hectares are available for fish farming. In addition, there are 2.0 million hectares of cultivable brackish water areas. In northeastern India, where fish and rice form part of the staple diet, demand for fish has been growing faster than supply. Freshwater fish prices have increased dramatically, and sell for at least 5 rupees ($0.70) per kilogram in urban centres. As a result, the poorer sections of the population can no longer afford to buy fish, and an improvement in their diet will only come about with a rapid increase in fish yield.

In a 1972 study by India's Central Inland Fisheries Research Institute (CIFRI), it was estimated that there existed an annual demand for fish of 8.5 million tonnes but a production of only 1.8 million tonnes. This prompted the Indian Government to place increasing emphasis on the development of fish culture between the fourth and fifth Five-Year Plans. This emphasis was reflected in their submission of a project proposal to IDRC that would involve expansion of basic scientific studies of various fish species and the establishment of composite fish culture (CFC) trials in village ponds.

1.2 Recipient Institution

Officially the recipient is the Indian Council of Agricultural Research (ICAR), which is responsible for all of India's government agricultural research. The actual research has been undertaken by CIFRI which falls under the umbrella of ICAR.

CIFRI was established in 1947, with headquarters in the northeastern Indian state of West Bengal since 1959. CIFRI is one of the

.../C-2

world's largest freshwater research institutes, comprised of 11 substations and 15 survey centres. The main function of the institution is to study the scientific principles which can be applied to increase the utilization of Indian inland waters to maximize the production of fish for food. The majority of the scientific staff are fishery biologists, with chemists and geneticists involved to a lesser degree.

CIFRI is recognized as one of the leading research institutions in freshwater culture. In 1957, CIFRI was the first institute to succeed in breeding an Indian major carp (rohu) in captivity. CIFRI began a major induced breeding program in 1962 on the major Indian and Chinese carps for large-scale production of seed.

IDRC's willingness to support this project was based on the Institute's record of success in an area where little research competence exists in developing countries and on the exciting potential of the composite fish culture system developed by CIFRI. CIFRI had already done some experimental tests using CFC in which it found that one could obtain up to 9000 kilograms per hectare per year under ideal experimental conditions. This compares to an estimated Indian average of 600 kilograms per hectare per year using traditional methods and species.

An essential precondition for the development of CFC is the supply of a large number of fish seed. Indian scientists were able to perfect techniques of induced breeding of the six needed species to allow large-scale production of fish seed. Broodstock of the desired species are given special care until the breeding age and season are reached, then combinations of one female and two males are injected with a pituitary gonadotrophin preparation that results in the final stages of egg or sperm formation. Either natural spawning is allowed to occur or the eggs and sperm are stripped from the parents and mixed together, then placed in a simple hatchery. When the eggs hatch, they grow to the fry stage and are then stocked in specially prepared nursery ponds. The young fish are now ready for use in the composite culture system.

The CFC system developed by CIFRI was based on the stocking of local and exotic carps with three local Indian carps--catla (Catla catla), rohu (Labeo rohita), and mrigal (Cirrhinus mrigala)--raised in the same pond with three exotic carps--Chinese silver carp (Hypophthalmichthys molitrix), grass carp (Ctenopharyngodon idella), and the Indonesian strain of common carp (Cyprinus Carpio communis). CFC is based on using different but complementary species of fish with different feeding habits and environmental niches to obtain maximum yield. The basic principle of composite fish culture is that when compatible fish of different feeding habits are stocked together they yield a greater amount of fish than if the pond was stocked with an equal number of a single species. In general, each specie does not compete with the others for food or living space and some have beneficial effects on the growth of the others. For example, the grass carp converts plant material into fish flesh and at the same time its excrement fertilizes the pond producing plankton which serves as food for some of the other species.

.../C-3

The soil and water conditions of the ponds are first determined; then the pond is poisoned by the addition of mahua (Madhuka latifolia) oilcake removing all fish snails and other aquatic creatures. The mahua oilcake--residue after vegetable oil is extracted from a locally available plant--has the additional advantage of fertilizing the pond. Its toxic compound is biodegradable and quickly (12 hours) breaks down into harmless substances. Supplementary fertilization may be achieved by the addition of cow dung or chemical fertilizers (urea or triple superphosphate) to produce the desired plankton production which serves as an initial source of food for the young fish. Depending on the type of pond, its location, and the availability of fish seed (small fingerlings), varying ratios of the six species of fish are stocked at the rate of 5000 per hectare of water area. A supplementary food mixture of oilseed cake and rice bran is broadcast daily on the water surface. Aquatic weeds available from local rivers or ponds banks, together with other vegetable waste, are also added as food for the grass carp.

1.3 Project Development

The States of West Bengal and Orissa were chosen as testing regions because CIFRI headquarters is located in West Bengal, and these two states are part of northeastern India, the main fish-eating area of the country and a place where traditional aquaculture is widely practised.

Originally, the project was to involve five scientists from CIFRI and seven scientists of the State Department of Fisheries seconded to work at CIFRI on the project. This situation has changed, with there now being twelve CIFRI and eight State Department researchers involved.

The project is under the control of a project leader responsible to the Director of CIFRI. One CIFRI fishery scientist operated the program in each state. The two village sites in each state had four senior research assistants responsible for organizing and directing the work at the village level. Two of these scientists were from CIFRI and two from the State Department of Fisheries.

The bulk of the experiments were undertaken in rural areas where farmers, public and private institutions and community associations were approached and persuaded to allow their ponds to be used for experiments. For the first year of pond operation the project provided labour and all inputs free of charge with pond owners receiving all proceeds from the harvest of fish in the first year. Pond owners were expected to use the proceeds from the first year's harvest to pay for all costs of this system in the second year with CIFRI providing only technical assistance. Most inputs required were purchased by CIFRI headquarters and provided to each site rather than purchased in the village.

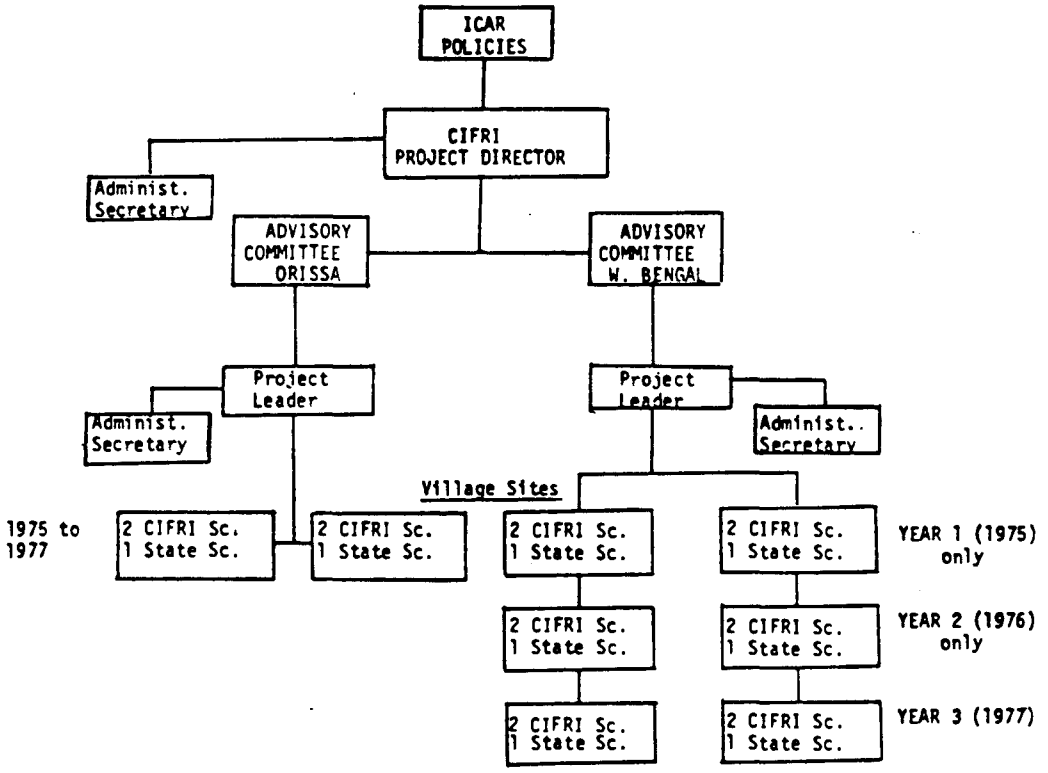
The demonstrations of CFC were very successful in the original two village sites in West Bengal, so in Year Two, two more sites were

.../C-4

chosen representing different pond conditions, with only technical assistance being provided in the original two villages. Again in Year Three, two more West Bengal villages were chosen. In Orissa, only the original village sites have been involved. In both states, smaller ponds were used as nurseries for rearing fry up to fingerling size prior to stocking in larger ponds.

Figure 1 shows the organizational structure of the project.

Figure 1: Project Organization



1.4 Objectives

The general objective was to support the development of CFC and to increase fish production at the village level through a major program of on-farm testing.

The specific objectives were:

a) To develop highly productive systems of composite fish culture;

.../C-5

b) To establish and evaluate the most productive experimental systems in village pond conditions at various locations in Orissa and West Bengal; and,

c) To identify and investigate the principal fundamental constraints to improved composite cultures.

2. PROJECT PERFORMANCE

2.1 Technical Achievements

IDRC staff feel the project has made substantial progress towards achieving the first two objectives. However, the Director and staff of CIFRI agreed that progress has been unsatisfactory in the third objective of identifying and investigating principal fundamental constraints. (See section (e) below).

a) In West Bengal, the project was located at Hanspukur-Bishnupur and Harishchandrapur in the year 1975-76. Fish production from ponds at these centres ranged from 3264 kg/ha/11 months to 6033 kg/ha/11½ months (3561 kg/ha/yr to 6295 kg/ha/yr) and 1038 kg/ha/7 months to 2793 kg/ha/8 months (1780 kg/ha/yr to 4190 kg/ha/yr), respectively. In 1976-77, the project was shifted from Harishchandrapur to Gaur. Additional villages were included under the project at Hanspukur-Bishnupur. Fish production ranged from 2588 kg/ha/9 months to 5645 kg/ha/yr at Hanspukur-Bishnupur and 4900 kg/ha/9 months to 7550 kg/ha/10 months at Gaur. Thus CIFRI was able to achieve yields on farmers' ponds in four locations in West Bengal ranging from 1038 kg/ha/7 months to 7550 kg/ha/10 months. For the 1977-78 culture period the project is being run at Sanko (Dist. Burdwan) and Pandapara (Dist. Jalpaiguri).

b) The results also showed that the cost of production, based on total inputs (feed, fertilizer, fingerlings, and casual labour), ranged from Rs 2.34 to Rs 4.89 per kilogram (Can. $0.33 to $0.69). The prices received for the output was a minimum of Rs 5.0 per kilogram (Can. $0.70). These figures provide an indication of all costs incurred by CIFRI except for the supervisory and managerial input by CIFRI staff. The individual pond owners' costs are likely to be higher because locally purchased inputs tend to be higher in price or are not readily available.

In Orissa, the project is located in two village sites where an average fish production of 2589 kg/ha/yr and 3873 kg/ha/yr was obtained. Here the cost of production was estimated to be Rs 2.81 per kilogram with a minimum price also of Rs 5.0 per kilogram. Thus CIFRI, which has been able to achieve yields in excess of 4300 kg/ha/yr in more than 100 trials on CIFRI station ponds, has proved conclusively that with similar management and input levels the production of fish under village pond conditions can be almost as high providing a dramatic increase in yield over that possible from the traditional

.../C-6

system. The major remaining question is whether the farmer will be able to achieve a major increase in yield over the traditional system without CIFRI assistance and ready access to input requirements. This will depend largely on the farmers' level of management, interest, accessibility to inputs, local marketing structures, and the apparent profitability of CFC.

CIFRI experiments indicate that the optimal size of pond ranges from 0.25 hectares to 2.5 hectares, but small ponds of size 0.045 hectares to 0.09 hectares have been effectively utilized for the production of fry and fingerlings. The techniques of rearing fish seed through induced breeding, hatching, and nursery management were successfully demonstrated in village pond conditions. The project staff produced and distributed several million fry and fingerlings in the areas around the project site, where exotic seed was not available.

As large numbers of the farmers' ponds are of small size, additional work on adapting CFC to smaller pond size is part of a proposed Phase II submitted by CIFRI to IDRC.

c) CIFRI research on nursery techniques has yielded a better data base on the system of induced breeding through to commercial size. The present culture system consists of hatching and seed production during July and August in farmers' ponds with an average of 50 per cent survival. Hatchlings grow to fry in about 20 days again with about 50 per cent survival, then in the next three months up until October-November fry grow to fingerling size again with a survival of about 50 per cent. Following this, culture of the carps in composite form proceeds within the next 7 to 10 months. Survival in this time interval for the species has been shown to range as follows: silver carp, 70 to 97 per cent; catla, 80 to 98 per cent; rohu, 70 to 80 per cent; mrigal, 60 to 80 per cent; grass carp, 30 to 90 per cent; and common carp, 60 to 80 per cent. The reason for the high variability in grass carp survival in the composite culture system is unknown at present and is being investigated.

d) Detailed studies by CIFRI of production costs and returns in 138 case studies of trials on their research stations with yields ranging from 3900 to 6600 kilograms per hectare per year, indicated that average income per hectare from the trials at West Bengal were Rs 27,973 per hectare and exceeded Rs 20,000 per hectare in 14 of the 15 districts. Expenditures averaged Rs 11,445 per hectare with little variation in input costs. The average cost of production per kilogram of fish was 2.62 rupees with a maximum cost of 3.50 rupees. The average sale price achieved was 6.39 rupees per kilogram, indicating that this technology can be extremely profitable.

The data available from project village trials indicates that returns are almost double all input costs. For example, in the village of Aska in the State of Orissa, data showed that the average input costs were Rs 2.88 per kilogram, while the average price was Rs 4.50 per kilogram. However, these results have been achieved with a high level of management control and the ready provision of all inputs

.../C-7

which in many cases would not be the case for the individual farmer. Further studies on the costs and returns, and other factors such as the level of risk and the profitability of serious shortfalls in yield, will be necessary to determine the profitability and acceptability of this technology to the individual pond owner.

e) Limited nutritional research including feed efficiency has been undertaken to date, partly due to delays in purchase of equipment. At present, groundnut cake (40 per cent protein) and rice bran (10 per cent protein) are fed at a rate of 1:1 during the summer and 2:3 during the winter. However, the high cost of oilseed cake, seasonal variability, and a lack of suitable alternatives would indicate further research is required here before most fish farmers will be able to utilize fully the intensive feeding system recommended by CIFRI. Experiments on the synergistic effect of grass carp and common carp indicated an increase in the weight of common carp fed exclusively on the fecal matter of grass carp by 4 grams per month. The growth rate of fish and their intake of feed is greatly affected by low oxygen levels in the ponds although the utilization rate of feed increases. Experiments on conversion ratios indicate that the growth rate is twice as high when a combination of animal and plant protein, equal to the 30 per cent level in the present oilcake and rice bran combination, is used. The growth rate is also doubled when pond temperatures are raised from 20°C to 30°C. These results are being used by CIFRI to identify the most productive feed ratios and pond environments.

2.2 Institutional and Personnel Development

IDRC staff believe that one of the important results achieved from this project has been the change in attitude of some of the CIFRI scientists. The CIFRI/IDRC project appears to have been an important factor in encouraging research scientists to get out into the field and to test their results in an applied field situation. IDRC staff have accompanied CIFRI personnel on field trips and have noted that CIFRI staff are very familiar with the pond owners in the area and the conditions of the ponds so that they are able to provide detailed advice concerning the initial stocking, management, and harvesting of the ponds.

Formal academic training for CIFRI staff involved in the project was not considered necessary, due to their already high degree of competence and efficiency in conducting fisheries research. However, seven project scientists did take study visits at other fisheries research institutes in the United States and Europe. They judged this to be very useful in identifying certain fields such as diseases and nutritional physiology and where CIFRI could usefully increase its research.

The Advisory Committee established in each of the two states has been concerned primarily with administrative functions and not with program planning or promotion and coordination with other agencies. The CIFRI Project Leader and the Headquarters staff have been responsible for most administrative functions such as purchase of

.../C-8

equipment and operating supplies, while the Advisory Committees have been responsible for selection of village sites and legal agreements with pond owners. The Advisory Committees have not been given any significant responsibility for evaluation and adjustment of the research program. CIFRI has maintained a policy of providing a 100 per cent subsidization of all costs on pond trials although the Director of CIFRI stated that in many cases this was not necessary and a new policy was outlined in the Phase II proposal. The farmers in West Bengal were provided with full subsidy for only one year as CIFRI moved to new sites, whereas farmers in Orissa were given all inputs for both full years that the project has operated. As already mentioned, CIFRI staff have become familiar with many of the typical problems facing the pond owner, and they have given prompt and practical recommendations on alternatives. However, IDRC staff felt that CIFRI could still improve its responsiveness to field problems as they are identified by undertaking corrective research programs on such problems as variations in pond acidity and netting problems in very deep natural ponds.

CIFRI staff have been much more conscious than most research institutions of the need to demonstrate the economic as well as the technical viability of new technology as indicated by several major CIFRI publications prepared on the economics of the CFC system. The yields and costs of all CIFRI standard inputs other than supervisory costs have been calculated in 138 case studies of on-station trials. CIFRI sought the support of the Agro-Economic Research Centre to undertake some field research as this institute is represented on both State Committees. However, the information they provided was very sketchy and of limited value. As CIFRI has only one junior economist on staff, it does not have the capability at present to undertake any detailed studies of the constraints that limit the adoption of the CFC system or the profitability of each component in the standard system being recommended. It should be possible to provide a stronger feedback during the proposed second phase since CIFRI is planning to provide one economist full-time for the project and discussions have been held with the Indian Institute of Management Studies concerning the use of their Masters degree level students to undertake jointly supervised field studies. It has not been necessary to use the project's Advisory Committees for promotion activities or coordination with other agencies since CIFRI has a regular on-going program of liaison and coordination with other agencies.

2.3 Administrative and Financial Problems

This project has been seriously delayed by a number of administrative problems which IDRC has found to be a common factor in projects supported in India. The project was delayed in starting up due to poor communications between the Indian Council of Agricultural Research (ICAR), the official recipient in Delhi, and the Central Inland Fisheries Research Institute (CIFRI) in Barrackpore. The project agreement was signed in July 1974 but the initial payment was not forwarded until January 1975, due to IDRC's initial payment, thus further delaying the project's initial start-up. In order to obviate further delays of this order on subsequent payment, AFNS now sends

.../C-9

copies of all official and financial documents addressed to ICAR to the project leader at Barrackpore.

A second problem common to IDRC projects in India concerns the purchase of equipment. At the onset of IDRC's involvement with projects in India, it was decided that the purchase of equipment should be made by the recipient, and not by IDRC. After many months of delay in this project, it was established that this was not a practical course of action in India with the present Government structure, so IDRC undertook to transfer the administration of equipment funds from the recipient-administered portion of the budget to the Centre-administered portion. Most of the equipment has now either been purchased or is on order.

The use of standard budget categories has also created some problems because Indian Government accounting procedures classify expenditures such as some operating expenses under contingencies. IDRC and CIFRI staff have resolved this problem and IDRC has suggested that future budgets be based on Indian accounting categories which project accountants are familiar with. (Appendices A and B summarize planned and actual expenditures in the project).

2.4 National Linkages

One of the most positive developments in this project has been the secondment of staff of the State Department of Fisheries of West Bengal and Orissa to CIFRI. CIFRI staff felt State Fisheries Deparments tended to be poorly organized and motivated relative to CIFRI personnel. By involving state research and extension officers, CIFRI is helping to train the very officials most likely to be sent to the newly established Fish Farmer Development Agency (FFDA) to carry out the long-term extension program of CFC (see section 2.7). As already mentioned, CIFRI unsuccessfully attempted to recruit the cooperation of the Agro-Economic Research Centre of the Government of India, in West Bengal and Orissa.

CIFRI has established some informal links with fish producer associations and Government agencies, such as FFDA and the Fisheries Cooperative Society among others. These linkages result largely from the setting of the terms and conditions with pond owners in using their ponds for research and demonstration.

The collaboration between FFDA and CIFRI has not been as productive as it should be, since FFDA is not represented on the State Advisory Committee, although FFDA is under the responsibility of the Director of Fisheries in each state, who does sit on the Committee. In the Burdwan District in West Bengal, FFDA and CIFRI have separate and unrelated subsidy programs in different villages close to each other. However, the proposed expansion of CIFRI's village testing and demonstration program to six states in a proposed Phase II will parallel the planned rapid expansion of state FFDA agencies. One of the major advantages of this expanding CIFRI village demonstration and testing program is that it will allow CIFRI staff to train more State officials in this new technology. This close working collaboration between CIFRI and FFDA staff will be even more important as the project expands in

.../C-10

Southern and Western India since the problems of promoting CFC will likely be different and more complex than in Northeast India, and CIFRI officials indicate that fish farming is usually considered a low status occupation in these areas.

During Phase II, an all-India seminar is planned to bring together scientists, fisheries workers, and extension officers from federal and state agencies, development agencies, financial and credit organizations, to demonstrate the technology and discuss what procedures can be implemented to hasten adoption of the technology.

2.5 Regional Linkages

CIFRI is the second institution involved in the planned network of IDRC's agriculture projects in South and Southeast Asia. The first is the Malaysian Agriculture Research and Development Institute (MARDI) in Malaysia.

At the end of the project, a regional seminar is planned to bring together scientists of Southeast Asia, to consider what parts of this technology can be developed in their countries. Many of the countries presently carry out some combination of polyculture using different species combinations, but much more work could be done to increase the yield and make available seed and feed for these farmers. The project also hopes to produce manuals for the use of farmers and extension workers, on how to carry out composite culture and induced breeding. This material will be useful to aquaculture programs in other countries.

2.6 Beneficiary

Fish and rice have traditionally formed part of the staple diet in West Bengal and the surrounding states, but with demand increasing faster than supply, fish prices have increased so dramatically that the poorer sections of the population can no longer afford to buy fish. Freshwater fish were selling for as much as 20 rupees per kilogram in Calcutta in 1977. Given these high prices, most of the benefits to the poorer sector of the population for the foreseeable future will be through increasing incomes and employment generated from CFC production.

While the CFC system can be adopted in ponds ranging in size from 0.1 to 2.5 hectares, optimal production levels require pond sizes from 0.25 to 2.5 hectares. As CIFRI estimates that less than half of the ponds in the northeastern region are more than a quarter hectare in size, there are still a number of small pond owners who will not be able to use this technology for production of adult fish. Small ponds can be used to produce fry and fingerlings for stocking larger ponds. The present shortage of fish seed, particularly of the exotic species, provides a very high income to small pond owners. (Selected CIFRI data indicates that an exceptionally high income of Rs 100 to 160 in 0.01 hectare ponds in a six-week period is possible.)

The results to date from CIFRI village pond trials indicate that the CFC system is attractive to pond owners and fish farmers.

.../C-11

Most pond owners who were reluctant to provide their ponds at the beginning, are now willingly offering them for further experimental work. In those villages which still demonstrate a reluctance to participate, indications are that they are interested in CFC, but they would rather wait to see more results.

While CIFRI has not measured the number of pond owners adopting this system in the villages they have worked in, a recent visit by IDRC staff to several sites in West Bengal which CIFRI has left confirmed that more than half the ponds selected by CIFRI for demonstration purposes are still employing most of the recommended package. Several other pond owners in the area had started to use some of this system, although problems with availability of fish seed and the increase in oilseed cake prices prevent them from following all CIFRI recommendations.

While most of the individuals who have adopted CFC practices are the wealthier and more educated pond owners, some villages are starting to use their communally owned ponds for CFC production. One of the problems that will hinder the use of village ponds for composite fish culture is that these ponds are used for a number of purposes— domestic water supply, livestock watering and other agricultural and personal needs. Some of the villagers have objected to "enriching" the water through fertilization by cow dung and other additives. However, there is an increasing number of villages with piped water supply and the high returns from CFC have encouraged one of the cooperating villages where CIFRI has worked to lay plans to sink tubewells for drinking water so that the ponds can be used for fish culture. This will have a beneficial effect on general sanitation.

There has been an increase in the number of educated unemployed youth living in the villages, and they have been particularly interested wherever CIFRI has run trials. As CFC production increases, so will the demand for induced breeding which provides, at the moment, an extremely good income without requiring ownership of a lot of property.

Private companies and public institutions practicing CFC have also shown interest, and the State Fish Production Corporation plans to establish 400 hectares of CFC production a year. Tata Corporation, the second largest private company in India, along with some schools and orphanages, is also beginning to utilize CFC methods.

Even where large landowners undertake pond production, there will be some benefits for the rural landless in a region where unemployment is a critical problem. As poaching is a problem in the Bengal Region, CIFRI estimates that one fisherman would need to be employed to provide watch and ward duties for each hectare of water area. A number of pond owners employ fishermen who are usually landless, to undertake the netting and maintenance of their ponds.

.../C-12

As CFC production increases, the demand for agricultural by-products such as rice bran, mustard seed cake or groundnut cake, mahua oilcake, and other products will increase rapidly, providing a spin-off effect on incomes of agricultural producers.

2.7 The Delivery System

The interest and commitment of the Central Goverment to increasing CFC production is evident from its decision to create the FFDA program. Thirty-five FFDA units, each covering one block (2000 to 4000 ponds per block), are expected in the next five years. Three of these units have already been established in West Bangal and Orissa, and two established elsewhere. The Central Government provides the funds to each state which establishes a state FFDA (staffed with officers from the State Department of Fisherjes) responsible for providing financing, inputs, and technical support for the promotion of CFC.

The first unit established in Burdwan, Bengal in 1974-75 has financed less than 100 farmers to date, although they expect to increase this now that the banks agreed to participate in 1977. The banks are expected to provide a 9000 rupee loan and FFDA will provide a 3000 rupee subsidy per one-hectare pond. At present, the Burdwan District has about 40,000 hectares in ponds and FFDA has a target to introduce composite fish culture on an additional 200 hectares per year with a minimum target production level of 2000 kilograms per hectare, as compared to average yields in the state of about 1000 kilograms. This would produce a minimum increase in yield per year, in this block, of 200 tonnes of fish.

FFDA's conservative projections of a minimum production of 2000 kilograms per hectare would provide farmers with an income of roughly 10,000 rupees per year for each hectare of pond, based on a minimum selling price of 5 rupees per kilogram. Input costs are estimated at 7000 rupees per hectare, leaving the farmer about 3000 rupees per hectare. This would not provide a very high return to the majority of pond owners with less than one hectare of pond (less than Can. $375), but the farmers in the FFDA program in Bengal have usually exceeded the 2000-kilogram production target and have been able to sell the fish for 6 to 7 rupees per kilogram.

3. IDRC'S ROLE AND INVOLVEMENT

IDRC supported this project after CIFRI had already developed the CFC system and demonstrated its potential by an extensive series of trials at its research stations throughout India. IDRC felt that the technology was promising and encouraged CIFRI to submit a proposal which would test whether CIFRI's results could be maintained on farmers' ponds, and whether this system was profitable and acceptable to pond owners. IDRC staff felt this project could accelerate the widespread

.../C-13

adoption of this technology and involve CIFRI in research on problems experienced by the farmer.

While the Central Government had plans to establish FFDA units before the project started, the State Department of Fisheries officials who were seconded to FFDA were unfamiliar with the system. The establishment of these village trials jointly operated by CIFRI and State Fisheries Department employees has allowed this latter group to gain practical experience and to bring CIFRI scientists into close contact with the problems experienced by farmers. Thus, it does seem likely that IDRC funding helped to accelerate the acceptance of the technology to the point where large-scale increases in cultured fish production will be achieved.

The project has been visited by IDRC staff on several occasions to discuss operational and administrative progress. CIFRI staff seemed to be aware of IDRC's role in this project and stated that IDRC's financial support has given them the opportunity to undertake this field testing program. Given the restrictions on expenditures on items, such as travel, equipment, and research expenses outside the main centres, imposed on government research stations in India, they felt they could not readily have carried this out with their own resources.

4. DEVELOPMENT IMPLICATIONS

The lack of government support and commitment to create the right conditions for adoption of new technology is often a critical constraint on the development impact achieved by research institutions. In this case, the Central Government has adequately demonstrated its awareness of the value of this system. Two of the senior CIFRI scientists have been awarded India's most prestigious scientific awards for their work in this area, and the Director of CIFRI has been appointed to the national planning committee for the sixth Five-Year Plan. The Government has provided funds for developing a strong delivery system through FFDA. CIFRI has also received increased recognition with above-average increases in its budget so that CIFRI's relative share of the total ICAR budget for all agricultural research has increased.

While CIFRI, through this project, has undertaken a major field testing program, ICAR has agreed to an expansion of this activity to an additional six states in a proposed second phase. This would allow for the continuation of one of the project's major objectives: encouraging scientists to adjust their CFC recommendations so that they suit the pond owners' needs and constraints.

The Director of CIFRI indicated that there has been some pressure from other ICAR Directors to shift CIFRI's focus back to research and away from what is perceived only as demonstration work in their field trials which should become FFDA's responsibility. However, the state FFDA units have no research capability of their own. IDRC

.../C-14

staff believe that separation of the research and delivery system in this way seriously reduces at least the immediate impact of any new technology.

The development of this more intensive system of aquaculture is likely to have a number of benefits other than the increased production of fish. There are no significant competing uses for the ponds; the system continues to be very labour-intensive and purchased inputs are largely non-industrial products drawn from the surrounding rural area. The large profits possible from this system could provide a powerful incentive to rural communities to cooperate through their village councils to utilize village ponds with the revenue to be used for improving the general provision of public services such as tubewells.

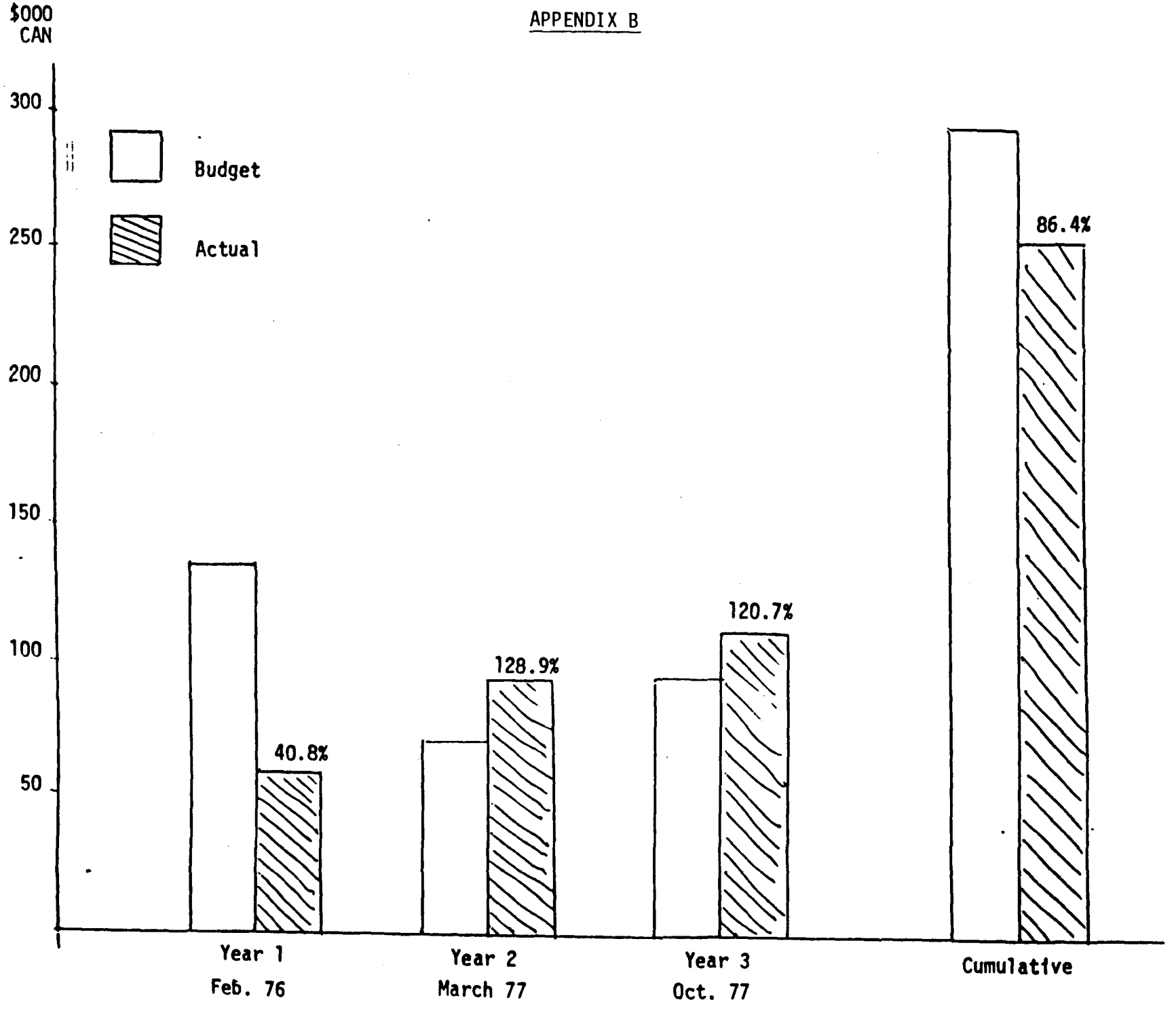
The significance of this applied research could have great potential outside of India, as well as within. With the exception of China, no other country has developed similar composite or polyculture systems. The results in India indicate that polyculture is a very effective way of maximizing the output of a given body of water. The Indian carp occurs naturally throughout Pakistan, India, Bangladesh, and Burma and has previously been introduced in many other Southeast Asian countries as well as some countries of Africa and some Pacific Islands. Increased emphasis on this polyculture approach using locally preferred species (especially those that feed on the wastes of others) makes good ecological sense and could be highly productive.

APPENDIX A

Budget and Actual Expenditures by Major Components

	YEAR 1		YEAR 2		YEAR 3		Cumulative		% Actua
	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	Total
Training	-	-	-	-	20,000	30,110	20,000	30,110	150.6
Salaries & Allowances	25,399	8,925	26,254	21,846	27,122	15,239	78,775	46,010	58.4
Research Expenses	39,962	19,365	34,836	42,207	34,836	17,453	109,634	79,025	72.1
Capital Expenses	63,000	22,905	3,000	17,700	3,000	42,164	69,000	82,769	120.0
Publications & Meetings	1,000	-	4,000	3	5,000	38	10,000	41	0.4
Travel	3,500	2,311	-	2,720	-	1,664	3,500	6,695	191.3
Service & Supplies	2,500	1,711	2,564	6,629	2,627	5,061	7,691	13,401	174.2
TOTAL	135,361	55,217	70,654	91,105	92,585	111,729	298,600	258,051	86.4

APPENDIX B


$000
CAN
300
250
200
150
100
50
Budget
Actual
40.8%
128.9%
120.7%
86.4%
Year 1
Feb. 76
Year 2
March 77
Year 3
Oct. 77
Cumulative

PRESENT AND PROPOSED SITES FOR COMPOSITE FISH CULTURE AND FISH SEED BANK CENTRES UNDER THE CIFRI/IDRC PROJECT ON RURAL AQUACULTURE IN INDIA (PHASE II)