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OUR COVER

An assortment of fish obtained from composite culture

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EDITORIAL

Aquaculture

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FISH is one of the fine items of food for man. Protein-rich and easily digestible, the role of fish in improving Indian diet and all in all augmenting the food resources of the country cannot be exaggerated. Its export potential also is enormous.

This issue is devoted to culture—the scope and possibilities in fresh, brackish and salt waters. It is estimated that nearly 70 million hectares of these waters are available, of which only 0.6 million hectares are under cultivation. From this, the possibilities of this great sector can be understood.

Faced with the challenges of dwindling food and energy sources, and the ever-worsening problem of pollution, the scientists and planners the world over are looking at earth's resources as an integrated whole where utilization and conservation go hand in hand. An over-intensified exploitation of land for food crops alone will cause suffering to, and progressive depletion of animal and fish resources. Thoughtless and ill-planned development of industries will bring within its wake pollution, particularly of the rivers and oceans. The fish will just vanish. Events in the nature of grave warning have already occurred. This means a totally integrated agriculture, animal husbandry and aquaculture, the whole operation being viewed as one ecological chain, meant for the healthy survival of men, animals and fishes.

In a humble way, this is also the philosophical and programmatic content of ICAR's own operational research projects.

There is also another noteworthy aspect about aquaculture in general. It is a labour-intensive programme. There is tremendous need for production and employment to go hand in hand. Production, without employment and the purchasing power that it creates, can cause its own problems. A close look at the rural areas will easily confirm this simple economic truism.

All in all, the subject deserves close study. The material that we present will help in this direction.

EEL CULTURE

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AMONG the different species of eels of the genus *Anguilla* distributed throughout the world three species, namely the European eel *Anguilla anguilla*, the American eel *Anguilla rostrata* and the Japanese eel *Anguilla japonica* are of economic importance. In India two species of *Anguilla*, namely *Anguilla bicolor* and *Anguilla bengalensis* occur in some of the major rivers and reservoirs along the east coast of India. All these eels are to a large extent similar in habits and could be cultured by the same method that is used in Japan. In recent years there has been an emphasis in the developing countries on the culture of luxury table fish to step up production, especially for export purposes. Eels are considered a luxury food and consumed as a delicacy in several Asian and European countries like Japan, Taiwan, South Korea, Denmark, Italy, France, Holland, Ireland, Greece, etc. Remarkable progress has been made in eel culture in the above countries particularly in Japan where annually about 24,000 tons of eels are produced through culture practices. As there is a great demand for cultured eels in Japanese markets, many Asian countries including India are making efforts to undertake eel culture on a big commercial scale.

Culture Methods

Eels are cultured by two different methods, namely still-water culture and running-water culture. The basic idea behind these two methods is to rear eels in high densities in a confined area by providing extra oxygen and more food to achieve maximum production in a short period of time. Depending upon the quality and quantity of water available any one of the two methods could be employed in eel farming. In still-water culture, water in the ponds will be more or less static. The still-water of the pond enables quick propagation and luxuriant production of phytoplankton by photosynthesis which in turn increases the oxygen content of the pond water and thus provides a suitable condition for the eels to thrive well. About 5 per cent of the volume of the pond water is changed daily to maintain oxygen content of water and facilitate fresh production of phytoplankton. There should be a minimum water level of about 60 cm in the ponds.

In the running-water culture, there will be a continuous flow of fresh water to the ponds and simultaneously an equal amount of water will be drained to keep the water level in the ponds constant. In this method eels are supplied with oxygen through constant flow of fresh water. To ensure smooth flow of water and to avoid flooding of ponds, the sluice gates have to be kept free from blocking.

Eels are cultured in two different ways, namely monoculture and polyculture. In the monoculture system eels are the only fish cultured in the ponds from elvers to marketable size whereas in the polyculture system in addition to eels other table fishes are also cultured. The selection and stocking density rate of other fish species or culture along with eels are decided on the basis of the role they are expected to play in the pond ecosystem. Silver carp, big head, common carp, mud carp and striped mullet are the fish species usually reared under polyculture with eels as principal crop.

Techniques of Eel Culture

The various techniques adopted in all stages of culture operations, commencing from the collection of elvers to harvesting of cultured eels are beiefly described below.

For conducting eel culture seed elvers measuring about 100 mm in length and about 2 g in weight are required. The elvers are generally collected from the lower reaches of the rivers during night when they ascend from the sea, by using different types of nets like scoop nets, bag nets, dip nets, screen nets, plankton nets and a special type of net known as 'Japanese elver net'. In India elvers of two species namely *Anguilla bicolor* and *A. bengalensis* ascend the rivers Hooghly, Godavari and Tambraparni during October-March period and they are collected with scoop nets, bag nets and screen nets. The captured elvers are transported from the collection centres to the culture centres in suitable containers like the conventional fish tin carriers. For transporting large quantities of elvers over long distances special vehicles like lorries provided with a series of tanks are used. These tanks are insulated and have an in-built aeration system. Elvers are also transported by air in some special containers like wooden frames and styrofoam containers. One of the important precautions to be taken before transporting elvers is that they should be starved for a minimum period of 24 hours prior to transportation.

Some important aspects which must be carefully considered and planned while setting up an eel farm are the topographical characteristics of the site, design of eel farm, construction of dikes and arrangements for water supply and drainage. An ideal eel farm should have a series of nursery and fattening or adult ponds in parallel rows each with its own independent water supply and drainage. The stocking density of elvers and young eels in culture ponds depends mainly upon the quality and quantity of water. In running water ponds stocking rate is always higher than those in still-water ponds. The normal stocking rate is 30 elvers per sq metre in the nursery ponds and 20 young eels per sq metre in adult ponds.

Feeding is an important aspect in eel culture which directly influences growth and hence production. In the initial stages of culture the elvers are to be fed with oligochaete worms and later on a mixed diet of oligochaete worms and fish flesh. After about a month or two, the growing young eels may be fed with fresh or cooked fishes like sardines, mackerel, silver-bellies and trash fishes along with prawns, clam meat and offal from slaughter houses. Artificial or concentrated dry foods especially formulated for eels are also used for accelerating the growth rate of eels. Normally feeding is done twice a day, in a corner of the pond in a sheltered place by placing the food in a wire basket or perforated trough and suspending it just above the water level so as to avoid contamination of water. The elvers are fed at the rate of about 30 per cent of their body weight and the young eels at 10 per cent of their body weight. It has been found that concentrated dry foods give much higher conversion ratio than traditional eel foods such as sardine, trash fishes, etc.

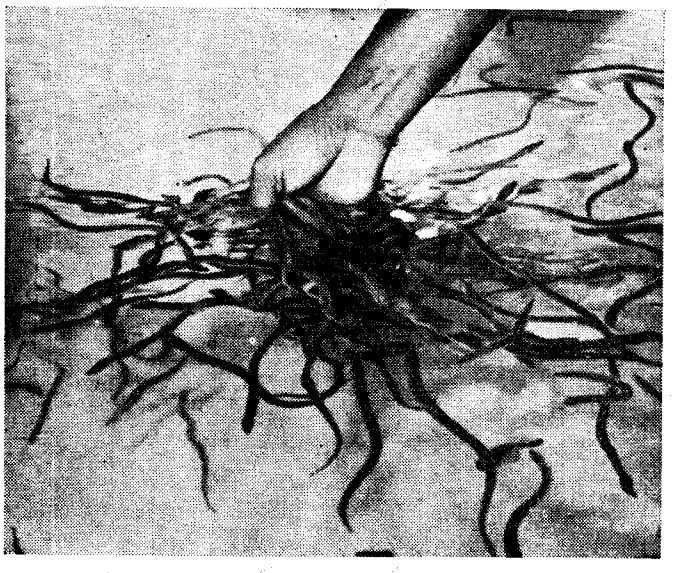
Maintenance of eel farms is another important aspect of eel culture. The water level in the culture ponds should be maintained satisfactorily and water should have a minimum oxygen content of 2.0 to 2.5 cc per litre and the pH 8.0 to 9.2 during day and 6.8 to 9.2 during night. A high percentage of phytoplankton in eel ponds is beneficial for eels. The pond water of a well-managed eel farm will be blue-green in colour with about 97 to 99 per cent phytoplankton and about 1 to 3 per cent zooplankton. At periodical intervals all the smaller and stunted eels are separated and removed from the ponds—a process known as culling—as this will ensure uniform size of eels at the time of harvesting. Attention should also be paid to the control and eradication of eel diseases. About ten types of diseases are known to attack eels causing death. A general method of eradication of diseases in eel farms is to disinfect the water with chemicals or by completely flushing the ponds with large quantities of water.

When the cultured eels grow to marketable size they are harvested and marketed. Scoop nets, trap nets, cast nets, seines, etc. are the common nets used for harvesting eels. Harvesting is usually done when the eels reach a weight of about 100 to 200 g. The Japanese eel reaches marketable size in about 2 years with a production of about 6,120 kg/ha in still water and 26,360 kg/ha in running water.

A portion of the eel culture laboratory at Mandapam Camp

Eel Culture in India

For the first time in India experimental eel culture in running water was done at the Regional Centre of the Central Marine Fisheries Research Institute, Mandapam Camp, Tamil Nadu in 1971. One consignment consisting of about 200 elvers with an average length of 100 mm and average weight of 2 g were collected from Srivaikundam anicut on the River Tambraparni and



Hand-feeding of the elvers in the running-water culture tanks

transported in fish carriers to Mandapam Camp where they were reared in a cemented experimental tank with running fresh water. The elvers and the growing eels were fed with a variety of fishes like silverbellies, sardines, goat-fishes, polynemids, flat-fishes, cuttlefishes, etc. as well as with minced clam meat. At the end of about one year the average length and weight of the large-sized eels were 35 cm and 106 g, respectively, and at the end of second year their respective average length and weight were 42 cm and 160 g. The maximum length of the eel at the end of one year was 50 cm weighing 202 g and at the end of second year 55.6 cm weighing 380 g. The results indicated that the growth rate of eels is faster during the first year and slower during the second year. Since the eels reach marketable size at the end of one year it was suggested that it would be more profitable to harvest and market them at this stage itself rather than allow them to grow for another year. The experimental culture of *A. bicolor* in running water had given a production rate of 3.8 kg per sq metre or 38,000 kg/ha in two years which is comparable to that obtained in other countries.

In November 1973 and in January 1974 two more consignments of elvers were collected from the same place and are being reared at the Regional Centre of the Central Marine Fisheries Research Institute. Experiments are also in progress to find out the conversion factors of different eel foods in order to select the best suited cheap food for the eels in commercial farming.

In India elvers have not been exploited at all even though they occur in good quantities in some of the east coast rivers during October-March period. If intensive efforts are made large quantities of elvers could be collected which could be utilised for culture purposes or exported to Japan. There is good scope for exporting elvers and cultured eels to Japan which imports annually large quantities from different countries paying very high prices. The wholesale prices in Japanese markets in 1971 for elvers ranged from about Rs 1,100 to Rs 1,400 per kg and cultured eels from about Rs 40 to 50 per kg.

The Central Marine Fisheries Research Institute is shortly going to take up a 'pilot project on elver resources survey and eel culture' to estimate the elver resources in some selected rivers on the east coast of India, to determine the peak period of abundance and the best places for collection and to demonstrate the economical viability of culturing Indian eels. The proposed survey is expected to throw light on the abundance of unexploited elver resources. There are very bright prospects for conducting eel culture in India commercially by exploiting the new resources to the best advantage which will provide employment opportunities to a large number of persons and augment our country's foreign exchange earnings.