

carbohydrate and (2) 40, 45, 50% protein, 5% lipid and 20, 25, 30% carbohydrate. Protein and energy ratios ranged from 89-198 mg protein/Kcal while the energy values for all diets were 165-415 Kcal/100 g. The diets were given twice daily at 10% of the body weight.

Results showed that a two- to three-fold increase was observed in the body weight of prawns fed with diet combinations of 40-50% protein, 5-10% lipid and 20% carbohydrate with energy values of 285-370 Kcal/100 g. Reduction in protein content of the diet from 50 to 40% while maintaining the total energy level (285 Kcal/100 g) resulted in a change in growth that was not significant. An increase in energy level, at constant dietary protein level, resulted in improved utilization of protein and feed conversion efficiency.

Effect of Various Levels of Squid Protein on Growth and Some Biochemical Parameters of *Penaeus japonicus* Juveniles

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An unknown growth factor previously suspected in squid meal was found in the protein fraction of squid (*Loligo vulgaris*). It is clearly different from hydro-alcohol-soluble feed attractants that are also present in squid meal. This squid protein fraction (SPF) improves the growth of *Penaeus japonicus* juveniles when added either in a semi-purified or in a more complex mixed diet. This growth-promoting effect does not seem to be related to the amino acid composition of SPF. In order to obtain more information on its action, several levels (1.5 to 16.0%) of SPF were added to a mixed diet. The diets were isoproteic (59% D.M.), isolipidic (8.5% D.M.), supplemented with vitamins, cholesterol, glucosamine, etc. They were fed as wet pellets to 3 replicates of 15 shrimp; blue mussel was used as the control. The growth of shrimp increased with the SPF level and attained a plateau above 6%. Body weight was significantly higher than that of the control group at this level. RNA content and RNA:DNA ratio increased with the SPF level indicating that growth was improved more by hypertrophy than by hyperplasy of the cells.

The hepatosomatic ratio remained unchanged. The assay of two digestive enzymes, proteases and amylases, showed no clear effect of SPF on protease or amylase activities. More experiments are needed to explain the effect of the unknown growth factor of SPF.

Imperatives for the Future Development of Prawn Culture in the Cochin Backwater System (Kerala, India)

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A traditional system of prawn culture practised in the Cochin Backwater System, the largest backwater system in Kerala State, has an estimated yield of 4,000 tons from about 4,500 ha. Governmental investments to encourage prawn production on a scientific basis continue to grow with the dual objective of improving the socio-economic conditions of fisherfolks and augmenting prawn exports. A geographic study of land and water uses and an assessment of environmental impact of these uses point to basic incompatibilities of city expansion and semi-intensive prawn culture. Population growth, urban expansion and industrial development projections for Cochin City and its surrounding areas support the view that water quality will deteriorate further making culture of prawns for export a difficult proposition. Functioning horizontal-communications between city and fisheries planning units are essential as are improvements in environmental protection than presently evident. Attention is directed towards examining other options for improving socio-economic conditions of fisherfolks and increasing prawn production and developing public policy for protecting prawn culture areas elsewhere.

The Economics of Different Prawn and Shrimp Pond Culture Systems: A Comparative Analysis

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The paper aims to present a comparative economic evaluation of different pond culture systems for prawn (*Penaeus monodon*) and shrimp (*P. indicus* and *P. merguensis*) using standard economic tools and methods of analysis. The different culture systems include extensive and semi-intensive monoculture of prawns and shrimps and the extensive polyculture of these species with milkfish (*Chanos chanos*). Data used in the analysis were taken from both SEAFDEC AQD and industry experience. The technical data were gathered from researchers and private sector experiences in prawn and shrimp farming. Financial estimates were determined after the peculiarities of aquaculture *vis-a-vis* other business ventures in agriculture and industry were taken into consideration.

The study shows that the extensive monoculture of prawns and the extensive polyculture of prawn with shrimp and milkfish are profitable culture systems. Return on investment (ROI) and payback period for prawn extensive monoculture systems range from 10 to 65% and from 1.4 to 8.6 years, respectively. For polyculture systems, ROI ranges from 8 to 85% and payback period from 1.1 to 10.5 years. The semi-intensive culture of prawn shows moderate results. This is largely due to higher capital requirements for semi-intensive culture as compared to extensive culture. The extensive and semi-intensive monoculture of shrimps on the other hand show poor results, with semi-intensive monoculture registering net losses after all costs are considered.

A Preliminary Economic Analysis for Extensive and Semi-Intensive Shrimp Culture in South Carolina, U.S.A.

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South Carolina has some 28,500 ha of impounded coastal wetlands. These impoundments are remnants of the rice culture industry of the 19th century and are now of interest for waterflow management and possibly aquaculture. The purpose of this study was to evaluate and compare the potential for extensive commercial culture of shrimp in salt-marsh impoundments with that for semi-intensive production of shrimp in highland ponds.

A hypothetical farm consisting of four 8-ha impoundments or ponds was chosen as the basis for the analysis, and it was assumed that only one crop of shrimp could be produced per year. Two alternative strategies for stocking the impoundments were evaluated: option 1, stock by natural recruitment via tide

gates; option 2, stock at low density (25,000/ha) with hatchery-reared postlarvae. Highland ponds were to be stocked at a density of 75,000 PL/ha with hatchery-reared animals. Major fixed costs other than land purchase were considered, including renovation of existing impoundments by cross-diking to form 8-ha units and addition of extra tide gates. Estimates of annual and variable costs for postlarvae (where applicable), feed, labor, chemicals, pumping, supplies, vehicle use, mowing, interest, overhead, and miscellaneous items were also included in the analysis.

Results indicated that extensive shrimp culture in salt water impoundments is likely to be a break-even or profitable activity for production levels of 90 kg whole shrimp/ha for stocking option 1, while option 2 would require yields of ≥ 225 kg/ha. In comparison, semi-intensive culture in highland ponds is likely to be successful if yields of ≥ 800 kg/ha are obtained. This preliminary analysis suggests that both extensive and semi-intensive culture of shrimp may be economically feasible in South Carolina, but this potential is as yet unproven and shrimp aquaculture must be considered a high risk venture in this area.

Cause of Musty Flavor in Pond-Cultured Penaeid Shrimp

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In 1983, penaeid shrimp shipped into the United States from culture ponds in Ecuador were found to have an intense earthy-musty flavor which made them unmarketable. High concentrations of geosmin (trans, 1-10-dimethyl-1-9 decalol), a musty odorous compound, were found in the tail muscle of the shrimp. The level of geosmin, 78 mg/kg muscle, was much higher than levels usually found in pond-cultured freshwater catfish of 13 ± 3 mg/kg muscle. Cause of the rare occurrence of off-flavor in the shrimp is hypothesized to be severe reduction in salinity in the coastal culture ponds which allowed growth of odor-producing blue-green algae.