Manufacture of thermocool boxes for fish transportation.

ening resource management systems providing return, creating employment opportunities of the fishers living in the bed and belt villages leading to self sustainable aquaculture.

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Effective marketing strategies for economic viability of prawn farming in Kuttanad, India

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Kuttanad is a low-lying deltaic wetland ecosystem in South India formed from four river systems, with an area of some 1,160 km^2 and a population of more than one million people. Agriculture and fisheries provide the main source of income to the people of Kuttanad, and an intricate polder system (low-lying tract of land surrounded by dikes) has been constructed over the years for agricultural purposes.

Kuttanad is the home ground of the giant freshwater prawn, *Macrobrachium rosenbergii*, often sold under the trade name 'scampi'. Although paddy cultivation in rice fields is being practiced on a regular basis, the successful integration of scampi in the rice fields had in fact evoked much response among farmers of Kuttanad as a means for improving their economic status. During the past decade, there has been a phenomenal increase in the cost of rice production. Paddy farming has, therefore, become less attractive and due to the diminishing returns, there is a strong tendency among the farmers to abandon rice cultivation and look for alternative uses of their fields. The integration of paddy farming with prawn/fish culture has turned out to be the only viable alternative to effectively utilize the vast expanse of fertile derelict water bodies available in Kuttanad[1].

Freshwater prawn farming is carried out in three types of natural grow-out environments such as 'polders', which are utilized for rice culture mostly only once a year, the 'homestead ponds' and 'coconut garden channels'. The extent of the polders generally varies from 0.5 to 100 ha. Homestead ponds are comparatively smaller and their area ranges from 0.01 to 0.2 ha. The 'coconut garden channels', on the other hand, usually have water area in the range 0.2 to 7 ha. The

Giant freshwater prawn - Macrobrachium rosenbergii.

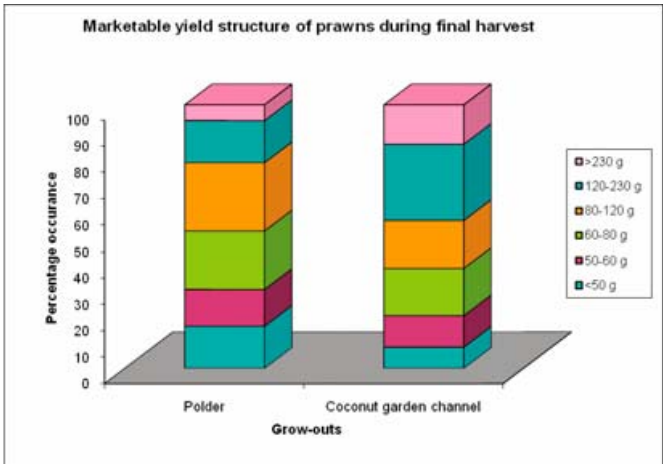
duration of culture varies from 5-6 months in polders to 8-10 months in coconut garden channels. In Kuttanad the majority of prawn farming activities occur in polders (65-75%) followed by coconut garden channels (15-25%) and homestead ponds[2] (10-15%). Unlike penaeid shrimp culture, the economic yield of *M. rosenbergii* in grow-outs is not a linear function of total biomass produced owing to the predominance of non-marketable undersized prawns in the harvested population. The differential growth pattern evinced in this species is one of the major bottlenecks confronting the profitability in the farming of this species[3]. The different size groups of prawns at the final harvest enable the exporters to grade them under different weight classes and prices. Hence larger prawns demand better prices, while the undersized prawns are usually low priced or not marketed.

Bottleneck in marketing

In Kuttanad, at present a bizarre and frail marketing structure persists that is often prone to variation with season and time. Prawns are marketed 'head-on' either under a six grade system (<50 g, 50-60 g, 60-80 g, 80-120 g, 120-230 g and >230 g weight classes) or under a two grade system (<50 g and >50 g weight classes). An attempt was made to analyze the different market grading structures prevalent in Kuttanad and their affect on the economic sustainability of the culture. Hence the final harvest details from two polders and two coconut garden channels that were uniformly stocked were economically analyzed under the two-market structure. The price structure prevalent for six-grade system were as follows: <50g = Rs.80/-, 50-60 g = Rs. 120/-, 60-80 g = Rs. 160/-, 80-120 g = Rs.200/-, 120-230 g = Rs. 260/- and >230 g = Rs. 320/-, while that for the two grade system was <50 g = Rs. 130/- and >50 g = Rs. 240/- (1 US$ = Rs. 42.20).

The final marketable yield structure of prawn from polder and coconut garden channels is given in the figure below. Results of economic analysis revealed that the margin of profit incurred in the polder increased from Rs. 26,258/ha under six-grade to Rs. 33,627/ha under 2-grade system. Contrary to this, in coconut garden channel six-grade system (Rs. 25,421/ha) was found to be nearly twice as profitable than two-grade system (Rs. 12,968/ha).

In the present study it was seen that a two grade marketing system was more profitable for polders, while for better economic returns a six-grade marketing strategy was beneficial for the coconut garden channels. This may primarily be because of the duration of culture in polders, which extends from five to eight months. During harvesting the resultant mean weight of the prawn fall just above the 50 g mark and since the percentage of larger prawns (>230 g) is considerably low it was found more appropriate to market the prawns under two grade system. On the other hand in channels the period of culture extends to 10 months or even year round, which along with low stocking density prevailing in the grow-out enables the prawns to grow to much larger weight groups (>230 g). Hence marketing under a six-grade system was found to generate more income in the channels. Consequently, large-size males, despite their relatively higher head to tail ratio, command a considerably higher price than females. Another management strategy to increase the revenue from polders was the practice of intermediate, partial harvest through cast netting, which is definitely a sound management strategy for two reasons. Firstly, the



Prawns are often grown in coconut garden channels.

females that dominated the population and matured relatively early at a small size (30-40 g) could be selectively removed in the early harvest. Selling of egg bearing berried prawns was also a major source of income to the farmer. Secondly the intermediate harvesting would remove the large males and allowed the smaller undersized males to grow until final harvest. Due to repeated harvesting the population density within the polder was kept at a minimal level, which in turn reduced the quantity of feed required. However, this method was not suitable for coconut garden channels since the only way to harvest prawns in these grow-outs is through complete draining.

A noteworthy observation in the present study was that most of the berried prawns during final harvest weighed from 50 to 55 g. It was also observed that the middlemen involved in the procurement of prawns avoided berried females or removed the egg mass before individually weighing the prawns. Without the egg mass, the weight of these female prawns fell below the 50 g and thereby demanded least price. To avoid this farmers are now compelled to extend their farming duration to even 8 months. Not only would this increase the cost of farming in the form of feed and management cost but also reduces the survival rate of prawns due to cannibalism inherent to this species.

Conclusion

A steady two-grade market structure is inevitable for making the culture of *M. rosenbergii* economically more viable and sustainable in Kuttanad, which also allows the farmers to curtail their farming operations from existing 8 months to 6 months. This in turn reduces the operational costs left aside

for feed and management. Marketing based on two size grades was found to profitable and therefore advantageous for farmers of Kuttanad for polders with culture duration of six months. But for coconut garden channels where the culture duration extends above 10 months, the six-grade structure was profitable.

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Applications of nutritional biotechnology in aquaculture

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Nutritional biotechnology in aquaculture

Globally, consumption of food fishes is projected to reach 165 million tonnes by 2030. As wild catch fisheries are now approaching full exploitation worldwide, a large part of this increase will have to come from aquaculture. The identification of alternative fish species and suitable feed ingredients for their diet formulations has therefore become very important.

The main goal of fish nutrition as a scientific discipline is to produce feeds that support good growth rates while maintaining fish health and quality, resulting in a safe and healthy product for the consumer at least cost. In this regard many scientists are studying the safe utilization of nutrients and their interactions when alternative feed ingredients from plants are used to substitute for traditional (and expensive) fish meal and oil, as well as evaluating alternative marine ingredients. Research focuses on issues such as the characterization of nutrient effects on brooders fish, eggs, larvae, juveniles and at different stages of growth. Measurements include nutrients effect on growth, feed utilization, digestibility, alterations in metabolic pathways, fish health and welfare parameters, nutrient bioavailability and retention. Modern tools within genomics and proteomics are gradually being taken up and focused, giving the opportunity to discover novel pathways and effects of nutrients.

The aquaculture feed sector of India has made tremendous developments during the last two decades. At present about 20 million tones of manufactured aqua feed are being used in aquaculture sector, of which the majority is consumed in shrimp culture (Chandrapal, 2005). If the rapid growth of aquaculture persists, the feed requirement may increase many fold. Hence, more scientific understanding and interventions are required for sustainable aquaculture of the country.

Sustainable commercial carp feed production has became a challenge to the aquaculture nutritionists. It has been estimated that a feed with FCR 1.3 could make a commercial carp feed sustainable. Exploration of novel genes related to growth enhancement and use of different nutraceuticals have raised the hope of achieving that target. Isolating a potential growth hormone gene and subsequent transfer of that gene to enhance the fish production is approaching near to reality. Addition of new immuno-stimulants in aqua feed has increased the possibility of safer production through high-tech aquaculture. Strategies for increasing utilization of cheaper nutrients like carbohydrate by various technological interventions and addition of feed attractants paved the way for developing lower cost feeds sustainable carp culture (Gopakumar, 2003). Currently, quality enhancement of fish flesh by dietary and gene manipulation is a focused area of research in fish nutrition.

Besides feed development, feed management and feed quality are critical factors for profitability of fish farming, especially in intensive aquaculture. A biologically ideal feed may not be economically viable if feed management is poor. A balanced knowledge on fish nutrition and feed management is of paramount importance for sustainable fish production. The following are the priority areas of research in fish nutrition:

- Nutritional requirement of fishes with respect to growth.
- Selection of proper feed ingredients.
- Energy requirements in fish.
- Feed formulation and preparation.
- Feed processing and feeding techniques.
- Carbohydrate utilization as protein sparing effect in fish nutrition.
- Omega-3 fatty acids in nutrition and health.
- Nutraceuticals in fish nutrition.
- Fish nutrition, biochemical and physiological responses in extreme environmental stresses.
- Quality control and storage of feed ingredients.