MARCHING FORWARD WITH AQUACULTURE

KANTAPADA SUCCESS STORY

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MARCHING FORWARD WITH AQUACULTURE – KANTAPADA SUCCESS STORY

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The two decades, 1980s and 1990s, have been remarkably rewarding for Kantapada farmers who set the ball rolling for aquaculture production with equal strength and footings. The major thrust on harnessing and reallocation of water resources helped to build and operate infrastructure for growth of sustainable aquaculture with components like fish culture, fish seed raising and integration with fruits and vegetable production. This has lent a unique support and reassurance to the farmers to make a positive stride within a local paradigm. Using this leverage, Kantapada is now among proud and independent first-rung performers. From over dependence on agriculture and deprivation, Kantapada farmers have been quick to break with the past when provided with additional option of aquaculture production systems that has gone to improve their self worth and economic power. This transformation is the outcome of a lot of background work, participatory approach and follow-up measures with a strong scientist-farmer interface in preparation and conduct of micro enterprises. Trained to work in tandem to solve and overcome hurdles all by themselves, the farmers have excelled as achievers in individual, group and community situations which stands out as a real challenge in itself. This booklet presents an anecdotal account of several years of progress and productivity in integrated aquaculture in Kantapada beginning with 1979. The success story will undeniably provide a great impetus to rural farmers in other parts of the state as well. I compliment both the farmers and the scientists for their support, involvement and contribution towards rural aquaculture development and the advancement of science at large.

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PREFACE

To meet the demands of high quality animal protein to ever increasing population at an affordable price, fish has to be produced en masse using low cost sustainable farming methods in the countryside relying on available freshwater resources. The rural aquaculture development is highly acclaimed as a guaranteed means of enhancing income and employment opportunities. As an added advantage it ensures availability of cheaper animal protein to the widely undernourished rural mass. The establishment of fish seed village which is technically feasible, economically viable and sustainable over a long period, contributes a great deal to regional self sufficiency in quality fish seeds and rural aquaculture development at large. The growth and prosperity of a farmer is further intensified when one or many compatible enterprises are added to aquaculture skillfully to increase the income and multi-commodity products. As a matter of fact, diversified resources and specific technologies are available at CIFA. The responsibility of disseminating the adaptive technologies to the end users through participatory and holistic approach lies with *Krishi Vigyan Kendra* and *Trainers’ Training Center* ever since 1977. In this process several pond owners have been converted into successful fish farmers. Each farmer has his own experience to relate. The present “Success Story” on horticulture based fish farming at Kantapada village is a record of achievements of over two decades. It attempts to trace the entire scenario from the beginning to various stages of technology adoption and activity expansion in sustainable aquaculture development as a holistic and convergent approach. In this booklet the background information, interventions, objectives, motivational drives, activity profile with particular reference to food fish culture, spawn production, fry & fingerling rearing, vegetable, banana, papaya, coconut production their economic profitability and impact are highlighted. We wish to express our sincere thanks to Shri Digambar Mishra and his team (village farmers) for extending facilities, co-operation and providing relevant information for this booklet. We hope, it will be a useful catalyst for the farmers, entrepreneurs, village level extension workers and scientists. We hope it will also be helpful in refinement of sensibilities, perception and scientific temper for furthering the goals of improved productivity performance in real terms.

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# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>2. Village background</td>
<td>2</td>
</tr>
<tr>
<td>3. Intervention</td>
<td>12</td>
</tr>
<tr>
<td>4. Objectives</td>
<td>12</td>
</tr>
<tr>
<td>5. Motivation</td>
<td>13</td>
</tr>
<tr>
<td>3. Activity profile</td>
<td>14</td>
</tr>
<tr>
<td>6.1. Productivity and profitability structure</td>
<td>14</td>
</tr>
<tr>
<td>6.1.1. Food fish culture</td>
<td>14</td>
</tr>
<tr>
<td>6.1.2. Carp spawn production</td>
<td>15</td>
</tr>
<tr>
<td>6.1.3. Fry rearing</td>
<td>20</td>
</tr>
<tr>
<td>6.1.4. Fingerling rearing</td>
<td>25</td>
</tr>
<tr>
<td>6.1.5. Vegetable crop production</td>
<td>25</td>
</tr>
<tr>
<td>6.1.6. Coconut production</td>
<td>32</td>
</tr>
<tr>
<td>6.1.7. Banana production</td>
<td>32</td>
</tr>
<tr>
<td>6.1.8. Papaya production</td>
<td>36</td>
</tr>
<tr>
<td>6.2. Economic profitability</td>
<td>36</td>
</tr>
<tr>
<td>6.2.1. Aquaculture</td>
<td>36</td>
</tr>
<tr>
<td>6.2.2. Horticulture</td>
<td>40</td>
</tr>
<tr>
<td>6.2.3. Cumulative profitability</td>
<td>4</td>
</tr>
<tr>
<td>7. Impact</td>
<td>40</td>
</tr>
</tbody>
</table>
1. Introduction

Land, labour and productivity are most synonymous with the wealth of the farmer. A farmer's growth and prosperity is further intensified when one or many new enterprises compatible to agriculture are added skillfully to increase his income. Considering the vast untapped water resources like ponds, swamps and vast low lying waterlogged areas dotting many of our villages, particularly in coastal districts, aquaculture practices are easy to integrate with agriculture and the benefits may accrue to all farmers irrespective of size or class. Our own survey has indicated that in Puri district (Orissa) alone, only 7 to 10% of available water resources are being cultured for production of fish in age-old traditional methods and the production is dismally low (300 kg/ha/yr). In contrast, simple attention to basic requirements like stocking density, species composition, reasonable culture duration, effective manuring only may spell a big difference in raising the production level by at least five times or more, for which easier technologies are readily available. Besides, a farmer can also earn substantial income from fry and fingerling rearing in small and seasonal water bodies in limited time and resources. It is true that a vast majority of rural farmers have not availed this opportunity as yet. Agriculture alone has confined the attention of the farmers. Aquaculture development could not make much headway because farmers have low risk-taking capacity, lack of awareness, perspective and technical skills outside agriculture. This clearly shows that the farmers are in need of help and technical assistance for a change of attitude and to reap the benefit of technological advancements in aquaculture and other production technologies that can be combined with agriculture for economic wellbeing. There have been instances of successful farmers taking to aquaculture on an industrial scale in many advanced states like Andhra Pradesh, Punjab, West Bengal and Tamil Nadu achieving fish production up to 10-12 tonnes/ha/yr. But the first step to make a stride in aquaculture development in rural areas lies in involving the grass root level farmers in large number and also aiming at bringing more and more available water bodies under aquaculture. A simple technique of manure based fish culture with farmers' management practices that fetches the minimum fish production of around 1500 kg/ha/yr is bound to make the farmer much happier when compared to profit and productivity from agriculture or allied systems.
An experiment with farmers of Kantapada in Puri district was conducted from 1979 to 1998 to carry home the message of income and employment generation through aquaculture utilizing agriculturally unsuitable, low, waterlogged land along with agriculture. Relying on major inputs like skill dissemination, awareness generation and sustained level of active follow-up action, the experiment aimed at horizontal spread of aquaculture production activities with majority participation. For the best level of land utilization and productivity, aquaculture was combined with horticulture. An evaluation of the impact of scientist-farmer interface over extended period, in transforming the aquaculture scenario of Kantapada has been made here.

2. Village background

Kantapada is situated in the interior rural pocket in Khurda district of Orissa, located between 17° 48' to 22°34' N and 81°29' to 87°29' E. The village is within the operational jurisdiction of Krishi Vigyan Kendra (Farm Science Centre) of Central Institute of Freshwater Aquaculture, Kausalyaganga (Fig 1). Communication to the village is difficult due to bad roads and rarity of transport facility. The village has a population of 584 in 87 households. The male and female ratio is 1.3:1. Of the total households 10% belong to Scheduled caste and 13% to backward caste community. The literacy rate among females and males was 15% and 45% during 1978 and 50% and 80% during 1998 respectively. On the basis of income and purchasing power, 60% of the families belonged to poor, 35% to medium and 5% to rich category in 1978, whereas, the proportion of poor, medium and rich families was 38%, 46% and 16% respectively in 1998. The annual income per family during 1998 was in the range of Rs.3,000-10,000 (poor), Rs.10,050-15,000 (medium) and above Rs.15,000 (rich). Agriculture with paddy as a single crop in Kharif continues to be the predominant economic activity of the majority. To the northern side of the village there is a river (Prachi) which is a cause of trouble during flash floods inundating large stretches of crop land. In the river side about 15 ha of low lying land existed as water logged marshy area usually not fit for crops. A barrage constructed in the year 1938 has somewhat, controlled recurrence of damage due to floods.
The occupational status of the households is depicted in Fig. 2. While source of income of the poor, medium and rich farmers is presented by Fig. 3, 4 and 5 respectively, the mode of the expenditure is illustrated in Fig. 6, 7 and 8 respectively.
Fig. 2  Occupational status of the households of the Kantapada village

1978

- Fish culture: 1%
- Live stock: 5%
- Horticulture: 7%
- Own agriculture: 23%
- Share cropping: 15%
- Service: 33%
- Business: 4%
- Wage employment: 12%

1998

- Fish culture: 13%
- Live stock: 6%
- Horticulture: 5%
- Own agriculture: 20%
- Share cropping: 11%
- Service: 34%
- Business: 1%
- Wage employment: 10%
Fig. 3  Source of income for poor farmers

1978

- Fish culture: 0%
- Horticulture: 5%
- Share cropping: 40%
- Wage employment: 45%
- Livestock: 5%
- Own agriculture: 5%
- Service: 0%

1998

- Fish culture: 1%
- Horticulture: 5%
- Share cropping: 45%
- Wage employment: 35%
- Livestock: 5%
- Own agriculture: 5%
- Service: 2%
- Business: 2%
Fig. 4 Source of income for the medium farmers

1978

- Live stock: 10%
- Horticulture: 10%
- Fish culture: 0%
- Service: 25%
- Business: 0%
- Wage employment: 0%
- Share cropping: 10%

1998

- Live stock: 5%
- Horticulture: 10%
- Fish culture: 10%
- Own agriculture: 30%
- Share cropping: 0%
- Service: 35%
- Business: 5%
- Wage employment: 0%
Fig. 5  Source of Income for Rich Farmers

1978

- Live stock: 20%
- Horticulture: 5%
- Own agriculture: 5%
- Share cropping: 0%
- Wage employment: 0%
- Business: 0%
- Service: 0%
- Fish culture: 2%

1998

- Live stock: 10%
- Horticulture: 5%
- Share cropping: 0%
- Wage employment: 0%
- Business: 10%
- Service: 55%
- Fish culture: 15%

Fig. 6  Mode of expenditure of the poor farmers

1978

Medicine, education, social work: 12%
Horticulture: 3%
Fish culture: 0%
Live stock: 5%
Business: 0%
Own agriculture: 0%
Share cropping: 20%
Food, house, cloth: 60%

1998

Medicine, education, social work: 20%
Horticulture: 5%
Fish culture: 5%
Live stock: 5%
Business: 5%
Own agriculture: 0%
Share cropping: 10%
Food, house, cloth: 50%
Fig. 7  Mode of expenditure of medium farmers

1978

- Medicine, education, social work: 15%
- Horticulture: 5%
- Fish culture: 0%
- Live stock: 5%
- Business: 0%
- Own agriculture: 10%
- Share cropping: 15%
- Food, house, cloth: 50%

1998

- Medicine, education, social work: 21%
- Horticulture: 2%
- Fish culture: 8%
- Live stock: 2%
- Business: 5%
- Own agriculture: 12%
- Share cropping: 10%
- Food, house, cloth: 40%
Fig. 8  Mode of expenditure of rich farmers

1978

- Medicines, education, social work: 15%
- Horticulture: 5%
- Fish culture: 0%
- Livestock: 5%
- Business: 0%
- Own agriculture: 10%
- Share cropping: 0%
- Food, house, cloth: 65%

1998

- Medicines, education, social work: 20%
- Horticulture: 5%
- Fish culture: 15%
- Livestock: 5%
- Business: 10%
- Own agriculture: 5%
- Share cropping: 0%
- Food, house, cloth: 40%
Although fish is an accepted delicacy, there was a big gap in the demand and supply. The villagers largely depended on fresh marine fish (40%), dried marine fish (25%) and freshwater weed fish (20%) for consumption in 1978 whereas in 1998 freshwater fish consumption rose up to 37%. Professional level of fish culture remained a low key affair until around 1983 and traditional, extensive to semi-intensive culture methods using mixed reverine fish seeds was in vogue earlier. The ponds here are classified as rain fed and undrainable. The existing culture area was insignificantly small prior to 1978 yielding extremely low fish production. A glaring mismatch between cultured and potential culturable water area for fish production was visible. With limited income from agriculture coupled with easy availability of a good deal of reclaimable waste land, the village presented a fit case for improving productivity and income generation by intensification of land use pattern and diversification of agriculture. Lack of awareness, skill and access to technology hindered the pace of progress to a considerable extent in the past. The villagers were totally in dark as to whom to approach for guidance and technical back-up to venture into a new economic activity.

The time line analysis showed that the village was established in 1800 AD. The first matriculate and the first graduate from the village came out in 1925 and 1929 respectively, although a primary school was established there much later in 1935. The period from 1960-66 saw some trends of modernisation like introduction of bicycle, scooter, car, truck, tractors, diesel pump sets etc. The first radio set appeared in 1975 and television came five years later. The first pucca house appeared in 1978. Electricity also came in the same year. The first attempt in agri-aquaculture along with horticulture was made in 1979 which gained progressive popular acceptance in future years as well during which carp breeding and spawn production were also introduced (1995). The severity of floods was remarkably high in 1982 and 1992 and the village witnessed near total devastation due to supercyclone in October 1999.
3. Intervention

A comprehensive survey was made in 1978 in Kantapada which indicated potentiality of economic development through aquaculture following utilisation of available aquatic resources. Among the major problems identified for intervention and strategic planning included (i) low productivity in ponds (ii) total neglect and exclusion of water logged areas for productive use (iii) risk of flash floods damaging crop (iv) non-availability of desired quality of fish seeds (v) neglect of horticultural practices supplemental to paddy and the need for intensification of crop productivity and land resource utilisation (vi) loss of risk taking capacity due to low income. The causes were analysed before deciding on specific intervention points, scale of operation, size of groups, critical input range, timing and initial investment. The planning included both horizontal and vertical expansion of aquaculture production systems, refining and evolving appropriate region specific aquaculture technologies, maximising productivity from unit area under aquaculture by combining horticulture crop production on pond embankments, creating infrastructural facilities for carp breeding and production of spawn, fry, fingerlings in a bid to create conditions of self-sufficiency in fish seeds in the village as well as employment opportunity. The KVK intervention started in the year 1979 putting through its action plan in a phased manner over a period of two decades with sustained technical back-up, skill training, demonstration, monitoring and other extension support measures.

4. Objectives

The programme undertaken by the KVK in Kantapada village had three distinct long-term objectives as under:

i. To rise the status of aquaculture in terms of productivity, area of operation, size of participation and share of contribution to family income level in the village by building up the resource base, strengthening technical support system, ensuring sustainability of production process with active follow-up measures.

ii. To maximise productivity per unit area by resorting to integrated aquaculture with horticultural crop production.
iii. To achieve self-sufficiency in production of spawn, fry and fingerlings of culturable carp species within the village to meet internal requirements and gradually moving on to intensify production to establish fish seed business and income generation.

5. Motivation

The KVK scientists stepped into the scene in 1978 and established rapport with the village leaders as well as the ordinary farmers by conducting group meetings, discussions in course of several visits. The scientists' association with the farmers lasted until 1998 with constant technical assistance, encouragement and advisory services to solve field problems. The prospective fish farmers were identified along with the causes of low productivity. A clear action plan was drawn up for the first year to implement low cost fish culture with major stress on eradication of predatory fishes, adherence to proper stocking density, culture duration, manuring with compost & cow dung and monitoring of water quality. The positive aspect of compatibility with occupational diversity and relative profitability of aquaculture and existing level of agriculture were clearly brought out for a positive change in attitude. An appropriate number of training courses were conducted to acquaint the farmers with the basic skills and technique followed in aquaculture practices. Farmers' confidence and reassurance was boosted by closer interaction and scientists' presence at work in the field. The farmers were motivated to plough back part of the income from aquaculture each year for raising input level in fish production and to bring in more areas as fish ponds especially the abandoned water logged areas by the river side. To improve income generation, integrated aquaculture with horticultural crops as additional components was added. Demonstrations were conducted on how to utilise small seasonal water bodies for rearing spawn to fry and fry to fingerlings which helped in earning a quick income several times over in one season. In the last phase the farmers were imparted skills in induced breeding of Indian major carps and thus completing the cycle from production of spawn to table size fish by the farmers. The motivational role of scientists helped in aquaculture taking deep roots in Kantapada village.
6. The activity profile

The major hub of activities in Kantapada was table size fish production along with production of carp spawn, fry and fingerling on commercial lines which were supplemented with raising of banana, papaya, vegetables and coconut crops.

6.1 Productivity and profitability structure

6.1.1 Food fish culture

During 1978, the village had 13 privately owned ponds, varying in size and seasonality, covering an area of 3.0 ha. Out of these ponds, 8 were completely shaded with large trees and/or with aquatic weeds. These ponds were also receiving huge quantities of organic matter from the surface run-off of the village resulting in heavy silt deposition and emitting foul smell. These semi-derelict and weed infested water bodies virtually served as breeding grounds for mosquitoes causing health hazards for the village community. At times, the pond owners were utilizing water from these ponds for their domestic purposes, like bathing, washing utensils, kitchen gardening, irrigation etc, but invariably they remained underutilized/unutilized for productive purposes. Although all the ponds were cultivable, only five ponds of 2.05 ha were put to traditional food fish culture. In addition to privately owned ponds, there were 10 Gram Panchayat tanks (3.0 ha) which were choked with aquatic weeds. Out of these GP tanks, 2 ponds were leased to village farmers in 1978. But no systematic culture practice was prevailing in leased out ponds. The farmers used to catch predatory and weed fishes along with rarely occurring carp fish, annually once or twice, particularly during summer months. During 1978, only 2.0 ha GP tanks (3.0 ha) became cultivable with adaptive management practices. Due to erratic leasing policy, fish culture in GP tanks could not be maintained regularly. Lack of data base on GP tanks, did not permit information to be incorporated in the communication.

Phase I (1979-84):

The food fish culture was initiated with 3 ponds (2.0 ha) in 1979. Ponds were cleared of aquatic weeds and netted out to remove the predatory and weed fishes. The ponds were stocked @ 2500/ha
with unidentified, mixed riverine fry of Indian major carps along with other fish species. The fish were harvested after one culture cycle, yielding 350 kg/ha/yr which were sold at the pond site @ Rs.7/- per kg. (Table-1).

In 1980 four new ponds were constructed and filled with rain water and/or canal water. The existing old ponds were dewatered to catch the entire fish stock which were then filled with canal water. In all the ponds cow dung was applied as basal manure @ 1-3 tonnes/ha. This management practice continued up to 1984. The ponds were stocked with riverine mixed seed @ 3000-4000/ha. Fish were harvested annually once after 9-12 months of culture operation which gave a production of 350-950 kg/ha/yr. It was experienced that with increase of pond age the fish yield rate also increased. However, there was a flood havoc in 1982 which not only affected the fish yield of the year (200 kg/ha/yr) but in 1983 also the fish yield was adversely affected (350 kg/ha/yr).

The harvested fish were sold @ Rs.7-10 per kg fetching net income in the range of Rs.1,900-23,000 from 1979 to 1994. The average income was Rs.10,383 per year. The percentage return on expenditure ranged between 14.29% and 271.88%. The reduction in percentage return on the expenditure during 1982 (14.29%) and 1983 (40.0%) was due to flood havoc.

Phase II (1985-89):

In 1985 five more ponds (2.0 ha) were added for fish culture. During 1985-89 the ponds were dewatered and filled with rain water and/or canal water. Along with cow dung, applied @ 3-4 tonnes/ha as base manure, inorganic fertilizers viz., urea and single super phosphate were also applied intermittently. Ponds were stocked with pure seed of catla, rohu, mrigal and common carp. Insufficient availability of pure carp seed forced some of the farmers to stock their ponds with fingerlings from riverine collection. In Phase II the stocking density (5000 - 6000 fingerling/ha) was relatively higher than that in Phase I. The fish were harvested through repeated netting and/or through complete dewatering of the ponds after 9-12 months' culture. During 1985-1989, the fish yield ranged between 1000, kg/ha/yr and
1,350 kg/ha/yr (Table-1) marking an average production of 1208 kg/ha/yr. The fish were sold @ Rs.12-18 per kg at the pond site to the consumers or middle men.

The cost of food fish production was estimated to be Rs.3.08-4.49 per kg. The percentage return on expenditure ranged between 249.20% and 336.15% with profitability index of 2.49-3.36. The economic profitability of food fish culture attracted the attention of many other farmers to construct new ponds or renovate unutilised semi-derelict weed infested ponds. As such in 1989, two ponds of 0.5 ha were added for food fish culture. In phase III many more ponds were constructed for fish culture operation.

Phase III (1990-1998):

This period saw a visible expansion of food fish culture both horizontally and vertically. Just at the beginning of this phase 38 ponds covering an area of 5.0 ha were constructed from the unutilized land or water logged low lying areas in 1991. In subsequent years also new ponds were added for fish culture eg. 4 ponds (0.5 ha) in 1992, 3 ponds (0.5 ha) in 1993, 3 ponds (1.0 ha) in 1996, 5 ponds (1.3 ha) in 1997 and 6 ponds (1.1 ha) in 1998.

For pond preparation, dewatering was done followed by treatment of bleaching powder to the bottom soil. In some cases the pond bottom was exposed to sun for one or two weeks before filling the ponds with rain water or canal water. Most of the ponds received cow dung as basal manure @ 5-8 tonnes/ha. The ponds not treated with bleaching powder were limed @ 250-300 kg/ha. Some of the ponds were treated with a mixture of cow dung, mustard oil cake and single super phosphate to hasten plankton productivity. As the farmers became better experienced the tendency to follow a more scientific approach in fish culture was visible. The ponds were stocked with catla, rohu, mrigal, common carp, silver carp and grass carp at a relatively higher stocking density of 6000-7000 per hectare. At times, prawn seed from riverine collection were stocked along with carp culture. Fish were harvested several times in a year according to market demand. Supplementary feeding with rice bran and groundnut oil cake was sparingly used by some progressive farmers.
Table 1: Fish yield in farmers managed ponds at Kantapada village in Orissa during 1979 to 1998

<table>
<thead>
<tr>
<th>Year</th>
<th>Nos. ponds</th>
<th>Area (ha)</th>
<th>Fish yield (kg)</th>
<th>Fish yield rate (kg/ha/yr)</th>
<th>Fish sale rate (Rs/kg)</th>
<th>Total fish yield (Rs.)</th>
<th>Total expenditure (Rs.)</th>
<th>Net income (Rs)</th>
<th>Cost of production (Rs/kg)</th>
<th>% return on expenditure</th>
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<td>3</td>
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<td>7</td>
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<td>750</td>
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Fig. 3  Fish yield in farmer managed ponds at Kantapada village during 1979-1998
Improved management practices accelerated the fish yield compared to phase I and phase II. It ranged between 1470-1935 kg/ha/yr except in 1993 and 1994. The production in 1993 (500 kg/ha/yr) and 1994 (800 kg/ha/yr) had declined in the aftermath of flood havoc in 1992 due to damage of pond embankments. The ponds had been harvested completely before the floods in 1992. Resource constraints and diversion of attention to other priority areas like agriculture, delayed the repair and restoration of fish culture facilities resulting in low production in 1993 and 1994.

There was a 3-5 fold increase in the selling price of fish over the years as compared to prevailing price in Phase I. The fish were sold @ Rs.20-35 per kg at the farm gate. The cost of fish production also increased to Rs.6.07-17.60 per kg. (Table-1). The cost of production was the highest in 1993 and 1994 (Rs.17.60 and Rs.11.30 per kg respectively) due to the adverse effect of post floods. The average percentage of return on expenditure ranged between 42.05% and 476.61%, the lowest being during the flood affected years. Yearwise fish yield rate and net income is given in Fig.9 & Table 1.

6.1.2 Carp spawn production

With the objective of making the village self-sufficient in stocking materials, carp breeding was initiated in 1995 with rohu and mrigal. Six sets of rohu (10 kg female) and 8 sets of mrigal (14 kg female) were used for hypophysation. The brood fish were collected from the ponds within the village. Pituitary gland extract in glycerine solution was used as inducing agent. While female brood fish were injected @ 4-6 mg PG/kg for the first dose and 8-15 mg/kg for second dose, the males were injected @4-5 PG/kg only once at the time of second injection to females. Breeding hapas were fixed in composite fish culture ponds inside the net enclosure to avoid common carp damaging the released eggs. Fertilization rate was 65-85%. Incubation of eggs was carried out in hatching hapas. The total spawn recovery was 38% in rohu and 32% in mrigal. A total of 10 lakh rohu and 17 lakh mrigal spawn was produced in 1995 and utilised for rearing in nursery ponds by farmers.
During 1996, 3 sets of catla, 5 sets of rohu, 8 sets of mrigal and 6 sets of common carp were used for breeding purpose. While common carp was bred under controlled condition without any inducing agent, the Indian major carps were injected with inducing hormones. The female brood fish were injected with Ovaprim @ 0.5 ml/kg whereas the males were injected with glycerine extract of pituitary gland @ 4-5 mg PG/kg or 0.2 ml/kg Ovaprim for hapa breeding. The spawn production of catla, rohu, mrigal and common carp was 10,15,10 and 5 lakh respectively in hapa incubation. The spawn recovery from the fertilized eggs ranged between 25-40%. Low recovery of spawn was traceable to a variety of adverse conditions. The hazards included sudden change in environmental factors (dissolved oxygen, temperature, water bloom), crab-cutting of hapa, entry of predatory fishes and insects in the hatching hapa and stormy weather conditions.

In subsequent years also carp breeding was carried out successfully. The spawn production in successive years was 50 lakh in 1997, 67 lakh in 1998 and 42 lakh in 1999. During the period of five years (1995-1999) the total spawn production of catla, rohu, mrigal, common carp was 25, 88, 89 and 18 lakh respectively suggesting that village is marching towards self sufficiency in spawn requirement.

Although the entire lot of carp spawn produced was stocked in the farmers' ponds to raise the fry, the money equivalent of spawn is estimated to be Rs.8,400-28,000 per year. If the expenditure part is excluded, the net worth of spawn produced was Rs.6,200 in 1995 and Rs.22,200 in 1998 which averaged to Rs.14,160 per year. The percentage return on the expenditure was found to be very high (281.82 - 382.76). The profitability index stood at 2.82-3.83.

6.1.3 Fry rearing

Fish seed nursing from spawn to fry level was started in 1983 using 12 small ponds. Out of these ponds five were seasonal and 7 were perennial. The two seasonal ponds dried up naturally during summer but three seasonal ponds maintained an average water depth
of 25-40 cm. These ponds were completely cleared off from fish by drying or dewatering. The pond bottom was exposed to the sun for a few days before filling up water from canal, pond or rain source. Marginal grasses were cleared. In order to avoid leaf litter deposits and shadowing of pond surface, the over hanging tree branches were cut off. The ponds were manured using cow dung @ 1-2 tonnes/ha as basal manure and were treated with lime @ 250 kg/ha. Before stocking the ponds, kerosene or soap-oil emulsion was sprayed @ 60-70 litre/ha on the pond surface to eradicate predatory insects. The ponds were stocked with spawn of catla, common carp, rohu and mrigal @ 50 lakh/ha. Fish larvae were fed daily once with a mixture of rice bran and groundnut oil cake at the rate of two, four and eight times the body weight of spawn for first 5 days, next 5 days and the remaining rearing period respectively. Fry were harvested periodically during the 30-45 days of nursing. The overall recovery rate was recorded as 20%. Poor recovery percentage of fry was mostly due to the delayed harvesting practice. Even though the farmers sold carp fry @ Rs.10 per thousand, the income and profit margin was very good within a short period of the production cycle. The average net return from all the ponds during 1983 was 233.33%. Such high profitability in fry rearing from the small water bodies attracted the attention of the farmers to continue with the practice year after year adding more ponds. The expansion of fry rearing was clearly visible as the number of ponds were three (0.2 ha) in 1983 which rose to 11 (1.0 ha) in 1995.

During the period 1984-1986 fry survival improved to 30-35% even though the input level and management methods were similar. This is attributed to better handling procedure and experience of the farmers. The rearing period ranged between 20 and 40 days and the fry were sold @ Rs.12.00 - 15.00 per thousand. The net income was Rs.12,700-22,900 with the percentage return on expenditure of 161.27-239.62%.

During 1987-92 the technological input was improved with better attention to pond preparation methods. All ponds were dewatered and the bottom treated with bleaching powder to kill bottom dwelling fishes.
completely. Some ponds were treated with mahua oil cake @ 2500-3,000 kg/ha-m or with the bleaching @ 300-500 kg/ha-m to eradicate the predatory as well as weed fishes from the ponds. When the ponds were treated with the bleaching powder, lime was not applied. However, the dose of basal manure application was increased. In mahua oilcake treated ponds, the cow dung was applied at reduced rate or completely skipped. Fry were harvested within 12-35 days of rearing and sold at the pond site @ Rs.15-20 per thousand. Improved rate of fry recovery (40.00-50.55%) was recorded in 1991 which is higher than that of previous years. The average annual net income was in the range of Rs.21,800-44,000. The percentage of return on expenditure ranged between 153.38% and 275%.

During 1993-1998 the status of nursery pond management further improved. Keeping all the management techniques constant, the basal manure application was enhanced. In this method, the basal manure was applied @ 2,000 kg/ha cow dung, 200 kg/ha mustard oil cake and 10 kg/ha single super phosphate or urea in the form of mixture. Cow dung, soaked mustard oilcake and single super phosphate or urea were mixed together in the ratio of 200:20:1 and made into a liquid form. This mixture liquid manure was applied over the pond evenly before 5-7 days of spawn stocking.

Fry were harvested within 12-30 days of rearing during 1993-97. However, in 1998 in a few ponds, harvesting could be completed in 45 days. Improved rate of fry recovery, recorded during 1993-98 was 53.33 - 61.11%. Fry were sold @ Rs.20-35 per thousand. The annual average income ranged between Rs.47,500 and Rs.1,15,000. The percentage return on the expenditure was 211.11-420.83% with the profitability index of 2.11 - 4.21 suggesting attractive economic profitability in the venture. Yearwise fry production and net income is given in Fig.10 and Table-2.
Table-2: Carp fry production under farmer managed nursery ponds for income generation at Kantapada village from 1983-1998.

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<thead>
<tr>
<th>Year</th>
<th>Nos. ponds</th>
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<th>Stocking rate (lakh/ha)</th>
<th>Rearing period (days)</th>
<th>Total fry harvested (th)</th>
<th>% recovery</th>
<th>Sale rate (Rs./th)</th>
<th>Total cost of fry (Rs.x th)</th>
<th>Total expenditure (Rs.x th)</th>
<th>Net income (Rs.x th)</th>
<th>% return on expenditure</th>
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Rs. x th = Rupees in thousand
Fig. 10  Carp fry production under farmer managed nursery ponds for income generation at Kantapada village from 1983-1998

![Graph showing carp fry production and net income from 1983 to 1998. The graph indicates an increase in fry production and net income over the years.](image-url)
6.1.4 Fingering rearing

In 1978 two small ponds (0.05 ha), virtually covered with aquatic weeds and shaded by surrounding trees were utilized for fingering rearing. There were no proper embankments and the ponds were receiving huge quantity of organic wastes from the catchment area. At times the water also emitted a foul smell.

As a first step, aquatic weeds were removed manually from the ponds and direct access to sun light was ensured by cutting down overhanging branches. Repair of embankments was made with provision for water inlet and outlet. Ponds were dewatered during summer and subsequently allowed to fill with surface run off in the rainy season. Unidentified riverine seeds (fry) were stocked @ 4 lakhs/ha. Fish were fed with household feeds like rice bran and kitchen wastes. Fingerlings were harvested within 2-4 months of rearing with 50% recovery. The harvested fish seed included rohu, mrigal, bata, catla, *Puntius* spp., *Esomus danricus*, *Chela* sp., *Ompock* sp. etc. Bigger sized fingerlings were sold @ Rs.70 per thousand which fetched a net income of Rs.500 in 4 months with very marginal expenditure. The percentage return on expenditure was 250%. After seeing this, the farmers developed confidence in the profitability of fingering rearing and continued the activity every year by expanding the water area. For example, they added one pond (0.02 ha) in 1979, 2 ponds (0.28 ha) in 1980 and 5 ponds (0.45 ha) in 1981 during the initial phase of fingering rearing. The stocking rate during these years were in the range of 1.9-4.4 lakhs/ha with riverine fry. Fingerlings of mixed fish species were harvested with the recovery of 50-62% and they were sold @ Rs.50-75 per thousand according to their size and species. The average annual income ranged between Rs.5,000 and 3,510 with percentage of return of 144.19-250%.

In phase II (1983-1986) 12 ponds covering 1.2 ha were used for fingering rearing every year. Ponds were dewatered and bottom was exposed to the sun. Ponds which were used for fry rearing, however, remained as such from where fry were harvested only by repeated netting. Cow dung was applied as base manure @ 1-3 tonnes/ha. The ponds were treated with lime @ 200-300 kg/ha. Pure seed of catla,
rohu, mrigal and common carp were stocked @ 2.4-5.8 lakh/ha. Fish seed were fed with household inputs. Fingerlings were harvested within 2-4 months of rearing with 41.2-58.33% recovery and were sold @ Rs.70-80 per thousand. The annual net income was within the range of Rs.5590-14510 with the percentage return on expenditure of 64.62-125.29%.

The phase III (1987-1991) was marked by the treatment of ponds with either mahua oil cake @ 2,500-3,000 kg/ha-m or bleaching powder @ 300-500 kg/ha-m to eradicate unwanted fishes from the ponds. In bleaching powder treated ponds cow dung was applied @ 4-5 tonnes/ha, whereas in mahua oilcake treated ponds it was applied @ 1-2 tonnes/ha. Lime was not applied in bleaching powder treated ponds. But mahua oil cake treated ponds received lime @ 250-300 kg/ha. Pure induced bred fry of catla, rohu, mrigal, common carp, silver carp were stocked @ 1.25-2.5 lakh/ha. Fingerlings were fed with rice bran and GNOC @ 4-5% of biomass. Harvesting was done after 2-4 months rearing with 55-65% recovery. The selling rate ranged between Rs.120-200 per thousand fingerlings. The annual average income ranged between Rs.4810-12720. The percentage return on the expenditure was estimated to be 130.86-178.89%.

In the phase III (1993-1998) the rearing technique remained more or less similar. To improve pond productivity a mixture of cow dung, mustard oil cake and single super phosphate in the ratio of 200:20:1 in liquid form was applied monthly once. The fingerling recovery ranged between 74 and 85%. The selling price during the period was Rs.220-300 per thousand. The average annual net income varied from Rs. 17380-89410 and the annual percentage of return on the expenditure was 103.39-137.49%. In 1982 and 1992 the village was affected by severe floods which nearly erased the fish seed rearing activity. No data could be collected for these two years. Details are given in Table-3 and Fig.11.
Table-3  Carp fingerling rearing under farmer managed rearing ponds for income generation at Kantapada villave during 1978-1998.

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<th>Year</th>
<th>Nos. ponds</th>
<th>Area (ha)</th>
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<th>Rearing period (days)</th>
<th>Total fingerling harvested (th)</th>
<th>% Sale recovery</th>
<th>Sale rate (Rs./th)</th>
<th>Total cost of fry (Rs. x th)</th>
<th>Total expenditure (Rs.)</th>
<th>Net income (Rs.) (Th)</th>
<th>% return on expenditure</th>
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Fig. 11  Carp fingerling production under farmer managed rearing ponds for income generation at Kantapada village during 1978-1998
6.1.5. Vegetable crop production

Vegetable crops were grown on the pond embankments and/or in the adjoining land during 1980-1998. The embankments of the newly constructed ponds were found to be most suitable for vegetable crop production. Brinjal, tomato, lady’s finger, chilli, cabbage, cauliflower, cucumber, pumpkin, ridge gourd, bitter gourd, bottle gourd, snake gourd, bean and leafy vegetables were grown from time to time as per the suitability of the site, season and needs of the farmers. For growing these crops soil beds/plots were prepared by mixing pond sediment and farm yard manure. The soil beds were exposed to sun for few days and then proper moistening was done using pond water. Before sowing the seed or seedling transplantation, the soil was prepared by hoeing.

For growing creeper/climber vegetable crops like cucumber, pumpkin, bottle gourd, snake gourd, ridge gourd and bitter gourd, about 30 cm diameter beds were prepared at 200 - 300 cm distance on the pond embankments in two rows. In each bed 3-4 seeds were sown. Periodical moistening of the bed was done using pond water. At growing stage stacking facility for the vegetable plants to climb were provided using bamboo sticks and branches of trees. Pesticides were sprayed to control the plant diseases when required. For leafy vegetables (spinach, amaranthas, radish, coriander etc), rectangular soil beds were prepared and crops were grown exclusively for household consumption.

Lady’s finger (Bhendi) seeds were sown in the month of June-July/October-November. Pond silt and farm yard manure were used for increasing soil fertility. Plants were irrigated using pond water. At growing stage inorganic fertilizers were also used. To prevent sucking insects systemic insecticides like monocrotophos was applied at leafy stage, whereas to prevent fruit borer malathion was sprayed. While first picking was started after 45-50 days of sowing 10-13 pickings were made during whole cultivation period.
After preparation of the plots tomato seedlings were transplanted at 75 cm row to row and 60 cm plant to plant distance in the month of November-December. First bloom appeared in 25-35 days. The fruits matured after 65-75 days of transplantation. Similarly the brinjal seedlings were transplanted at 60 cm plant to plant and 90 cm row to row spacing. Light irrigation was provided using pond water. For plant protection Thimet/Sevin was applied at growing stage and monocrotophos/malathion was applied to control fruit borer. First harvesting was done after 60-65 days of transplantation.

Seedlings of cabbage and cauliflower were transplanted in well-prepared plots on the pond embankments at 60 cm row to row and 30 cm plant to plant spacing in the month of October-November and frequently irrigated using pond water. In prepared plots 30 days old chilli seedlings were transplanted during June-July or September-October at 75 cm row to row and 60 cm plant to plant distance. After 2 months of seedling transplantation, the chillies were picked. The farmers of Kantapada had grown vegetable crops mostly for their household consumption. However, the surplus vegetables were sold in the local market at variable rates. The estimate of gross income was based on the prevailing market price at the time of harvest.

Vegetable production on the pond embankments was initiated in 1980 using 0.1 ha area with the total vegetable yield of 520 kg. The total value of the vegetables produced was estimated to be Rs.1,300 with the net income of Rs.800 (Fig.12). The return on the expenditure was 160%. In the following years also vegetable production activity was continued with the expansion of cultivated area of 0.2 ha in 1994 and 0.3 ha in 1996. The vegetable production ranged between 360 kg and 1470 kg with the estimated net earring of Rs.500-590. Percentage return on the expenditure was in the range of 80-300% and the average being 223.35%. The average annual net income was Rs.2,725.
Fig. 12 Vegetable yield on the embankments and income generation during 1980-1998 at Kantapada village
6.1.6 Coconut production

Farmers grew the coconut seedlings on the pond embankments using local coconut breed themselves. On the embankments of newly constructed ponds 60 pits of 75 x 75 x 75 cm dimension were dug covering 0.2 ha area. A mixture of 2-3 baskets FYM, 1-2 baskets paddy husk and 2 kg common salt was filled in each pit and exposed to the sun. After a gap of one month, each pit was filled with 200-250 gm single super phosphate and 50-100 gm gamaxine thoroughly mixed with soil. Then one and half year old coconut seedlings were transplanted in the prepared pits. Plants were irrigated periodically with pond water. Later, on every year during pre-monsoon period hoeing was done, which was followed by the application of pond silt, farm yard manure and a mixture of 300 gm inorganic fertilizer (calcium ammonium nitrate and potash) for each plant. These management practices were continued throughout the cultivation period. After eight years of seedling transplantation fruiting started from 1988, though the yield was poor initially (Fig.13).

From 1980-1987 farmers were only spending money without getting any return. 1988 was the first year when they started reaping the coconut crop, with an average yield of 12 coconut/plant, fetching a net income of Rs.1,310/ only (Fig.13). While per plant coconut production increased with the time, the expenditure decreased, resulting enhanced profitability. In 1988 the percentage return on the expenditure was only 154.2% which increased to 6300% in 1994 and 6272% in 1995 and later on gradually decreased to 209.62% in 1997 due to various bio-physical and socio-economic constraints.

6.1.7 Banana production

On the newly constructed pond embankments, banana was found to be the most suitable horticultural crop. Initially 250 circular pits (30 cm dia and 30 cm deep) were prepared covering an area of 0.13 ha. Each pit was provided with one basketful of FYM and exposed to sun for two weeks. Then the banana suckers of the Bantal, Patkapura and Champa were transplanted & the field was irrigated using pond water. When new leaves came up, a mixture of 250-300 gm calcium ammonium nitrate and 100-150 gm potash was applied
Fig. 13  Coconut yield on pond embankments and income generation during 1980-1998 at Kantapada village
after proper hoeing and soil dressing in three installments i.e. first dose at 30-45 days, second dose at 60-75 days and third dose at 90-100 days of transplantation followed by light irrigation using pond water. After 9-10 months of transplantation bunching occurred which grew to maturity in 3-4 months. Once banana plantation was done, it continued to 3-4 years. However, appropriate management practices were applied.

The first crop of banana was harvested in 1980 with the yield of 210 bunches, which fetched Rs.5,250/-. The farmers made a net income of Rs.3,675 with the percentage return on the expenditure of 233.33%. In 1981 the banana yield increased to 225 bunches but during 3rd year the production declined to 98 bunches due to the flood havoc of 1982 (Fig.14). In 1983 the suckers of Champa and Bantal variety were again transplanted by changing the site on the pond embankments. It sustained up to 1986. Banana cultivation was continued every year by changing the plantation site and the variety of banana periodically. Once the banana is harvested the old plants along with roots were removed and the pits were filled with the pond silt. However, an adjacent sucker was managed to grow for the next crop. Since production from the old plants gradually declined, the new suckers of the Champa variety was transplanted in 1987 covering 0.18 ha which sustained up to 1990. In 1991 suckers of Patkapura were transplanted in 0.23 ha area but it was damaged in the flash flood of 1992. Hence in 1993 farmers again transplanted the suckers of local Bantal variety which continued up to 1996. In 1997 new suckers of Bantal were transplanted which was again damaged in the super cyclone of 1999.

Inspite of severe flood havoc of 1982 and 1992 and several bouts of cyclonic storms, which damaged the banana crops partially and/or completely, the farmers of the Kantapada village did not lose their interest. They continued with banana cultivation every year and succeeded to harvest 90-410 bunches of banana annually. The banana crop was sold at the farm site @ Rs.20-70/bunch depending upon the variety, size of the bunches, fingers of the banana and its market demand. Farmers also sold the leaves of the banana and suckers. While Re.1 per plant was earned through the sale of the leaves, annually, Rs.0.75-2.0/sucker was earned through the sale of suckers annually.
Fig. 14  Banana yield on the pond embankments and income generation during 1980-1998 at Kantapada village

Yield (bunch) vs. Net income (Rs.)

- Yield
- Net income
6.1.8 Papaya production

For papaya cultivation pits of 45 x 45 x 45 cm dimension were prepared on the pond embankments. In each pit one basketful of FYM, 25 gm single super phosphate, 25 gm calcium ammonium nitrate and 50 gm 10% BHC were mixed with the soil and the pits were exposed to the sun for few days. Then about 2 month-old papaya seedlings were transplanted. Proper dressing of the basal area was done to avoid water logging. After 2-3 months, hoeing was done and a mixture of calcium ammonium nitrate and potash along with pond sediment/compost was applied periodically. Plants were irrigated with pond water. After 7-8 months of transplantation fruiting started which became harvestable after 4-5 months of fruiting. Fruiting continued for three years at a stretch. First year yield was comparatively less but in the second year the yield was maximum. During 3rd year again the production declined.

During 1980-82, there were 100 plants in 0.06 ha area, from where two crops of 200 kg and 327 kg could be harvested fetching total gross income of Rs.400 and Rs.572 in 1980 and 1981 respectively. The percentage return on the expenditure was 122.22-281.33%. In 1982 all the plants were damaged in the flash flood. After the floods receded, farmers again transplanted 100 seedlings in 1983, which continued upto 1985. During this period 240, 348 and 298 kg papaya could be harvested annually and sold at the farm site, fetching net income of Rs.292-650 per year. In the following years also papaya was cultivated by changing the site on the embankments and extending the area up to 0.15 ha at three years intervals. Details of papaya yield and net income is give in Fig.15.

6.2 Economic profitability

6.2.1 Aquaculture

Food fish

The year wise fish yield rates and annual income generation through food fish culture during 1979 to 1998 are given in Fig.9. The cost of fish production ranged between Rs.1.88/kg and Rs.11.3/kg (average being Rs.6.37/kg fish). The annual gross income through
Fig. 15  Papaya yield on the pond embankments and income generation during 1980-1998 at Kantapada village.

![Graph showing papaya yield and income generation from 1980 to 1998 at Kantapada village.](image)
food fish culture was Rs.2,72,904 against an annual expenditure of Rs.73,971, leaving a total annual net income of Rs.1,98,993\textsuperscript{1}. The percentage return on the expenditure was 268.93\% and the profitability index Rs.2.69. This suggested that composite fish culture is dependable as an income generating enterprise for the rural poor.

The total expenditure in the entire venture of food fish culture during 1979-1998 amounted to Rs.14,79,434\textsuperscript{1}. It is a well known fact that supplementary feed is the major cost component to the extent of 50-60\%, of the total operational cost of food fish culture. However, in the present observation the feed cost was limited to only 19.09\% of the total expenditure. Many of the job tasks like renovation of ponds, removal of aquatic weeds, application of feed, fertilizer & manure, watch and ward, netting, harvesting and marketing of the fish were actually carried out by the village farmers themselves. They contributed 36\% of the total cost of operation. Thus labour intensive fish culture took precedence over feed intensive system. Cost composition of the various items in food fish culture operation is presented by Fig.16.

Fig.16  Average cost composition of various items in food fish culture during 1979-1998
Spawn

Carp spawn production was carried out for a period of five years (1995-1999) with total yield of 22 million spawn. Spawn was sold @ Rs.300-600/lakh depending upon the carp species. The cost of spawn production was estimated to be Rs.91/lakh spawn. The total gross income through carp spawn production was Rs.90,900 against the total expenditure of Rs.20,100/. The expenditure was attributed to cumulative cost of inducing hormones, brood fish management, labour, breeding tools etc. The net income was Rs.70,800 in five years (during monsoon period only) with an average percentage return on the total operational cost of 352.24%. High profitability index (3.52) of carp spawn production technology attracted the attention of many. Though taken up on a small scale, the production of carp spawn in the village made the region not only self sufficient with stocking materials but also opened up an avenue for income generation through part time self-employment.

Fry

In spawn-to-fry rearing venture the actual gross income was Rs.9,77,400 in 16 years (1983-1998) against the total expenditure of Rs.2,83,400/. The maximum expenditure was attributed to manpower for pond renovation, weed clearance, watch and ward, daily feeding, manuring, netting, harvesting and marketing etc. (31.36%) followed by feeds (25.20%), stocking materials (17.23%) and pond preparation (10.59%) etc. Year wise fry production and net income figures are presented by Fig.10. Total net income was Rs.6,94,000 (annual average net income being Rs.43,375) in 1-2 months rearing period each year. The return on expenditure was significantly high (244.88%) with the profitability index of 2.45%.

Fingerling

During the period of 21 years (1978-1998) farmers of the Kantapada village earned a gross income of Rs.7,60,660 against the total expenditure of Rs.3,40,930 through fingerling rearing using 20
small ponds of 2.0 ha. The fingerlings were sold @ Rs.70-300 per thousand, fetching a total net income of Rs.4,79,730. The annual average income was Rs.19,987 within a period of 4-5 months. The overall average return was 123.11% from fingerling rearing with profitability index of 1.23%.

While both fry rearing and fingerling rearing proved to be economically viable enterprises, the former was accepted to be more lucrative in terms of profit margin. The results of the study showed that the establishment of "fish seed village" not only proved to be technically feasible, economically viable & sustainable over a long period but also contributed to self-employment generation.

6.2.2 Horticulture

Vegetable

From the above account it is obvious that in 19 years farmers of the Kantapada village produced 1,7475 kg fresh vegetables using 0.1-0.3 ha pond embankment area, which was sold and/or consumed by the households. The total production of vegetables was valued at Rs.74,950 against an expenditure of Rs.23,170, thus leaving a net income of Rs.51,780, (annual average being Rs.2,725/-). Average percentage return on the expenditure was 223.35% with the profitability index of 2.23%.

Coconut

Within a period of 11 years (1988-1998) farmers harvested 1,185 coconuts from 60 plants, which was sold @ Rs.3-4/coconut at farm-gate. This fetched a gross income of Rs.36,915/ against an expenditure of Rs.13,700/- leaving Rs.23,215 as net profit (annual average income being Rs.1,222/-). The average percentage return on the total expenditure was 169.45% with profitability index of 1.69%.

Banana

In Kantapada village banana cultivation was sustained for 19 years from 1980 to 1998 with the total banana yield of 4844 bunches.
The gross income ranged between Rs.1,960 and Rs.28,700 and net income ranged between Rs.760 and Rs.23,240. The percentage return on expenditure was in the range of 63.33-1553.33%. During entire cultivation period the gross income was Rs.2,07,265/- against the total expenditure of Rs.51,535/- leaving the net income of Rs.1,55,730/- (annually average being Rs.8,196/-). The profitability in banana cultivation was significantly high with the percentage return on the expenditure of 302.18%. Year wise banana yield and net income is depicted in Fig.14.

**Papaya**

During 1980-1998 the farmers raised 100-125 plants using 0.06-0.15 ha pond embankment area and harvested 200-1,050 kg papaya annually. The gross income through papaya sale ranged between Rs.400 and Rs.8,975 per year with the percentage return on the expenditure of 50.81-295.45%. Although papaya cultivation continued for 19 years, there were periods of interruption like flood havoc of 1982 and 1992 and super cyclone of 1999 when the crops were totally damaged. During the entire period of papaya cultivation 9279 kg of papaya could be harvested and sold @ Rs.1.5-5.5/kg fetching total gross income of Rs.36,669 against an expenditure of Rs.13,910. The net income was computed to be Rs.22,759 (annual average being Rs.1197 only). Average percentage return on the expenditure was computed to be 163.62% with the profitability index of 1.64%.

**6.2.3. Cumulative profitability**

The ratio between area of pond water used for fish culture and embankment area used for horticultural crops was computed to be 14.4:1. During the period of 1978-1998 farmers made a gross income of Rs.72,87,045 from fish farming and Rs.3,55,799 from horticultural crops in the ratio of 21:1. The net income through fish culture and horticulture was Rs.52,35,161 and Rs.2,53,484 respectively. The average annual net income from fish culture, (Rs.2,76,448) included Rs.1,98,932 from food fish culture, Rs.14,160 from carp spawn
production, Rs.43,375 from fry rearing and Rs.19,981 from fingerling rearing. The average annual income from horticultural crops was Rs.14,040/- (Papaya, Rs.1897; bananas, Rs.8196; coconut, Rs.1222; vegetable crops, Rs.2,725). The percentage return on expenditure was Rs.247.29% for fish culture and 214.6% for horticultural crops. The total average annual income from all the commodities was Rs.2,90,488/- due to the maximum contribution of food fish culture (68.48%) followed by fry rearing (14.93%) fingerling rearing (6.88%), carp spawn production (4.88%) bananas (2.82%), vegetables (0.94%), papaya (0.65%) and coconut (0.44%) (Fig.17).

Fig.17 Contribution of various commodities in annual income through integrated fish farming at Kantapada village during 1978-1998
7. Impact

The novel endeavour of Kantapada farmers in sustainable aquaculture development along with horticulture as a holistic and convergent approach created visible impact on productivity, economic growth, poverty reduction and equipping people with skills they needed to participate fully in the economy. The integrated aquaculture technology not only opened up new opportunities for the poor and disadvantaged for all round development of human potential - both material and economic, but also contributed significantly to refinement of sensibilities, perception and scientific temper for furthering the goals of improved productivity performance.

Culture fisheries in Kantapada which remained quantitatively insignificant and characterised by structural imbalance prior to 1978, acquired a new importance over next two decades well suited to the needs and aspirations of the farming community. Concerted efforts and meaningful partnership of scientists and farmers resulted in manifold increase in infrastructure and its utilisation. The number of privately owned ponds in 1978 was 13 with cultivated area of 2.05 ha which rose to 73 with 15.9 ha in 1998. An additional cultivated water area of 3.0 ha as 10 community ponds was in operation in 1998. The number of privately owned ponds in 1978 was 13 with cultivated area of 2.05 ha which rose to 73 with 15.9 ha in 1998. An additional cultivated water area of 3.0 ha as 10 community ponds was in operation in 1998. The average yield of food fish rose from 700 kg/ha/yr to 1935 kg/ha/yr in private ponds and from 50 kg/ha/yr. to 1560 kg/ha/yr in community ponds between 1978-1998. Acceptance of a common structure of growing horticultural crops like banana, papaya, coconut and seasonal vegetables on pond embankments gained rapid momentum over the years increasing profitability by optimum land utilisation. In integrated fish farming the major contribution to average annual income in 1998 came from fish production (68.48%), fry rearing (14.92%), fingerling rearing (6.88%) and carp spawn production (4.88%) while the contribution of banana, papaya and coconut together accounted for 3.89% and vegetable 0.94% (Fig.17). The post 1978 period saw a significant shift in occupational status of farming communities which showed professional fish culturists constituting 13% in 1998 as against only 1% in 1978 and there was a marked reduction in share cropping and wage employment seekers in 1998 compared to 1978 level (Fig.2).
### Table 4

**Changing scenario of the farmer families of Kantapada village during 1978 to 1998**

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</tr>
<tr>
<td>Cots</td>
<td>80</td>
<td>190</td>
</tr>
<tr>
<td>Almirahs</td>
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</tr>
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<td>5</td>
<td>75</td>
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<tr>
<td>Radios</td>
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<td>20</td>
</tr>
<tr>
<td>T.V.</td>
<td>-</td>
<td>80</td>
</tr>
<tr>
<td>Cycles</td>
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<td>150</td>
</tr>
<tr>
<td>Scooters</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Cars</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Gas Chulha</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Electric fans</td>
<td>-</td>
<td>120</td>
</tr>
<tr>
<td>Fish farm tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nets</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>Hapas</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>Diesel pump</td>
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<td>10</td>
</tr>
<tr>
<td>Electric pump</td>
<td>-</td>
<td>2</td>
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<tr>
<td>Sprayers</td>
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<td>10</td>
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</tbody>
</table>
### Table-5


<table>
<thead>
<tr>
<th></th>
<th>Privately owned ponds</th>
<th>Village community ponds</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of ponds</td>
<td>13</td>
<td>73</td>
</tr>
<tr>
<td>Area (ha)</td>
<td>3.0</td>
<td>15.9</td>
</tr>
<tr>
<td>Percentage of weed infestation/ shading (%)</td>
<td>100</td>
<td>Nil</td>
</tr>
<tr>
<td>Leased out ponds</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Lease rate (Rs/ha/yr)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cultivable area (ha)</td>
<td>3.0</td>
<td>15.9</td>
</tr>
<tr>
<td>Cultivated area (ha)</td>
<td>2.05</td>
<td>15.9</td>
</tr>
<tr>
<td>Culture practices</td>
<td>Traditional fish culture using riverine seed</td>
<td>Fry/fingerling and food fish culture, integrated fish culture, induced carp breeding, prawn culture.</td>
</tr>
<tr>
<td>Source of fish seed</td>
<td>Unidentified riverine seed</td>
<td>Induced bred carp and riverine prawn seed</td>
</tr>
<tr>
<td>Status of food fish yield (Kg/ha/yr)</td>
<td>700</td>
<td>1700-2350 (Av.1935)</td>
</tr>
<tr>
<td>Carp seed production</td>
<td>Nil</td>
<td>Spawn 67 lakh Fry 4000 thousand Fingerlings 3800 thousand</td>
</tr>
</tbody>
</table>
A marginal readjustment in occupational diversity is also marked in other sectors like own agriculture, service and business between 1978 to 1998. These changes had a crucial role to play in the process of modernisation and living comforts as well. Between 1978 and 1998 there was an exponential growth in male and female literacy, number of pucca houses, household assets like furniture, electronic entertainment devices, improved farm implements and machinery, scooters, cars, tractors and trucks (Table-4).

Kantapada presented an impressive record of steady expansion of the scale of operations in aquaculture to cover the whole range of production technologies like fish, fry, fingerlings and spawn. The ever increasing operational area, number of participating farmers, rising production and income from each enterprise testified to the intensity of action with passage of time. Starting from a mean production of 700 kg fish and net income of Rs.1900/- in 1979 from only 2.0 ha water area, the production had reached a peak of 30,767 kg worth Rs.10,76,845/- in 1998 utilising 15.9 ha water area (Table 1). A more or less stabilisation in fish productivity rate is visible from 1991 onwards with the exception in 1993 due to floods. The landmark years in carp fry production were 1995-1997 reaching an annual peak of 55 lakh fry with net worth of Rs.1.15 lakh which marked a 5.5 fold increase in production compared to the starting year of 1983 (Table-2). From 1983 to 1998 the fry survival improved by three times and the operational area by two times. For carp fingerling production 20 ponds (2.0 ha) were utilised in 1998 as against only 2 ponds (0.05 ha) in 1978 (Table-3) which gave a big jump to fingerling production of 38 lakh (1998) worth Rs.3.30 lakh starting from a very low production of 1 lakh fingerling (Rs.5600/-) in 1978. The highest production of fingerlings was achieved during 1996-1998. As the farmers achieved professional dexterity in fry & fingerling rearing, they moved on to acquire the technical skills at the tertiary stage in induced breeding and carp spawn production during 1995-1998 which provided an absolute fillip to the farmers' efforts to achieve self sufficiency in fish seed. In the whole range of aquaculture operations the maximum return on investment came from carp spawn production at 352.24% followed by fish (268.93%), fry (244.88%) and fingerling (123.11%) in the same order (Fig.18).
The Kantapada farmers achieved a unique distinction of boosting up pond productivity by integrating horticulture as an additional component. Banana fetched maximum income per annum as high as Rs.23,240/- from 500 plants (0.25 ha) on pond embankments. There was more than a five-fold increase in net income between the years 1980 (Rs.3675/-) and 1998 (Rs.15040/-). The area under papaya ranged between 0.06 and 0.15 ha which fetched a maximum annual net income of Rs.3,975/- in 1997. Sixty plants of coconut on pond embankments yielded production from 1988 onwards and the average net annual income in 10 years was Rs.2573/-. The income from seasonal vegetables grown on pond embankments had a rising trend with as little as Rs.800/- in 1980 to Rs.5190/- in 1998. Among horticultural crops, contribution of banana to the total annual income was the highest at 2.82% followed by vegetables (0.94%).

The promotion of aquaculture in Kantapada had helped bring about a favourable change in the fish consumption pattern in the village. The availability of carps was only 10% in 1978 while marine fish and dried fish consumption was up to 65%. The impact of fish culture within the village led to an increase in consumption of carps to 37% with a simultaneous decline in the demand for fresh marine fish (20%) in 1998 (Fig.19). The bulk of the freshwater fish in 1978 came from river (45%) and abandoned waterlogged areas (30%) while a major turn around occurred in 1998 with 65% of freshwater fish coming from...
culture fishery sources (Fig.20). The major contribution of freshwater fish in 1978 was from weed fish (50%) followed by predatory fish (35%) whereas in 1998 the carp fish contributed maximum up to 70% (Fig.21).

The concerted efforts and determination of the farmers of Kantapada in adoption of aquaculture as an alternative income source to supplement agricultural income has ensured widening its spread and intensity of action at a fast pace. The positive aspect of this is visible by its influence on better quality of life, overall prosperity and social development.

The success of Kantapada has indeed continued to serve as a wake up call for prospective aquaculture entrepreneurs in neighbourhood areas. The message is very loud and clear.

**Fig.19  Quality fish consumption by the farmers**

*1978*

- Fresh marine fish: 40%
- Dried marine fish: 25%
- Weed fishes: 20%
- Predatory fish: 5%
- Carp fishes: 10%

*1998*

- Fresh marine fish: 20%
- Dried marine fish: 22%
- Weed fishes: 17%
- Predatory fish: 4%
- Carp fishes: 37%
Fig. 20  Source of freshwater fish

1978

Road side ditches
10%

Adjoining water logged to paddy field
30%

Paddy field
12%

Culture pond
3%

River
45%

1998

Road side ditches

Paddy field
5%

Adjoining water logged to paddy field
10%

River
19%

Culture pond
65%
Fig. 21 Composition of available freshwater fishes

1978

Predatory fishes
35%

Carp fishes
15%

Weed fishes
50%

1998

Predatory fishes
10%

Carp fishes
70%

Weed fishes
20%