Economic Viability of an Integrated and Sustainable Resource Use Model for Kuttanad

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1. Introduction

Kerala's agriculture is traditionally oriented towards perennial cash crops in view of their agronomic suitability. This orientation has resulted in the State becoming deficit in food crop production. Kerala has been historically dependent on other regions for meeting its food requirements. The gap between demand for and supply of food grains, which was around 50 per cent till the mid-seventies started widening thereafter consequent on the large-scale shift of paddy fields to cultivation of other more remunerative crops like coconut. Kerala had a gross cropped area of 7.69 lakh ha in 1959-'60; it increased to 8.75 lakh ha in the mid-seventies raising the annual production of rice to around 13 to 14 lakh tonnes. The area under rice came down to 4.31 lakh ha and production of rice to 8.71 lakh tonnes in 1996-'97. The present study was conducted against the background of Kuttanad. We shall now examine the general trends in rice production in Kuttanad (spread over Pathanamthitta, Alappuzha, and Kottayam districts). In all these places where rice cultivation is done in vast polders a declining trend in areas under rice is noticeable. The productivity was showing, however, a marginal increase. The general trend in rice production in Kuttanad is summarised in Table 1.1.

The major reason for the poor performance of rice and the declining tendency of the area of its cultivation is undoubtedly the escalation in costs of production. The costs of production have increased four-fold during the past decade whereas the rise in the price of rice was 200 per cent, resulting in heavy loss to the majority of farmers. There is an acute shortage of labour for paddy cultivation resulting in deterioration of the amount and quality of work rendered by the available workers. It is in this context that the Regional Agricultural Research Station (RARS) of the Kerala Agricultural University in Kumarakom came up with

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Table 1.1 Area and production of rice in districts comprising Kuttanad

	1994-'95	'95-'96	'96-'97	1994-'95	'95-'96	'96-'97
	Area (ha)			Production (tonnes)		
Pathanamthitta	11045	10810	10985	24984	27210	23690
Alappuzha	54864	44132	41447	99240	121047	85192
Kottayam	25006	24878	20200	56102	55609	43728

Source: Economic Review, 1997

the integrated farming systems model for these rice tracks and by an enterprising farmer in Kumarakom took up the model for experimentation in his farm. The central objective of this study is an in-depth analysis of this experiement and in comparison with the performance in the existing farming systems.

Objectives

(i) Systematic monitoring of a case study of a farmer who practised the model and study of its economic viability.

(ii) Analysis of the input-output matrix of farmers who practise the conventional systems of double crop rice, single crop rice, and single crop rice-cum- aquaculture.

(iii) A perceptional study of different groups of farmers in the region to assess the economic viability and scope of replication of the model.

Method

The study was inter-disciplinary in nature and used economic, environmental, and sociological indices. Participatory techniques were also used. The Principal Investigator was a resident and social activist in the study area who could bring into the study insights from his long interactions with the people and the processes in the area. One of the co-investigators was involved in farming systems research in the area for the past two decades as a scientist in the regional research station of the Kerala Agricultural University. The other co-investigator stayed in the study area for seven months and could bring in the 'objective element' in perception of an outside researcher. The different disciplinary backgrounds and constant interaction among the researchers could strengthen the multi-disciplinary character of the study. The following were the methods used:

(i) A daily assessment of the variable costs and returns of farming activities of the model farm was done for a period of 15 months starting from December 1996 to February 1998. The rice harvest in the first year was low due to climatic factors; the study was continued also for the next year. The farmer was provided with a record book where the daily details of all the farming activities were noted. This was supplemented by periodic visits by the Principal Investigator: One of the co-investigators stayed in Kumarakom from January to July 1998 and collected data in detail.

(ii) A questionnaire survey was carried out to compute the cost of cultivation of rice. For the survey, 53 farmers who maintained written records of the daily costs of cultivation were selected based on the following criteria: ,

(a) Size of holding
(b) Caste
(c) Class i.e., erstwhile position in the traditional agrarian structure
(d) Occupation and sources of other income
(e) Lesseeship (informal)

A purposive sampling design was adopted for the study.

(iii) In-depth case studies of selected farmers, were conducted on the technology adoption and economics of farming.
(iv) Interviews were held with a range of actors including agricultural labourers, fishermen, political activists, trade union leaders and Government officials.

Structure of the project

This report is divided into five major section: Section 1 gives an account of the area of the study and cropping background. The second Section presents a broad view of the regional dimensions of agriculture of Kuttanad. Section 3 which pertains to details about the Kumarakom *panchayat* within Kuttanad presents a detailed analysis of rice cultivation in the area, especially discussing the economic viability issues. Section 4 gives an account of the integrated farming experience in Kumarakom. The policy dimensions of the discussion are presented in Section 5..

2. Kuttanad: A macro view

Historical background

Kuttanad is a low-lying area with backwaters, canals, and stream networks extending over 874 sq. km. There are garden lands of average elevation of 1 m above Mean Sea Level (MSL) covering an area of 304 sq. km. About 500 sq. km is 0.6 to 2.2 m below MSL. The Greater Kuttanad region is unique and extends from 9^{0} 17^{1} N to $9^{0}40^{1}$N and 75^{0} 19^{1} E to 76 ^{0} 33^{1} E (Chattopadhyay and Sidharthan, 1985). The Kuttanad basin is fed by four rivers and a lake that extends from Alappuzha in the south to the Kochi harbour in the north where it opens out to the Arabian Sea.

Institutional evolution of Kuttanad

Kuttanad is a fertile tract of land replenished by silt brought by the river systems; the area was found to be highly suited to rice cultivation from early days. However, reclaiming land from floodwaters was a hazardous task. Reclamation of land for cultivation and flood control used to be undertaken by private farmers, with assistance from the State (Pillai and Panikar, 1965). Over a period Kuttanad became the rice bowl of the State with a predominantly rice-centric economy.

Historically, Kuttanad was a thickly populated area because of the scope for multifarious economic activities like rice cultivation, fishing, coir making, etc. The traditional agrarian structure was hierarchical and caste-based, land being owned or possessed only by upper caste Hindus or non-Hindus. Tenants undertook the actual cultivation; the agricultural labourers who tilled the land and harvested the crop were of Scheduled Castes and the backward communities. The characteristic feature of this system was that it was inherently coercive in nature, and perpetuated itself by trapping the poor and the weak in a vicious circle of poverty and bondage.

From the last century onwards, the initiative for institutional reforms came from the monarchy. Consequently, by 1850 a major share of the cultivated land and the whole of the wasteland came under the State. This led to the emergence of a class of independent peasantry, who reclaimed the backwaters of Kuttanad for rice cultivation through operations that required substantially large capital investments (For a detailed account of the whole process, see Pillai and Panikar, 1965, Ch. 2).

The penetration of capital into Kuttanad agriculture and the attendant technological advancements led to a decline in labour use. Rice cultivation, which is a labour-intensive activity, became uneconomical owing to the breakup of the traditional labour relations consequent on the emergence of a labour market and the rise of labour militancy due to unionisation (Jose, 1977). Changes in the society, particularly the ramification in Kerala society brought about with the spread of education led to a tendency among all sections of the society to move away from traditional agriculture. The possibility of greater occupational mobility that unfolded after the 1970s also led to this tendency. The tenancy reforms of the 1960s and the subsequent fragmentation of land holdings made the average holding size ‘uneconomic’. New institutional arrangements like concealed tenancy are becoming increasingly prevalent among owners of land who have other occupations and find no time to manage their lands.

State interventions in the Kuttanad system

Almost all the State interventions in Kuttanad were oriented towards achieving a single objective - to boost rice production. The earlier ones were aimed at intensifying cultivation by conversion from single crop to double crop rice. Studies identified two preconditions for achieving this goal in the region.

(i) speedy drainage of the flood waters during the north-east monsoon, and
(ii) prevention of saline water incursion into the *Vembanad* Lake during summer.

Two engineering structures were suggested for these purposes:

(i) a spillway at Thottappally meant to drain off flood waters, and
(ii) a regulator of Thanneermukkom to check the incursion of saline water.

Improvements of *padasekharam* bunds under Kerala Land Development Corporation (KLDC) schemes were also suggested to safeguard rice cultivation from natural calamities.

The spillway, reported to have been designed after detailed hydrographic and hydrological studies, is draining only less than one-third of the desired capacity (Kannan, 1979). The Thanneermukkom Regulator, 1402m-long, located at about 22.5 km north of Alappuzha has also proved itself to be a disaster.

However, these developmental activities have reduced the risks of natural hazards like flood and saline water intrusion for *Punja* crop and helped extension of area under cultivation. Now the entire Kuttanad area is under high-yielding varieties of rice. Owing to the elimination of the risks from natural hazards, the discipline observed in earlier times in respect of agricultural practices during seasons of rice cultivation has disappeared. With the use of HYV seeds having only low resistance to pests and diseases, high seed rate, non-judicious fertiliser application and plant protection measures, the incidence of pests and diseases and consequent crop losses have become quite common (Aravindakshan, 1990)

In the sixties, self-sufficiency in food was conceived of as a national policy and the Government of India launched programmes like the Integrated Agricultural District Programme (IADP) in 1960 and the Integrated Agriculture Area Programme (IAAP) in 1963. These programmes were implemented in the form of packages of high input cultivation in selected locations that had natural resource potential to enhance food production. Kuttanad was one of the two regions selected in Kerala. Massive use of fertilisers and pesticides, made possible through a policy of heavy subsidies, promoted the widespread use of HYV seeds that in turn necessitated further intensive use of fertilisers and pesticides. A major problem faced by the cultivators in raising the second crop of rice was the flooding of fields due to breaches in the temporary bunds. The State government drew up a scheme to construct permanent but submersible bunds in 1974. The roads too were constructed as symbols of the State's 'development' programmes. The roads together with these bunds have fragmented the wetland ecosystem into tiny units and disrupted the natural hydrological balance. Effective draining of the toxicity developed by the fertiliser-pesticide residue became impossible and the system deteriorated (Kannan, 1979).

The per capita availability of low cost food grains from the Central pool increased in the State by 1974-'75 due to the Central Government's policy of introducing an efficient Public Distribution System. Consequently, rice prices declined; rice cultivation became increasingly uneconomic, more so in a situation of increasing cost of cultivation. Though the adverse effect was felt on the entire rice economy of the State, it was the highest on the rice bowls like Kuttanad and Palakkad where rice cultivation had already become unprofitable due to institutional changes (Narayanan, 1994).

In this scenario, all the earlier economic interventions intended to boost rice production were becoming not only ineffective but positively counterproductive as well. The rice-centric economy was becoming increasingly undependable for both the cultivators and the agricultural labourers. The cultivators' concern for maximising returns from land results in increasingly high input cultivation practices, which deteriorates the ecological system and threatens its sustainability even more.

Ecological consequences

All the above institutional and economic interventions had their ecological consequences too in Kuttanad. The estuaries and the backwater systems of the Kerala coast are the nurseries of several species of marine shrimps. The construction of the regulator has reduced severely the backwater area available for the prawns to spend their larval and growing stages of life. The prevention of the flow of seawater into the lake during summer has led to the decline or disappearance of several fish species that grow in saline water (Jhingran, 1975). Decline in the catch of fish has resulted in decline in the opportunities of employment for the fishermen and in their consequent impoverishment, particularly since alternative employment opportunities do not exist for them.

Apart from cultivation of rice and fish, there are other important occupations in Kuttanad:

(i) lime-shell[1] collection from the *Vembanad* lake, and
(ii) retting and defibering of coconut husks to cater to the raw material requirement of the coir industry.

The fishing resources of the *Vembanad* lake also include shellfish (molluscs). All species of molluscs require optimum ranges of salinity for their breeding. The changing conditions of salinity are likely to affect their life cycles adversely. In considering the impact of the regulator on coir-processing, it must be noted that, while retting of raw-husks takes three months in saline water, it takes 10-12 months in fresh water[2]. Hence, retting has been hampered by the operation of the regulator.

The consequence of such programmes, commonly called the 'Green Revolution' strategy, are manifested in the ecological deterioration as evidenced by the high pollution levels in the water bodies of Kuttanad. The closure of the regulator stops completely the tidal ebb and flow, and results in the stagnation of the entire water body on the eastern side the regulator. The water body gets polluted quickly, resulting in the spread of diseases like dermatitis, jaundice, colitis, and amoebic dysentery. Kuttanad, with these contrivances and the changing cultivation practices, is well on the way to an ecological disaster.

Physical

Kuttanad is peculiar in its topographical features with a sizeable area lying below the sea level. The area has a concave relief and slopes towards the north-west. Physiographically, the major portion of the area that forms a basin remains water-logged for most of the year. *Achencoil, Pamba, Manimala,* and *Meenachil* rivers discharge their water and sediments into the basin lake. The Kuttanad area is a recent sedimentary formation. Originally it had been part of the shallow coastal area of the Arabian Sea. With the upheaval of the *Warkalli* Laterite Formation, the tract became elevated forming a bay into which the rivers, draining from the mountains to the east,discharged their water. Deposition of silt carried by the rivers formed the present coast and the shallow bay became an extensive lake and backwater system. The lakes and lagoons gradually filled up leaving the present *Vembanad* lake. Three identifiable topographic areas are apparent: the dry lands, the wetlands, and the water spread.

Dry lands

These are elevated lands ranging in level from 0.50 to 2.50 m above Mean Sea Level (MSL). Crops such as coconut and banana are grown on these areas, which extend over 31,000 ha. Most of the population lives on this land, which is located in the peripheral areas of Kuttanad.

Wetlands

Wetlands are either low formations above MSL or areas below MSL reclaimed from the surrounding backwaters. They are mostly waterlogged with levels ranging from 0.60 m to 2.00 m below MSL. In Kuttanad, according to village records, there are 66,000 ha of wetlands. The relatively elevated formations, which are essentially depressions skirted by dry lands, are found mostly in Upper Kuttanad and amount to 11,000 ha. The remaining wetland, traditionally called *padasekharam*, literally means groups or blocks of paddy-fields. Each *padasekharam* is protected from inundation by embankments called 'bunds'. The land enclosed within the bunds is called *padasekharam*, a 'collection of farms'. There are in total 1167 *padasekharams*, varying in size and area. These lands cover a total area of about 55,000 ha and can be further classified into *Karappadom, Kayal,* and *Kari* lands[3] .

Water areas

The rest of the area, the water surfaces of the lakes, river systems, and channels, amounts to 13,000 ha.

Soils

The soil characteristics in the wetlands exhibit the effects of accumulation of toxic products from anaerobic decomposition of organic matter, production of ammonia, reduction of nitrates and sulphates, mobilisation of iron and manganese, and variations in soil reaction and conductivity. Seasonal fluctuations of salinity together with intermingling of fluviatile and estuarine silts have further modified the chemical and biological character of the soil. Lime is used extensively all over the project area confirming the existence of acidity in Kuttanad farming. Relatively large quantities of urea are applied despite the relative abundance of nitrogen and the occurrence of soil acidity. A large irrigation project, the Pamba scheme (20,000 ha) was recently completed upstream and the diversions for this scheme will increasingly reduce the flow available to Kuttanad. There will be further diversions for supply of drinking water, domestic water, industrial water, and water for minor irrigation. A reduced water supply probably does not lead to an immediate reduction in cropping intensities, as farmers are aware of the increased risk. They have already started experiencing yield reduction due to increase in salinity and acidity.

3. Kumarakom: A micro view

Profile of Kumarakom *panchayat*

The Kumarakom *panchayat*, part of the greater Kuttanad region, is located in the western part of Kottayam district adjoining *Vembanad* Lake. The name Kumarakom is derived from the words *Kuminja* and *Akam*, which means that land formed by the accumulation of sediments. It is a speck of depositional and reclaimed land in the entire region, which is a product of fluvio-estuarine agencies modified by human activities in the shape of reclamation. Hence this *panchayat* is characterised by both natural and man-made landscapes. Being located in the lower Kuttanad region, it exhibits all the characteristic features of the region such as water logging, salinity incursion and high soil acidity.

The *panchayat* falls under the low land zone of Kerala, nearly 0.6 m below MSL on an average. Hence, the entire area is prone to flooding during both the monsoons. The *Thanneermukkom* Regulator constructed across the *Vembanad* lake and commissioned in 1976 has checked the salt-water intrusion to the area, except during summer.The high levels of pollution due to addition of organic wastes, pesticides and fertilisers contaminating the lake ecosystem mentioned earlier have a direct bearing on Kumarakom too.

Tourism is an emerging development sector in the *panchayat* owing to the lively backwaters, bird sanctuary, and rich mangroves.

The *panchayat* has total population of 22,232 according to 1991 Census with a literacy level of 96 per cent. The Census figures (1991) indicate a fairly high work participation rate of 37.4 per cent. The female work participation rate (25.4 per cent) is much higher than the district average (12.3 per cent). The male work participation rate in the villages is 51.2 per cent, slightly higher than the district average (50.37 per cent). Among agricultural labourers, women contribute more than 50 per cent. Another notable factor is that a substantial proportion of the work force depends on fisheries and animal husbandry for their living.

Soil type and characteristics

The soil of this region is reverine alluvium varying from sandy loam to clay loam. It exhibits much variation in their psycio-chemical properties. It is deep soil containing moderate amounts of organic matter, nitrogen, and potassium. The soil is mainly acidic in reaction in the pH ranging between 5 and 5.4. Table 3.1 gives the taxonomic classification of the soil of Kumarakom.

Rice is the major crop that covers 57 per cent of the total land area. The physiographical set-up of the area, a low-lying zone, supports rice cultivation; two crops are usually raised *Viruppu* (Kharif) during May-September and *Punja* (Rabi) during November-March. Rice is raised after bailing out water and bunding the low-lying fields.

Table 3.1 Kumarakom *panchayat* - soil characteristics

Soil type	Reverine alluvium
Order	Entesol inceptsol
Sub orders	Fluvient
Group	Tropfluvient
Nutrient status	
N	Medium
P	Low
K	Low

Source: Land Use Board

Land use

Table 3.2 gives the details of Land use.

Table 3.2 Kumarakom *panchayat* land use

No.	Land type	Area in ha	Percentage coverage
1.	Total area	5167	
2.	Area under seasonal agriculture	1575	
	a. Paddy	1515	29.6
	b. Plantain	55	
	c. Vegetables	15	
3	Area under tree crops* and plantains	1179	22.3
	a. Coconut	756	
	b. Cocoa	30	
	c. Rubber	4	
	d. Mixed crops	389	
4.	Water bodies	2413	48.1

Area under tree crops includes settlement land use also. Source:
Participatory Resource Mapping Survey - CESS

Cultivation is practised in blocks of farms called *padasekharams*. There are 45 *padasekharams* managed by 45 different elected *padasekharam* committees in the *panchayat*. Several cultivators, who cultivate their land individually, own land in these *Padasekharams*. Dewatering is taken up on a co-operative basis. The marginal farmers owning less than one hector account for 57.6 per cent of operational holdings followed by small farmers (32.5 per cent). Therefore most of the farmers have to depend on collective ventures for cultivation in the *padasekharams*. The productivity of the crop is high; 3.8 tons/hectare as against the State average of 2 tons/hectare.

Water bodies occupy a sizeable area in the *panchayat*. This intricate channel/canal system and other areas permanently under water constitute 2413 ha. The paddy-fields of 1111 ha were vast breeding and growing grounds for various types of fishes. Consequent on the commissioning of *Thanneermukkom* Regulator, 464 ha paddy-fields were converted to double crop and the criss-crossed tidal channels (1250 ha) choked with aquatic weeds and almost dried up during summer severely, reduced the water area available for breeding and growth of fishes. Earlier fish was cheaply available in the *panchayat;* now it is a costly item.

The very purpose of *Thanneermukkom* Regulator was increase in the production of food crops. But when the village got one additional crop of rice in 464 ha, it denied fish growth in 1714 ha. There was a steep rise in fish prices too denying the poor of their traditional protein source.

Constraints on rice cultivation

Production problems: The main economic activity in this wetland tract is rice cultivation. The increasing cost of cultivation was found the major constraint to farming. A detailed survey conducted in Kumarakom has shown the following as the major problems of rice cultivation:

(i) Problems of labour: Scarcity of labour and diminishing labour productivity,
(ii) De-watering: High cost of dewatering; power failures; and delays associated with this activity,
(iii) Poor in-field irrigation and drainage,
(iv) Weak bunds and recurring cost of maintenance,
(v) High weed growth and high cost of weed control,
(vi) Salinity intrusion and crop loss during summer months,
(vii) Acidity and iron toxicity and declining soil fertility due to constant use of chemical inputs,
(viii) Pest and disease damage and poor grain formation,
(ix) Rodent damage,
(x) Non-availability of quality seeds, and
(xi) Inadequate transportation facilities

Marketing problems: Low price of output and inadequate storage facilities are severe problems. The *padasekharam*s vary in size from 5 ha to 500 ha with an average size of 47 ha. Rice is the only crop grown in *padasekharams*, poor drainage conditions having made most of the land in the *padasekharam* unsuitable for other crops. The Land Utilisation Order (1967) prevents the farmer from shifting to other crops.

Intensive cultivation using high breed varieties of rice, chemical fertilisers, and heavy doses of pesticides has caused both fertiliser and pesticide pollution to the aquatic environment of Kuttanad. The KWB study (1989) has estimated that 20,228 tons of chemical fertilisers and 485 tons of pesticides are applied every year in Kuttanad. Spread of noxious aquatic weeds due to fertiliser pollution has an added effect of killing fishes and rendering fisherfolk jobless.

The cost of rice cultivation has increased considerably and made it unremunerative. Farming in Kuttanad brings, consequently, heavy loss to farmers (Table 3.3 and 3.4). Young men and women are not ready to work in the paddy-field. As a result, an acute shortage of labour is experienced for rice cultivation. Many of the cultivators are unwilling to take the heavy risk involed in rice cultivation. They even try to convert paddy-fields to coconut gardens or to housing sites. Conversion of paddy-fields is done in violation of law and it is detrimental to the economic and developmental interests of the society. Rice being the staple food of the State, we must have a reliable domestic supply to ensure food security[4] .

Economics of rice cultivation

To begin with, a comparative study of major components of costs and returns between 1988 and 1998 was done so as to bring out the magnitudes of increases in both during the period (Table 3.3 and 3.4).

Table 3.3 Increase in farm gate prices of inputs and outputs in rice cultivation in Kuttanad,1988 and 1998

Item	Unit	Mean Price) (1988)	Mean Price (1988)	Price Index (1998)	Price Index (1998)	Increase percent
A. Input						
Seed	Rs/Kg	290.00	830.00	100	286.21	186.21
Lime	Rs/Kg	0.90	3.55	100	394.44	294.44
Fertiliser						
Mussooriephos	Rs/Kg	0.65	2.05	100	315.38	215.38
Urea	Rs/Kg	2.40	3.95	100	164.58	64.58
Factomphos	Rs/Kg	2.65	6.65	100	250.94	150.94
Pottash	Rs/Kg	1.33	3.85	100	289.47	189.47
Pesticide						
Monophos	Rs/litre	120.00	315.00	100	262.50	162.50
Henosan	Rs/litre	220.00	815.00	100	370.45	270.45
Metacid	Rs/litre	140.00	280.00	100	200.00	100.00
Hired Labour						
Man	Rs/day	23.00	112.50	100	489.13	389.13
Woman	Rs/day	14.00	50.00	100	357.14	257.14
B. Output						
Rice	Rs/kg	2.30	4.98	100	216.52	116.52
Straw	Rs/kg	0.27	0.50	100	185.19	85.19

Source: 1. KWBS Report (1988) 2. Narayanan (1998)

Table 3.3 shows the uneven rates at which input and output prices increased during the period. For comparison, the prices indices of selected inputs and outputs and corresponding percentage increased have been worked out. The highest increase was observed to be in wages. This fact is also reflected in Table 3.4. The cost of machine power increased by 479 per cent whereas cost of bullock power registered a decline of 73 per cent, showing a possible

Table 3.4 Changes in cost and returns of rice cultivation in Kuttanad for 1988 and 1998 (Rs/ha)

Item	Average-1988	Average-1998	Hike	Cost Index-88	Cost Index-98	per cent Increase
Input cost	**Rs**	**Rs**	**Rs**			
Seed	482	1026	544	100	212.86	112.86
Fertiliser	1174	2249	1075	100	191.57	91.57
Plant Protection	434	799	365	100	184.10	84.10
Manure	5	55	50	100	1100.00	1000.00
Bullock Power	371	101	(-) 270	100	27.22	(-) 72.78
Mach. Power	215	1244	1029	100	578.60	478.60
Labour	2105	9786	7681	100	464.89	364.89
Other Inputs	256	871	615	100	340.23	240.23
Total input	4560	16131	11571	100	353.75	**253.75**
Value of output	8129	15884	7755	100	195.40	**95.40**
Net return	**(+) 3087**	**(-) * 247**				
Average yield (kg/ha)	3266	3320	54	100	101.65	**1.65**

Source: (1). KWBS Report (1988)-Table11 p.79. (2). Narayanan (1998); If the government subsidy of Rs 300/ha is added to this, a nominal profit of Rs 53/ha can be arrived at.

substitution of manual labour by machines. On the other hand, the increase in labour cost can be explained by a more than proportionate increase in wage rates by around 390 per cent for males and 257 per cent for females. Our survey has shown that per hectare cost for ploughing by bullock power is more than that by machines and that the farmers have very low preference for bullock ploughing. Yet, a section of farmers are forced to practise bullock-ploughing because of the pressure from trade unions for it as a traditional right. The increase in cost of fertilisers and plant protection chemicals is not proportionate with increases in unit costs during the same period, due either to a decrease in the use of these inputs or an increase in the use of urea as the more sought-after fertiliser. The unit price increase of urea is lower than the average. The unit prices of pesticides have increased within the range of 100 to 270 per cent, while the hike in cost of plant protection is only 84 per cent. This might be indicative of a decreased use of pesticides, which may be due to the economic factor of high prices leading to a reduction in use; alternatively, it may be a positive indication of the environmental sensitivity on the indiscriminate use of pesticides.

The hike in the cost of total inputs was not proportionate to the increase in the value of output. While the input costs increased by around 254 per cent, the rise in the value of output was only 95 per cent. Such a mismatch in increases between input costs and value of output during the decade is reflected in the lowering of net returns from Rs 3087 in 1988 to a negative net return of Rs 247/ha in 1998. The rice equivalence of cost of cultivation was attempted. The estimates of rice equivalence were arrived at by dividing total input by the unit price of rice in the respective years. Such estimates show that the rice equivalence of cost of cultivation for the year 1988 was 1983 kg/ha, which rose to 3239 kg/ha in 1998. This indicates that a minimum yield of 32 quintals is necessary to break even rice production in Kumarakom. Out of the 53 samples surveyed, only 19 samples were observed to have reached this level of yield. The yield range in the rest of the 34 cases was found to be between 1671 kg/ha to 3220 kg/ha. This is a pointer to the fact that for a vast majority of the farmers in the study area, rice production is uneconomic.

Some detailed exercises on costs were carried out from the 53 samples. This was done with the detailed cost of cultivation figures collected from farmers doing both the *Punja* and the *Virippu* crops. Thus per crop, per hectare data on rice cultivation were obtained. Wages is the predominant component of cost, with a share of more than 50 per cent in most cases. An exception of 4.64 per cent and 7.83 per cent may be observed for two crops of the case of farmers, who use family labour in their smallholdings to a substantial level. There are seven farmers whose labour cost comes to below 50 per cent of total cost. Out of this, five of them are small holders having holdings below 1 ha and have positive net returns as a result of using family labour. But the other two samples despite low labour component of costs, have negative net returns. This is owing to the fact that they are lessee farmers farming on big holdings (above 5 ha). The labour component of cost appears low because of the existence of a high element of rent in total cost.

The second major component of cost is the material cost, which ranges from 13.48 per cent to 46.5 per cent of total cost. The lowest proportion of material cost in total is found for a small lease farmer using only 60 per cent of the average fertiliser use and only 46 per cent of the average pesticide use for all samples taken together. A major share (32 per cent) of his total cost is accounted for by land rent. The highest share of material cost is for a farmer having the smallest holding and using family labour, since the major component of his paid out cost is accounted for by fertilisers.

All the farmers incur expenditure on electric power; only two of them incur power cost of more than 25 per cent of total cost. One farmer spends around 47 per cent of his total cost for power since the major part of labour comes from family labour. Another is a farmer who takes up integrated farming and has substantial savings in material and labour cost but significant increase in the cost of power. There is also another reason for the increas; he has had to bear the cost of electricity consumed by two other rice farmers who defaulted reimbursement of costs to him. He is not availing himself of the subsidy amount for dewatering either, considering the cumbersome procedures to be followed for getting the amount from the *Puncha* Special Office. From this problematic scenario of the uneconomic nature of rice cultivation, the integrated systems of farming are catching up in the area. In this context, the need for, and the general characteristics of, the integrated farming systems, are examined in Section 4.

4. Integrated Farming Systems

The developmental activities in Kuttanad have helped to some extent increase the area and production of rice and to improve employment opportunities for farm labour. However, on a closer analysis, these positive aspects turn out to be only marginal. The environmental consequences of the developmental interventions are reviewed below:

(i) emergence and proliferation of new waterweeds causing serious problem to rice cultivation and navigation;

(ii) fall in fertility status of the soil. The fertility level used to be maintained by annual deposition of silt during monsoon floods;

(iii) decrease in organic matter content owing to intensive agricultural practices followed without making additions of organic manure;

(iv) increased incidence of pests and diseases necessitating the use of large quantities of pesticides, polluting the ecosystem;

(v) fall in breeding, growth, and catch of fishes, prawns, and other shellfishes due to prevention of saline water entry and reduction in the expanse of natural fish growing areas;

(vi) extinction of mangroves and other estuarine ecosystems that used to function as favoured nursery areas of brackish water, finfish, and shellfish resources;

(vii) increased scarcity of water due to lowering of water table during summer leading to drought effects on coconut cultivated on garden lands in the area;

(viii) aggravation of flood situation as a result of continuous reduction of water spread area owing to increased land reclamation; and

(ix) indiscipline in the season of rice cultivation and non-judicious use of fertilisers and pesticides resulting in increase of pests diseases and consequent crop loss.

Increasing cost of cultivation due to large increases in prices of inputs like fertiliser, pesticides, and labour unaccompanied by any commensurate increase in output price, is the major factor that contributed to the persistent pressure for replacement of rice by other more remunerative crops. Apart from diminishing returns from rice cultivation, acute shortage of labour also discouraged rice farmers from continuing the traditional occupation, as successful rice cultivation demands crop operations at the right season and time. This has tempted some of the farmers to switch over to other enterprises. In many areas, paddy-fields have been systematically converted into coconut plantations, further altering the ecology and aggravating flood problems.

In this context, diversified agriculture covering livestock and poultry farming, aquaculture, horticulture, etc., following new economic climate, is not only essential to ensure nutritional security for the households, but also to develop ability to import commodities by exporting agricultural commodities. Further, rise in farm production is the most efficient way of alleviating poverty, protecting the environment, and bringing about economic transformation in rural areas. The growth in farm productivity will accelerate growth not only in industry but also in the economy as a whole.

Production of livestock, fishery, and poultry together with rice, in combination, has been recognised as a revolutionary concept to increase production in several countries. Rearing of fish in paddy-fields is known to improve the soil conditions leading to increase in the rice yield. Rice-fish rotation is also considered to be effective in suppressing weeds, pests, and diseases. With the popularisation of aquaculture as an integrated activity with rice, several of the *padasekharam*s, presently remaining uncultivated for the past several years in the region could be brought to farming with enhanced profitability.

In the background of aquaculture emerging as one of the most promising industries in the world, with high growth potential, the Research and Development support in India has rendered aquaculture a bankable rural industry recording an average growth rate of 11.4 per cent. Aquaculture, however, needs to take lessons from our experiences in agriculture and its recent crash on the east coast of India[5]. These lessons indicate that application of wrong technology or over-exploitation of natural resources yields only short-term gains. Hence, environment-friendly, integrated fish-farming, suitable to the overall agricultural system is a sound alternative to capital-intensive hi-tech aquaculture. Again, it is essential to develop a threshold grow-out strategy for aquaculture integration, making rotational farming of rice mandatory, whereby the waste generated by aquaculture is assimilated in rice farming and vice-versa. Integration of aquaculture with rice-farming is the safest strategy for sustaining rice production, increasing profit, and maintaining ecological balance of the region.

International status

A wealth of documented evidence has accumulated in favour of the integrated farming approach (bio-diverse farming). Studies demonstrate that integrated farming can compete with industrial agriculture as well as industrial fisheries in terms of producibility and that bio-diverse farming offers the important additional advantages of sustainability and risk reduction. Padmakumar (1997) has reviewed the major studies on integrated farming.

Khoo and Tan (1980) observed that introduction of fish in paddy-fields controlled weeds and reduced feeding costs. Sevileja (1986) demonstrated that rice-fish integrated farming yielded about 40 per cent more income than monoculture of rice. Grass carps in paddy-fields, when polystocked with other species, were found to manure and fertilise pond water and generate natural food to filter feeders and omnivores (Yang et al., 1994). Huang and Ming Xian (1984) studied the tropic levels in winter fallows of rice-fish system in China and postulated a model for computing production in this system.

The energy relationship in rice-fish farming system was extensively studied by Pan (1996). However, Sevilleja (1986) identified the need to verify the technology of rice-fish integration through farmer-managed trials. A significant saving in fertiliser cost was demonstrated in rice production in fields previously utilised for fish production (Sevilleja and Lopez, 1986). While observing the performance of individual fish species in rice-fish system, Li and Pan (1992) observed that fresh water catfish grew much faster under monoculture systems in paddy-fields. Moody (1992), however, observed that under rice-fish systems, *Cyprinus carpio* not only eradicated weeds and algae in the paddy-fields but saved the cost on ploughing and harrowing as well. Yuan (1992) observed that grass carp was most effective in controlling sheath blight in rice by directly eating selerotes of sheath blight and hyphae germinating on sclerotia. Nie et.al. (1992) traced the mutualism of rice and fish farming and concluded that grass carp controlled weeds more thoroughly than hand weeding or use of herbicides. Fagi et.al. (1992) postulated that under optimum stocking intensities in paddy-fields, *Cyprinus carpis* enhanced availability of P to rice. Miltner et.al. (1993) found that rice-straw detritus are good feed supplements for prawns. Stahl (1975), however, noted that decomposition of straw and stubble served as detritial supplements to prawns. Guerrerro et.al. (1982) reported that when *Macrobrachium rosenbergii* was cultured together with rice, rice plants provided feeding surfaces essential for this species. In their studies on the beneficial effects of fresh water prawn as a stocking component in rice-fish integrated situation, Sanh et.al. (1982) observed that prawns contributed up to 43 per cent of cash income as compared to 20 per cent from rice. According to Wang (1992), one of the most important farming models suited for paddy-field, is azolla-rice-fish integration. Lightfoot et.al. (1980) observed that integrated rice-fish system offered the possibilities of increasing rice yields by as much as 15 per cent while continuous monocropping of rice led to a decline in soil microbial biomass and fertility. Identifying the importance of fish in Asiana rice-farming system, a network to popularise this practice has been mooted by IRRI and ICLARM (Lightfoot et.al. 1990).

The observations of the Chinese scientists on the apparent advantages of rice-azolla-fish system as reflected in the increased grain yield, fish biomass, soil fertility, decreased incidence of pests, weeds, and diseases have been highlighted by the Food and Agricultural Organisation (FAO, 1988).

***Pokkali*: A pioneering integrated system**

The practice of utilisation of paddy-fields for sequential farming of fish and prawn is an age-old practice in the *pokkali* paddy-fields of Kerala. These are brackish water fields adjoining Vembanad lake. The practice is popularly known as *Chemmeenkettu* or prawn filtration. Here, in one and the same filed, rice and fish/prawn are framed in a cyclical manner, the detritus supplement of straw after the rice crop forming bulk of the food material for prawns. In these fields, rice is cultivated during the low saline phase (June-October) and shrimps reared during summer months (November-March), when salinity builds up and when the field is unsuitable for rice. In this system, the shrimp seeds naturally entering from the coastal seas are trapped and cultivated as a mutually beneficial and ecologically efficient enterprise-farming model (Vannucci, 1996). Several studies conducted in the *pokkali* paddy-fields have shown that the production of prawns and the net profit could be improved by selective stocking of commercial species (Jose et. al., 1987; Mathew and George, 1987).

RARS experiments

The studies conducted by the Kerala Agricultural University at the Regional Agricultural Research Station (RARS), Kumarakom have set the pace for a change in integrated farming in Kuttanad. These studies indicated that in addition to rice production averaging three tons per ha, fish production ranging from 600-1000 kg per ha could be obtained by simultaneous farming of rice and fish. As compared to the practice of simultaneous farming that requires several modifications in the paddy-fields, to protect the fish from the inherent risks of pesticide applications, utilisation of paddy-fields for rotational farming was found more advantageous. This was so because rotation permitted adoption of better management practices for both rice and fish (Padmakumar et al., 1990). In these investigations, wherein fish varieties such as Indian major carps, *Cyprinus*, *Etroplus*, and *Macrobrachium rosenbergi* were polycultured, fish yield up to 1005 kg per ha without incurring any additional expenditure on feeding or manuring was achieved. From these observations it could be inferred that rotational farming of rice and fish is a viable proposition for Kuttanad. Certain species of fishes, viz., Cyprinus and Grass Carps were shown to be suitable candidates for culture in this situation. Giant fresh water prawn, *M. rosenbergii* was demonstrated to be an economically important species suited to Kuttanad paddy-fields and they were found to attain 180-200 gm in 6-7 months in the paddy-field environment (Padmakumar et al., 1988).

In the studies on the economic viability of poultry-rice-fish integration in the lowland paddy-fields in Tamil Nadu, Rangaswamy et. al., (1992) reported an increase in profit margin by 60 per cent, as compared to the conventional farming practice. Ghosh (1990) reviewed the different works on farming of fish in paddy-fields in India and observed that monocrop paddy-fields under high monsoon precipitation and deep-water paddy-fields are ideal zones for such integration. Mukhopadhyaya, et al. (1992) studied the relative advantages of rice-fish integration in the deep ware paddy-fields of West Bengal and reported fish yields ranging from 263-1215 kg per ha. Shanmukhasundaram and Balaswami (1992) compared rice-fish and rice-fish-azolla systems in Bhavanisagar, Tamil Nadu and found that the latter system was more advantageous. Tiwari (1993) observed that a farming system involving flooded rice, poultry, and fish had a high degree of complementarity.

The complementary beneficial integration was more pronounced in farms where rice-fish-livestock and piggery are integrated. This integrated intensive and eco-friendly alternative that increases production and profitability can check degradation of the resource base effectively. Such a regenerative farming strategy that blends different farming practices through biological diversification and nutrient recycling is most relevant to the wetlands of Kerala where escalation in cost of production and environmental degradation have become a matter of major concern. Based on the research done by the Kerala Agricultural University and Central Inland Fisheries Research Institute, some farmers in Kuttanad are practising a new method of agriculture by integrating rice cultivation with fish, cattle, and pig farming. Studies made in Kuttanad and other similar settings have brought out the ecological and economic viability of this innovative system of farming (Padmakumar, 1990; Dutta et al, 1979; Dutta et al, 1986; Ghosh, 1980).

Kumarakom model: Evolution and modification

This innovative farming technology was taken up by an enterprising farmer (Mr Joy Ittoop who owns 20 acres of the 25 acre *Pazhaya Kayal Padasekaharam*). His farm (Lijo Farm) is an individual block separated by an earthen bund form the remaining five acres. Integrated farming started in 1993, with the support of Fish Farmers Development Agency (FFDA) in Kottayam and technical advice from the RARS, is still continuing with enthusiasm and constant modifications as a result of learning by doing. As mentioned earlier, a major thrust of the project is an in-depth study of the integrated farming in Lijo farm, Kumarakom (model farm) and compares it with other farming systems.

The farming started with the nursery preparation and subsequent deposition of fish seeds (numbering 68,000) arranged by the FFDA, purchased from Government hatcheries at Polachira; information on various combinations of fish seeds and the required quantity according to the growth of fish, was given from RARS. The need to add poultry droppings to enhance the plankton growth at required level was also advised. The new demand feeding technique through a suspended open gunny bag on the farm was also adopted on the advice of RARS. Both FFDA and RARS inspired and helped the farmer a lot to make the experiment a success. Safeguarding the nursery was a difficult job. The following measures were adopted for the purpose.

(i) Spreading net on the top of nursery to keep off birds;
(ii) Fixing electric bulbs at selected spots to attract flies and;
(iii) Net-fencing to safeguard the nursery from the attack of snakes and predators.
(iv) Employing a full-time labourer for feeding and guarding the nursery; and
(v) Operating a pump-set for pumping in water for oxygenation.

Preparation of nursery

The procedure for preparation of the nursery pond was as follows:

After dewatering the nursery pond, copper, sulphate, and lime (1 kg each mixed) was applied to kill the weed fishes.Quicklime (@100 kg) was applied to the field for washing (three times) to reduce the acidity of the soil.

After the last washing of leachates from the nursery, cow dung (@500 kg) was applied. Then water was let in through a netted sluice. Cow dung was applied a second time to nourish the water to enhance plankton growth. The pH of field water was tested periodically to ensure that it is maintained between 7.5-6.5. After ensuring that the plankton growth and pH level in water is satisfactory, the fish seeds were introduced into the nursery.

Stocking rate

The normal stocking density of fish seeds is 4000 to 6000 numbers per ha. It is also possible to stock fresh water prawns additionally at the rate of 10,000 members per ha. In such cases bottom feeding fish species are avoided. However, as the seeds were supplied through the FFDA availability of seeds influenced the stocking density. The desired stocking density could not be maintained always.

The general species mix and stocking models adopted comprised surface feeders, (25 per cent) column feeders, (30 per cent), and bottom feeders, (45 per cent).
Catla and Grass Carp are surface feeders.
Rohu is column feeder; and bottom feeders like Mrigal, Common carp, and fresh water prawns feeders were also stocked.

Grass Carp that eats weeds was included to control weeds, depending on the extent of the weed problem in the field.

Water quality monitoring

The quality of environment had a profound influence on aquaculture production. Acidity is a major problem and hence periodic application of lime was necessary. Water quality monitoring was done by the cultivator himself with the help of FFDA and research scientists of RARS. The FFDA guidelines on water quality are reproduced in Table 4.1.

Table 4.1 Water quality tolerance guidelines for fish farming

. **Dissolved Oxygen**	
Effect of dissolved oxygen concentration on pond fish	
Desirable range	5 mg/litre
Fish survive but growth slow	1-4 mg/litre
Lethal if exposure is prolonged	1-0.3 mg/litre
Lethal concentration of Dissolved Oxygen for Selected Fish	
Species	**Lethal level (mg/litre)**
Catla	0.7
Rohu	0.7
Mrigal	0.7
Grass Carp	0.2-0.6
Silver Carp	03.-1.1
Common Carp	0.2-0.8
2. **Salinity**	
Highest concentration of salinity which permits normal survival of some cultured fish salinity (mg/litre)	
Species	***Salinity*** (mg/litre)
Catla	Slight brackish
Rohu	Slight brackish
Grass Carp	12,000
Common Carp	9,000
Silver Carp	800
3. **pH**	
Effect of pH on fish pond	
Desirable range for fish	6.5–9
Alkaline death point	9.5-11
Slow growth	5.0-6.0
Acid death point	4.0-5.0

Source: FFDA, Kottayam.

Feeding in the nursery

Rice bran and groundnut cake powder (500 gm) were mixed in water and given in trays immersed in the water at four different places in the nursery every morning and evening. The feed trays were immersed with the help of a stone weight and taken up with the help of coir rope tied to it. The seedlings remain in the nursery pond for four months. After the rice harvest, the nursery pond was opened to the paddy-field (*padasekharam*). By this time, the fish acquired an average weight of 50 gm.

Feeding in the *padasekharam*

Fish is allowed to grow in the paddy-field immediately after the rice harvest by flooding the field. After flodding no feed was applied to *padasekharam* during the first month. After that rice bran, cassava, cooked meat waste, groundnut cake, etc., were fed to the fish. Feed was suspended in perforated gunny bag, a device suggested by the RARS. Aquatic weeds were utilised to feed Grass Carp, which was always an integral stocking component. This species (Grass Carp) consumed vegetation up to 60 per cent of its body weight.

Integration of pigs, livestock, ducks, and poultry

During the first year, the farmer integrated livestock and pigs, next year ducks were added too, and during the third year poultry was integrated. Livestock and duck rearing were discontinued on economic reasons, as the maintenance cost was high. But piggery and poultry proved to be profitable. Pig dung and poultry droppings enriched the fields. Cultivation of garden crops in the bunds has enhanced the productivity from unit land. Pigs were reared in the outer bunds of fields in such a way that the waste and washings are drained into the field for the fish to feed on. In this way, the fish could utilise the feed spilt by pigs and also feed on the fresh pig dung that contains 70 per cent of digestible food for the fish.

Harvesting and marketing

Fish became available for marketing from the sixth month onwards. The fish crop was totally harvested and marketed in one month's time so that the rice crop could be raised on time. Harvesting was carried out by dragnetting or gill netting and finally by total draining of the field. Fish was marketed the same day in fish markets at Ettumanoor, Kottayam, and Moovattupuzha.

In this model, during the first year, livestock, the second year, pigs, the third year ducks and the fourth year, poultry, were integrated.

Profitability

A detailed income and expenditure statements of the model integrated farm at *Pazhaya Kayal* for two years,is given shown in Table 4.2

Table 4.2 Income and Expenditure accounts of the Model Integrated farm *Pazhaya Kayal* Lijo Farms at Kumarakom for 1996-97 and 1997-98 (Area 20 Acres/ 8.1 ha)

FISH CULTURE	**1996-97**	**1997-98**
1 Total cost of fish cultivation	1,64,858	1,50,952
2 Income from fish sales (8210Kg & 9280kg)	2,21,582	2,39,040
Gross Profit (A) (2– 1)	**56,724**	**88,088**
II. PADDY CULTIVATION		
1. Total Cost of Paddy cultivation (7.2 ha.)	58,125	73,520
2. Income from paddy (18.9 tons)	95,685	-
3. Income from paddy (23.18 tones)		1,17,375
Gross Profit (B) (2 – 1)	**37,560**	**43,855**
III. PIG REARING		
1. Cost of pig at the beginning of the year (Opening Stock)	13,100	30,000
2. Cost of feed- (for collection of hotel waste) (365 days x Rs. 50)	18,250	18,250
3. Total Cost	31,350	48,250
4. Sale Proceeds of pigs	33,000	39,600
5. Stock of pigs at the end of the year		
(Closing Stock)	30,000	23,100
6. Total Income	63,000	62,700
Gross Profit (C) (6-3)	**31,650**	**14,450**
Note: Owing to shortage of hotel wastes a number of pigs were sold at their early stages in the second year.		
IV. CATTLE REARING		
1. Cost of cows at the beginning of the year (Opening Stock)	8,000	
2. Cost of feed	15,925	
3. Total cost	23,925	
4. Income from milk	1,080	
5. Income from sale of cattle & calves	23,000	
6. Total Income	24,080	
Gross Profit (D) (6-3)	**165**	
Note: Owing to low income, all the cattle were sold out in the first year and instead poultry was started.		

V. POULTRY		
1. Cost of 6,000 chicks @ Rs. 14/-		84,000
2. Cost of feed		2,06,430
3. Transportation of feeds		6,000
4. Cost medicines and glucose		6,870
5. Total Cost		3,24,900
6. Total income		3,46,500
Gross Profit (E) (6-5)		**21,600**
VI. CULTIVATION ON THE BUND		
Gross Profit (F) from pineapple 300 kg. x 4.50		1,350
Gross Profit (G) from sales 967 Kg x 4		3,868
Note: The cost of cultivation on bund is included in the common expenses (under item VIII).		
VII. Total Gross Profit (A + B + C + D + E + F + G)	**1,26,099**	**1,73,208**
VIII. Common Expenses		
Wages of permanent labour @ 1850x2	22,200	22,200
Electricity charges for lighting & plumping	780	800
Interest on working capital	12,000	12,000
Depreciation of sheds & farm equipment's	8,700	8,700
Total Common expenses	43,680	43,700
IX. Net income from integrated farming (8.1 ha) (VII – VIII)	**82,419**	**1,29,508**

Source: Narayanan (1998)

Note: The net income will be enhanced by Rs 4300 for every ha. if Rs 4000 (assistance received from FFDA) and Rs 300 (assistance received from *Krishi Bhavan*) are also accounted. The cost of family labour is not included.

Cost reduction in integrated system

A comparison of costs of paddy cultivation of different holdings in Kumarakom Village is shown in Table 4.2A

Table 4.2A Costs reduced for rice due to integrated farming

Code	Fertiliser	Land preparation	Plant preparation	Weeding	Total costs
33 Joy Itoop	532	680	35	0	1247
32 Joy Itoop	811	936	7	0	1754
8 Thankappan	1662	6	300	0	1968
45 Vijayan	1073	1197	114	750	3134

7 Thankappan	1066	2216	115	0	3397
34 N.I.Abraham	1311	1436	283	371	3401
46 Vijayan	1013	1113	836	550	3512
37 Samuel	1558	1710	0	950	4218
53 Shaji	1356	2122	247	1500	5225
16 NC Gopalan	1490	1597	1417	1235	5739
29 PS Shibu	1195	1945	637	2150	5927
47 TV Kurian	1785	1945	1880	450	6060
35 Varghese	2546	2671	74	1140	6431
5 Thomas	2504	2654	610	1000	6768
22 Prasannan	2743	2893	728	427	6791
13 Pithambaran	1432	3025	199	2150	6806
28 Sabu	2076	2201	292	2300	6869
24 Sreedharan	2924	3074	372	505	6875
15 NC Gopalan	1491	2836	717	1853	6897
14 Pethambaran	1978	1978	1100	2000	7056
23 Prasannan	2403	3418	601	792	7214
3 Surendran	1920	3008	70	2223	7221
51 Ravindran	1978	2122	940	2223	7282
25 Sreedharan	2403	3927	361	500	7595
9 Alex Chacko	1920	2701	884	2100	7645
52 Ravindran	1997	2987	940	1729	7653
36 K. John	2347	3015	1003	1383	7748
6 Thomas	2601	3664	239	1250	7754
26 Lalitha	3043	3193	192	1550	7978
42 Mathew	2270	2418	1638	2350	8676
1 A.P. Gopi	3047	3763	601	1500	8911
17 Joy Mathew	3305	4206	832	827	9170
18 Kochumon	3140	4066	70	2200	9476
48 Vasappan	3178	3326	665	2470	9639
27 Lalitha	3031	4250	240	2425	9946
19 Kaimal	3229	4305	1192	1850	10576
50 NK Natesan	2649	3847	869	3211	10576
2 A.P. Gopi	3047	3232	1109	3200	10588
12 Pappachan	2860	3734	1617	2470	10681
44 K. Menon	3155	3243	1192	3459	11049
43 PI. Iype	3567	3691	1275	3700	12233
10 Alex Chacko	2871	2871	1161	7473	14376

Source: Narayanan, 1998.

It was also noted that there is substantial reduction in the cost of rice cultivation too for the farmer (Joy Ittoop) since he reduces exogenous inputs consciously to maintain the ecological quality of the paddy-field to facilitate the fish farming. The dominant cost component of weeding and land preparation is saved by fish farming since fish such as Grass Carp ate up the weeds. Table 4.2A gives the components of costs saved by the Kumarakom model (codes 32 and 33). For all the other samples costs are very high. Farmers under codes 8 - 37 are small holders employing family labour and all the remaining farmers are moderate holders who employ wage labourers for all farming activities. If substantial reduction in costs of cultivation is not effected, this section that constitutes the large segment of Kuttanad farmers,has little chance to survive in paddy cultivation. As revealed by Code 32and 33 figures, integrated farming is the best alternative before the Kuttanad farmers for reducing cost of cultivation and attaining to sustainability.

Comparison with rice-fish systems

The Kumarakom Model is practised only by an individual farmer. But in Kuttanad, normally rice cultivation is done in large tracts of *padasekharams;* fish cultivation integrated with rice is slowly gaining ground here. But integration with poultry and cattle is difficult here because of the management problems of collective farming. But the integration of rice and fish is spreading, mostly in the Kottayam district of Kuttanad.

In this sub-section, a detailed comparative study of detailed cost of cultivation and returns from fish farming is attempted. Data on costs and returns collected from four samples are given in Table 4.3. Code 1 (Ittoop), as explained above, is an individual farmer doing integrated farming in an area of 8.1 hectares. Code 2 (Kuruvila) is also an individual farmer cultivating in 3.87 hectares. But he integrates only rice and livestock. The remaining two samples (code 3 and 4) are paddy-fields covering areas of 21.86 ha and 46.74 ha with 34 and 59 farmers respectively. Codes 3 and 4 are different in character in the sense that one family which had originally owned this paddy-field even now owns half the area under code 3. This family has other sources of income which they can invest as capital for fish farming; and it exerts control over decisions of this *padasekharam*. Code 4 is owned by a large number of small farmers and decision-making here is more democratic. Their initial capital was mobilised from one big holder who owns a big tourist resort in the vicinity. Their feed cost is substantially reduced due to the free supply of food waste from this resort.

Nursery stage

The cost of fish seeds is given in column 5. FFDA channelises assistance from the government to the fish farmers. One of the main components of the subsidy is free distribution of fish seeds. The cost of fish seeds (which is also accounted in column 22 as a subsidy) supplied by FFDA and the cost of seeds purchased by farmers is accounted here. Code 1 used only the fish seeds supplied by FFDA. Farmers under codes 2 and 3 purchased seeds from other sources too. The cost of seeds is the lowest for Code 4 since they had to bear their entire cost. The cost of materials for nursery preparation such as lime, ammonia and cow dung, are given in Col. 6. The next column gives the cost of labour for the preparation for nursery. Column 8 shows the feed cost in the nursery; it gives a low figure for Code 4, the reason being that

Table 4.3 Economics of Fish Farming (per hectare)

Code	Name	Area(ha)	No. of farmers	Seed	NP Mat	NP Lab	NF Mat	NF Lab	PS Mat	PS Lab	PF Mat	PF Lab	Har Mat
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	Ittoop	8.1	1	3120	113	420	1210	2716	75	37	2981	177	370
2	Kuruvila	3.87	1	4082	103	512	3967	1163	258	114	1780	0	387
3	Antony	21.86	34	3850	521	66	939	293	110	201	1030	187	493
4	Mali	45.74	59	1473	121	299	71	-	52	355	20	79	0

Mar Mat	Mar Lab	Mar Transp	Organisa-tional	Commission	Total cost	Subsidy	Sale income	Total income	Profit / ha	Fish qty (kg)
15	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
760	0	1124	0	2100	18638	3120	33125	36245	17607	1145
0	0	0	0	0	15490	1912	39050	40962	25472	1562
720	329	1401	182	1900	15682	1940	21527	23467	7785	979
365	192	175	305	175	4597	0	6259	6259	1662	271

NP: Nursery preparation, NF: Nursery Feeding, PS: *Padasekharam*, PF: *Padasekharam* feeding, Mat: Material, Lab: Labour, Har: Harvesting, Mar: Marketing, Transp: Transportation, Tot: Total the fish remained in the nursery only for a short duration since fingerlings of bigger size were put. But the number was very small since they could not avail the free seeds from FFDA. The labour cost for feeding in the nursery is given in the next column followed by the material cost of preparing the *padasekharam* after rice harvest.

Grow out stage in *padasekharam*

The material cost of preparation of the *padasekharam* is given in Column 10 followed by column 11which shows the cost of labour for feeding the fish during the 'grow out' stage in the *padasekharam*. The next column(col.12)gives the cost of feed during this period, followed by the labour cost of the same (in column 13). Code 2 has saved this entire cost by family labour since this activity could be done once in two or three days. Code 1 also has substantial saving since his permanent worker attended to this activity along with his routine duties of farm management. Code 3 had to depend on wage labour for this and hence the high figure. But Code 4 comprises mostly wage labourers who themselves perforemd this work as their duty in turns.

Harvesting

The next two columns give the harvest cost. Column 14 is the cost of materials for harvest such as nets, canoes, etc. Availability of thse materials reduces the cost of harvest labour. That is why the first three codes invested on this item. Code 4 being represented by fishermen also, used their own gears to save this cost. The cost of harvest per kg (refer column 26 also) is highest for Code 4. However, this has turned out to be the cost incurred by those farmers who are also fishermen and engaged themselves in harvesting.

Marketing

The marketing costs are given next. Column 16 is the cost of marketing materials such as ice, crates, boxes, etc., followed by the labour cost for marketing. For Code 1, this is completely served by family labour. For the other (Codes 3 and 4) this brought in employment for two to three persons every day who had to accompany the load to far away markets. The next is the transportation cost for marketing and then the commission given to middlemen in the fish market, which normally works out to be 10 per cent of the sales. This is an unavoidable cost for sales in public market.

The cost incurred by the committee responsible for fish farming is given in Column 19. This includes the meeting, communication, and travel expenses of members. This seems to be high in the case of Code 4. Column 21 gives the sum of all costs mentioned above. It is found that in bigger *padasekharams*, cost becomes less due to economies of sale.

The next column gives the receipts starting with subsidy, that is financial assistance, received from the Government through FFDA. Code 4 has not availed any subsidy because of their late registration. The sale income, total income, and productivity are the highest for Code 2. The high productivity is partly because of the higher investment on seed and feed. The largest share of his saving came from his marketing arrangement. A fish merchant was given contract for marketing and the entire fish harvest was taken on the spot without the producer incurring any cost related to marketing. This is evident from the high marketing expenses to other farmers. The amount of family labour (especially for fish-feeding) and personal time spent on the farm are very high in his case. Profit per hectare is the highest for him. But the profit that Code 4 could manage is also worthwhile considering the fact that they pursued integrated farming without any financial or technical support from the State. Employment generation and accrual of profit more than compensated the loss of a second crop of rice. Code 4 is the model, which confirms mostly to the realities of Kuttanad where farmers with smallholdings have to come together for collective fish farming.

The magnitude of the process that has already been initiated in the area is brought out in Table 4.4. The integrated farming model tested in a farmer's field of 20 acres in 1993-'94 is now extended to 30 *padasekharams* spreading over 4,900 acres in Kottayam district alone.

Table 4.4 List of integrated farms in Kottayam district from 1993 to 1998

year	**Name of farmers**	**Panchayat**	**Area** (Acre)
1993-'94	Joy Ittoop	Kumarakom	20
1994-'95	Raj Mohan*	Kumarakom	09
	P. K. Chacko	Nattakom	10
	V. J. Varkey	Kallara	12
Cumulative Total			**51**
1995-'96	John Mathew	Kallara	10
	T. A. Babu	Kumarakom	10
	T. K. Kurien	Kumarakom	12
	Varkey Geroge	Aymanam	25
	P. J. James	Udayanapuram	15
Cumulative Total			**123**
1996-'97	Thoopram *Padasekharam*	Vazhapally	266
	Kurian	Aymanam	07
	Pattithanam *Padasekharam*	Vazhappally	76
	Kuruvila V. V	Kumarakom	10
	Thuruthikattukandom*	Aymanam	10
	Lukose Thodukayil	Neendoor	19
	Anthonikayal *Paadom*	Kumarakom	54
Cumulative Total			**565**
1997-'98	Thundiyilkadavu *Paadom*	Vazhappally	22
	Chirakkadavu	Vazhappally	40
	Kalathodu*	Kallara	89
	Pallom *Thollayirom*	Nattakom	320
	Kavalackal Block	Aymanam	100
	Vaniyamkary	Kurichi	48

	Kurichi-Karivattom	Kurichi	315
	Ayyanadan Puthenkary	Vechoor	232
	Shaji Joseph	Kallara	30
	Thattamparampu S. Block	Kallara	105
	Kalapurackal	Thalayazhom	50
	P. J. Sebastian	Thalayazhom	28
	Vanam Vadakke Block	Thalayazhom	287
	CKN Block	Thalayazhom	135
	Sebastian John	Kumarakom	28
	Cumulative Total		**2394**
1998-'99	Kolam-Kary	Vechoor	163
	Kattamada	Vechoor	71
	Pothenmyali	Kallara	61
	Madathilpara	Kallara	37
	Venthagiri	Kallara	113
	Manchadikary	Arpookara	201
	K. Vattakayal	Arpookara	320
	V. Viripukara	Neendoor	250
	Malikayal	Aymanam	113
	V. Thatepada	Aymanam	204
	Kuthiathodu	Aymanam	50
	Vadakepalli *Padam*	Kumarakom	90
	Seminari kayal	Kumarakom	400
	Kelakary	Thiruvarp	150
	Vanam-S	Thiayazham	285
Cumulative Total			**4902**

* Discontinued after the first year. Source: FFDA, Kottayam

Ecological benefits of integrated systems

The ecological variables were monitored to compare the integrated farming system practised at *Pazhaya Kayal* farm with the conventional rice-farming system. The environmental parameters were observed during the fish-farming season, one month before the fish harvest. The water and sediment characteristics were analysed and the results were compared with the earlier results of reported figures of paddy-field environment of the RARS farm. The physico-chemical characteristics of water were analysed after APHA (1980).

The nutrient concentrates in the open water and conventional paddy-fields in adjoining areas were perceptibly lower than fields under the integrated system. The phosphate concentration was 10 Mg at/litre in the integrated system as compared to 0.4 to 1.4 in the open water system. Similarly Nitrate concentrates were only 1 to 1.3 Mg /litre and nitrites only in traces. High primary productivity characterised by accelerated phytoplankton count was observed in the integrated system. The phytoplankton density was 8.16x10.5 cells. /litre in the integrated

Table 4.5 Environmental variables in the rice-fish integrated system, *Pazhaya Kayal*

pH	7.00
Free Carbon Dioxide (CO_2)	3.8 ppm
Dissolved Oxygen (DO)	9.66 ppm
Turbidity	72 cm
Nitritrite (No2-N)	40 M at/l
Nitrate (No3-N)	20 ,, ,,
Phosphate (Po4-P)	10 ,, ,,
Phytoplankton	8.16×10^5……cells /litre
Zooplankton	$.9 \times 10^5$……….cells/litre

system whereas it was only 0.9x10…5 cells/litre in the open water system. This high-standing crop was facilitated by the organic enrichment brought about by integration whereas it was found to be negligible in the non-integrated system. The critical environmental parameters such as pH, Dissolved Oxygen (DO), Carbon Dioxide (CO2), and turbidity were found to be at levels favourable for sustaining high biomass productivity. This naturally contributed to higher fish yields too. Despite high organic enrichment which can normally lead to environmental deterioration and high biochemical oxygen demand (BOD), the high DO levels (9.66 ppm) observed in the system indicated that organic additions were utilised continuously for biological production. The high DO level is presumably due to photosynthetic production of phytoplankton.

The soil organic carbon was analysed after Buchanan (1971). The sediment organic carbon content was observed to be 3 per cent in the integrated system as compared to 2.1 to 2.6 percent for the non-integrated paddy-fields in the adjoining areas.

Table 4.6 Manure conversion equivalence in the rice-fish-piggery-poultry integrated system – *Pazhaya kayal*

Source of Manure	No. of Units	Period of Rearing	Manure Input Dung/ Dropping Dry Wt. (kg)	Organic Matter (kg)	Nutrient Equivalence (kg)		
					N	P	K
Piggery	23 No.	12 months	Solid 23000	4140	143	131	96.6
			Liquid 27600		110	30	124.2
Poultry	6000No.	6 months	15000	3825	244.5	231	127.5
Straw	7.2 ha		25100	-	301.2	50.2	125.5

Note: The Manure conversion equivalents except straw are worked out from the standard levels as per table 6 and that of straw is the analysed values of RARS study, 1998.

Manure conversion equivalence of the enterprises in the integrated system in *Pazhaya Kayal* is given in the Table 4.6. The NPK equivalence gives extent of nutrient enrichment. The

Manure Conversion Factor (MCF) that indicates the manure use efficiency for pig dung is reported to be 2.17 to 5.77 which means that 2 to 6 kg of pig dung can produce 1 kg of fish. MCF of chicken manure is 2.28 to 5.48. In addition, the positive effects of enhanced soil fertility by contribution from detritus including bacterial load is considered phenomenal. According to Yang (1994), the bacterial load for a pig-manured pond is 4.15×10^6 individuals/ml and that of chicken manured pond is 11.05×10^6 individuals/ml. On the contrary, in the rice-fish system, only the integration of straw is facilitated and hence the organic enrichment is comparatively reduced than in the multi-tier integrated system involving crop, livestock, and fish. The absolute avoidance of pesticides in the integrated system makes this ecologically superior to the conventional rice-farming system. More than the mineralised plant nutrients, the contributions of the detritus and bacteria are the most important nutrient source that brings about high and spontaneous secondary fish production in the integrated system.

Table 4.7 Composition of animal manure commonly used in integrated farming systems

Composition	Dung	Urine	Mixture
Pig manure			
Moisture	85	97	72.5
Organic Matter	15	2.5	25
N	0.50-0.60	0.30-0.50	0.45
P (P_2O_5)	0.45-0.60	0.07-0.15	0.19
K (K_2O)	0.33-0.50	0.20-0.70	0.60
Cow manure			
Moisture	80.85	92.95	77.5
Organic Matter	16.4	2.3	20.3
N	0.30-0.45	0.63-1.20	0.34
P (P_2O_5)	0.15-0.25		0.16
K (K_2O)	0.05-0.15	1.30-1.40	0.40
Poultry manure			
	Chicken	**Duck**	**Goose**
Moisture	50.5	56.6	77.1
Organic Matter	25.5	26.2	23.4
N	1.63	1.10	0.55
P (P_2O_5)	1.54	1.40	0.50
K (K_2O)	0.85	0.63	0.95

Source: NACA Technical Manual 7, 1989*. * NACA Technical Manual 7, 1989, NACA, Bangkok, Thailand, pp.277.

The study points to the ecological benefits of the integrated farming systems in the Kuttanad paddy-fields. The environmental monitoring studies carried out revealed that by integration of fish, livestock, and poultry in the rice farming system, there is a perceptible improvement of the paddy-field soils. This was evident from the high organic carbon content in the sediments. Further, the plant nutrient level (NPK) in the integrated system was also high, in addition to the high nutrient levels in the overlying water. More than the inorganic enrichment, the contribution of the organic detritus in the food chain was evident from the high photosynthetic productivity observed in the integrated system. The problems of replication of this environmentally suitable and economically viable farming system in large tracts of paddy-fields of Kuttanad are summarised as follows:

Constraints

As fish culture in paddy blocks can only be taken up collectively,several problems arise.

(i) Organisational: There are problems involved in collective action in *padasekharam*s because of the multi-fragmented nature of farmers and their resource constraints.

(ii) Financial: The existing credit policy of lending institutions does not allow group loans. Fish farming, being a collective endeavour, suffers lack of capital especially capital needed for initial investments for nursery preparation, strengthening of bunds, purchase of seeds, etc. The financial assistance from FFDA is given only after the expenditure is committed. There exists no legal provision to issue financial assistance to *padasekharam* committee, the body responsible for organising collective fish farming in *padasekharam*.

(iii) Labour: There is non-co-operation from agricultural workers in some parts of Kuttanad, owing to their apprehensions of labour loss.

(iv) Non-availability of seeds: There are limitations in supply of fish seeds. The capacity utilisation and services of hatcheries in the public are far from satisfactory. The hatcheries in Kerala import seeds from neighbouring states to meet the growing requirements of fish seeds. But there is a widespread complaint of their poor quality and low survival rate.

(v) Predation of fish by wild otters and migratory birds reduces the stock in the farms. The existing wild life rules pose limitations for controlling this menace.

(vi) Marketing: There is absence of adequate deep-freezing and storing facility and even timely availability of ice in rural Kuttanad factors which hamper the activity of marketing of this highly perishable commodity. Consumer taste, which has prefernce for traditional varieties of fish, is also a serious constraint to marketing.

(vii) Inadequate extension services pose another serious problem.

1

5. Scope and Policy Decisions

The legal support

When any interested farmer comes forward to initiate fish farming integrated with rice cultivation, no agency exists to help him with technical advice. The *Puncha* Special Officer has to be made responsible to convene a meeting of the *padasekharam* for discussing the possibility of fish cultivation if any farmer demands so. In Kuttanad, a system of group farming or co-operative farming has evolved. Every *padasekharam* in Kuttanad has a committee and all cultivators are members of the General Body, from which an Executive Committee and a convenor are elected. The Executive Committee and the convenor perform the following duties.

(i) Auction dewatering with the help of *Punja* Special Officer and appoint a contractor.
(ii) Liaise with the Agricultural Department.
(ii) Arbitrate conflicts among member cultivators on land and water issues.

(i) Efficient management by *Padasekharam* Committee depends on the dynamism, resources, and capabilities of the convenor and the Executive Committee as well as the enthusiasm of the cultivators. An efficient *Padasekharam* Committee and convenor will be able to organise fish cultivation collectively. The law governing the collective work of *Padasekharam* Committee and the functioning of *Punja* Special Officer are provided in the Kerala Irrigation Works (Execution by Joint Labour) Act 1967. Amendments to the above Act to suit integrated farming are called for.
(ii) The *panchayat*-level integration of different departments viz Agriculture, Animal husbandry, and Fisheries, is suggested. The *Krishi Bhavan*, *Matsya Bhavan*, and the *Panchayat* Veterinary Hospital have to come under a single roof under the control of the *grama panchayat* for facilitating integrated farming by pooling of resources – both financial and technical. An efficient system to monitor the problems of this evolving technology is to be introduced by giving training to the farmers and constant interaction with the above-mentioned technical personnel and Kerala Agricultural University.

(iii) The macro-level policies also have to be re-oriented so that the above-mentioned departments may come out with recommendations to facilitate integrated farming, particularly in wetland tracts like Kuttanad. The possibilities have to be explored in the light of the People's Planning Programme.

Insurance coverage

The United India Insurance Company offers insurance for fish-farming after rice crop. The risk coverage includes damages on account of disease, natural calamity, flood, unexpected pollution, and deliberate poisoning by enemies. The insurance period is for a maximum period of 10 months or for the period from the stocking day to the harvest day, whichever is shorter. If the cultivator does not make the claim, the company will pay 'no claim bonus'. The total premium to be paid is Rs 640 per ha (which is 4 per cent of the total cost of cultivation per ha i.e., Rs 16,000). FFDA gives 50 per cent of the premium. The *grama panchayats* are allowed to sanction 25 per cent and the beneficiary needs to pay only 25 per cent of the premium amount. There should be provision to assess the extent of damage scientifically so that damage up to even 25 per cent has to be compensated instead of the existing limit of 70 per cent.

Financial assistance for FFDA and *panchayats*

FFDA in the district gives financial assistance for construction of nursery at the rate of Rs 8000 per ha apart from the subsidy for seeds and feed amounting to Rs 4000 per ha. The panchayats also have provision to give financial assistance for rice and fish rotational farming[6] . Any assistance targeted for fish farming should be given in advance since the capital cost for initiating this system is huge and the small holders of Kuttanad cannot afford such cost.

The Kerala Agricultural University may be mobilised to document the experience of the integrated cultivators, monitor them closely and especially examine the possibility of replication of the successful cases.

Infrastructural development such as ice factories, deep freezing units, marketing networks, insulated vehicles for transportation, farm roads, and Research and Development facilities, may be ensured.

Appendix I **List of *padasekharams* in which fish farming started in 1998**

Name of *Padasekharam*	Panchayat	Area	No.of Farmers
1. Kolamburattukary	Vechoor	163A	51
2. Pothenmyali-Vattamattam	Kallara	61 A	60
3. Madathiparamban Block	Kallara	37 A	19
4. Manchadikkary Mission	Arpookara	201A	120
5. Valiyakuzhy Virippukara	Neendoor	250A	121
6. Kelakkary Vatta*Kayal*	Arpookara	320A	160
7. Kattamada Pandara Parambu	Vechoor	71 A	48
8. Mali *Kayal*	Aymanam	113A	61
9. Vatta *Kayal*-Thattepadam	Aymanam	204A	78
10. Venthakary Vadakku	Kallara	113A	86
11. Vanam South	Thalavazhom	285A	215
12. Kuthiyathodu Mekkary	Aymanam	50 A	30
13. Seminary *Kayal*	Kumarakom	400A	142
14. Vadakke Pally Padam	Kumarakom	90 A	70
15. Kelakkary-Madappally Kadu	Thiruvarpu	150A	60
		2508 A	
	Total	1015.38 Ha	

Source: FFDA, Kottayam.

Appendix II

Name of *Padasekharam*	*Panchayat*	Area	No.of Farmers	Year
1. Thundiyilkadavu	Vazhapally	22 A	11	1997
2. Chirakadavu Karichira	Kurichy	40 A	22	1997
3. Pallam Thollayiram	Nattakam	320 A	163	1997
4. Kavalakkal Block	Aymanam	100A	49	
5. Anthony *Kayal*	Arpookara	54 A	34	1995
6. Ancheril Fish Farm Varkey George Gandhinagar P.O.	Aymanam	50 A	1	1994
7. Kurichy Karivattam	Kurichy	315 A	163	1997
8. Shaji Joseph, Chittakkatu House, Kallara	Kallara	30 A	1	
9. Thattaparambu, Thekke Block	Kallara	150 A	22	
10. Kalapurakkal Kari	Thalayazhom	50 A	40	
11. P.J.Sebastian, Palathungal Thalayazhom	Kallara	28 A	1	
12. Vanam Vadakke Block	Thalayazhom	287 A	45	
13. C.K.N. Block	Thalayazhom	135 A	51	
14. Sebastian John, Mannoo Parambil, Parippu	Kumarakom	28 A	1	
Total	1564 A 633 Ha			

End Notes

[1] The lime shell resources are sub-fossil deposits of shellfish found extensively in *Vembanad* Lake.

[2] The quality and colour of fibre are reported to be inferior compared to that processed in earlier days.

[3] *Karappadam* lands are areas of alluvial soils generally situated along the waterways and constitute the lower reaches of the eastern and southern periphery. They cover 33,000 ha. *Kayal* lands are the recently reclaimed beds of the *Vembanad* Lake. Their elevation ranges from 1.5 to 2.5 m below MSL and they cover 13,000 ha. *Kari* lands are areas of black peaty acidic soils lying at or below MSL to the north, east and south-west of the Kuttanad. They cover 9,000 ha.

[4] The Government of Japan buys rice from the farmers at about 10 times the international market price. It also subsidises part of the cost to consumers. Still Japanese consumers pay four times as much as they would if they could buy rice in a California Supermarket. These activities cost the government about 25,000 million dollars in 1992. The expected result of such activiteis is that land will stay in rice production that might otherwise be available for housing. Five per cent of the city of Tokyo is classified as farmland worked by 13,000 families. (Oeter T. White-Rice the essential Harvest - National Geographic-May 94).

[5] Shiva (1997) criticises the experience of high-tech industrial fisheries in India "to be a breeding ground for ecological and political corruption" and estimates that "behind every dollar of earnings from it, there is $200 worth of damage to the local ecology and economy (if the ecological footprints of the industrially produced shrimp are taken into account)." The Supreme Court of India banned the high-tech shrimp farms in all the coastal states by an order on December 11, 1996.

[6] An advance by way of financial assistance form Pallom Block *Panchayat*, Kottayam for the preliminary expenses of fish farming enabled the Seminary *kayal padasekharam* having 402 acres to start fish farming in 1998.

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