UTILIZATION OF SALINE LAGOONS FOR FISH FARMING

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While exploring the possibilities of increasing our food resources, the question of proper utilization of coastal mud-flats and lagoons has special significance. On account of their highly saline nature, agriculture of any kind is impossible in these areas and as such extensive coastal regions remain barren. Notwithstanding certain basic drawbacks affecting organic production in such waters, their conversion into fish farms, capable of yielding a reasonable supply of fish throughout the year, seems feasible. Based on experience gained by scientific experiments in this direction, conducted by the Central Marine Fisheries Research Institute, the extent to which these saline beds should be made use of for fish culture and the practical implications are discussed in this paper.

INTRODUCTION

The extensive low-lying, barren, mud-flats along our coasts should have [illegible]ted the attention of those who are familiar with the coastal topography. [illegible]count of the periodical inundation with salt water and the consequent [illegible]linity of the soils, no agricultural crops can be raised in these areas, [illegible]often remain fallow with a thick salt encrustation or with only salt-[illegible]vegetation. During the brief monsoon seasons, however, these low-lying [illegible]rve as the nursery ground for a limited fish population from which the local fishermen seek a meagre sustenance. Such barren areas are more typical of the east coast of peninsular India, while the backwaters of the south-west coast are comparatively fertile. It is estimated that such unproductive salt water lagoons of the east coast extend over 3,000 hectares. If these can be suitably converted and managed to produce food, the yield that can be obtained may well be imagined. Considering their location and their physical and chemical characteristics, the obvious choice in the mode of utilization of such areas seems to lie in their possible conversion into farms for fish culture. What follows in this account will be a discussion on the existing peculiarities of these areas with particular reference to the salty lagoons of the south-east coast, and the extent to which their practical utilization is possible.

CHARACTERISTICS OF COASTAL LAGOONS

A proper understanding of the environment becomes an essential prerequisite for planning a successful scheme on fish culture. Some of the methods now being employed for salt water fish culture are on a merely empirical basis, whereas the saline waters which vary widely in their characteristics would seem to need a more scientific approach.

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Our culturable coastal waters may be broadly categorised into two types, viz. (i) the extensive backwaters adjoining the seas and estuaries where the salinty and other conditions afford a sustained source of fishery. The backwaters of the Kerala coast and the Sundarbans region in West Bengal are typical examples of this category. Perhaps more intensive exploitation from these areas can be achieved, (ii) the second type includes the shallow lagoons of the east coast, particularly of the Ramanathapuram and Tinnevelly coasts of Madras State. These are mostly open marsh lands which get flooded periodically with tidal waters from the sea. The soil is loose and the waters are only transient. Excepting for this brief period of the year, the place remains semi-dry and the salinity reaches lethal levels for many living organisms. Our immediate problem, therefore, is to find out how well these fallow regions can be made use of for increasing the fish yield.

A general ecological survey of these lagoons (Tampi 1959) would reveal that during the four or five months following the monsoon time when these lagoons remain connected with the sea, the fish that enter these waters account for an average production of only 50 kg per hectare. But, for a major part of the year there is practically no fish production as the lagoons remain some what dry. There is also a paucity of fauna and flora during the post-monsoon and summer months, which just indicates unfavourable environment for sustaining normal life in these waters.

The chemical characteristics of this area have been determined and the data are summarised (Table I).

While phosphorus and other essential nutrients are usually at a low level during the monsoons there is also periodical leaching of the soil. What little nutrients that are replenished by incoming tides are rapidly used up by the organisms and only a small part is restored after bacterial activity and organic decay. It is also generally noticed that the available nutrients are largely confined to the top layers of the soil, while the subsoil remains always poor with some amount of hydrogen sulphide trapped in the interstices. Although phosphorus may be consistently found deposited in these muds, the amount of soluble phosphorus in the water is actually small. Most of the phosphorus seems to remain in an insoluble form. Thus, this vital element does not become available for the growth of the smaller plants and in turn for the fish. The levels of nitrates are also very low and these two factors appear to be primarily responsible for the extremely low biological productivity of these areas. The very high increase in salinity of the stagnant water, combined with the high temperatures in summer, also creates adverse conditions for the growth of organisms.

The primary productivity in these areas has been generally assessed by employing the light- and dark-bottle technique, taking the photosynthetic activity as an index of organic production (Varma *et al.* 1967). It has been found by our experiments that the primary productivity of such salt water lagoons is of a comparatively low order, often not exceeding 0.125 g/ml. The values obtained have been far lower than those for many of the natural waters of the tropics, and even of the open seas adjoining the lagoons. The lack of

TABLE I

*General composition of saline lagoon soils**

Silt (%)	pH	Ignition loss (%)	Organic N. (%)	Mn (%)	Water Soluble Salts						Total phosphorus (Mg/g of silt)	Interstitial phosphorus (Mg/g of mud)
					Total (%)	Cl (%)	SO_4 (%)	Ca (%)	NO_3-N (%)	Fe (mg/ 100 g)		
4.5-22.1	8.0-8.8	5.5-19.8	0.105-0.186	0.005-0.01	1.2-6.5	0.5-3.2	0.144-0.742	0.04-0.74	0.001-0.003	0.03-0.67	202.0-632.4	4.20-6.37

* Compiled from : Pillai, V.K. (1956). *Proc. Indian Acad. Sci.*, **44**, 130-136 and arma, P.U., Tampi, P.R.S. and George, K.V. (1963). *Indian J. Fish.*, **10** (1), 197-208.

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some of the trace elements is another factor of significance. The waters in the lagoons have been found to be deficient in Fe, Mn, B and Zn throughout the year which may possibly be yet another reason for the low biological activity (Pillai 1955).

Methods for Improvements

Under the circumstances described above, improvement of the soil conditions should be the first effective approach to successful utilizations of the area. The first step is to increase the phosphates and nitrates and make these available for ready use of the growing micro-organisms. The addition of the usual agricultural fertilizers is one of the possibilities. Their dosage, mode and the frequency of application will depend on the characteristics of the area and hence will have to be determined in individual cases by experiments. However, it has been found that 25 kg of superphosphate (16.5 per cent) per 1,000 m^3 of water at a time is a fair estimate to produce a reasonable increase in organic production. It is ideal to suspend the fertiliser in small gunny bags at different places along the bottom than to sprinkle it over the surface of water or to plough it into the mud.

Experiments on such artificial fertilization of saline ponds have shown that the effect on the growth of microflora is somewhat quick. Within a week an outburst of phytoplankton bloom occurs, followed by increase in other organisms. The increase in organic production after the addition of superphosphates has been estimated to be nearly nine times. However, it has also been noticed that this effect is only short lived and within about ten to fourteen days the bloom disappears and the level of phosphate as well as the primary production revert to the original low level. This happens probably because a large part of the phosphate precipitates due to the ferric-organic complex, or is adsorbed by the calcium compounds of the soil. Repeated manuring in smaller doses at regular intervals of time can, to some extent, overcome this deficiency, but it becomes a wasteful process and does not offer a permanent answer to the problem. In order to release the fertilizer phosphorus and to make it go into solution for use by the plants, acidification of the mud-water system seems to be one of the procedures. While this had been successfully experimented in some of the Wisconsin freshwater lakes (Zicker *et al.* 1956), the commercial limitations of this technique for our alkaline salt water ponds are yet to be ascertained.

Our culturable species of fish are predominantly herbivorous and the role of plant life in supporting such a fish population is generally appreciated. Thus the object in increasing the fertility of the pond is to improve this primary food of fish. Experiments have shown that the natural by-products can substantially induce the growth of microflora in saline waters (Pillai 1955). For example, composts prepared out of sea-weeds and cowdung, both of which are available in plenty along the coastal areas, can be successfully utilised for supplying the ponds with valuable nitrates and some of the essential trace elements. The exact quantities to be used will have to be determined in each

case, depending on the soil and water requirements. Besides supplying the nutrients this also improves the quality of the soil by adding to the humus content.

Salt Water Fish Farms and Their Management

As our ultimate object is to convert the areas into productive fish farms, it may be relevant to mention a few general points, although the scope of this paper does not warrant any discussion on actual constructional details. As the type of coastal environment can vary widely, the choice of the site as the lay-out of the farm would need careful planning. A region with clayey soil, where a regular in- and out-flow of water can be assured with suitable irrigation channels should be the first choice. An immediate source of fresh-water supply in addition to the sea-water will be an added advantage. While the ponds are excavated and the bunds stabilised, removal of the comparatively rich surface layers of soils is inevitable. Therefore, all deficiencies of the bunds after their formation will have to be made up before any fish is introduced into them. Thus, the preparation of the ponds is an important step in ensuring successful fish culture. Other precautions to be generally followed in fish farm contructions need hardly be pointed out here.

The types of fish that could be cultured in our coastal saline areas are not limited and we are often left with very little choice in this matter. The milk fish *(Chanos chanos)* is the one most widely used for such purposes. Its power of adaptation to a variety of environmental conditions, from almost freshwater to hypersaline conditions, is well known. Perhaps the only drawback of this fish is the fact that the young ones for stocking the ponds will have to be caught from their natural surroundings in the bays and tidal creeks and brought to the farms for rearing. This involves efficient fry transport system and satisfactory nursery management, all of which need special skill. Another fish of more or less the same popularity and advantage is the mullet (*Mugil* spp.). Barring these and some of the prawns, there are only few other species that may be commercially reared in the salt water farms.

In a properly managed salt-water fish farm, it has been found from our experience that an annual yield of at least 227 kg of fish per acre should be possible in the initial stages. A farm, in order to be commercially feasible, may have to be planned on a 10-acre site, so that in two or three years' time a satisfactory income is possible after the recovery of the capital cost. Owing to the fairly high cost of investment, the time taken to bring in a net income to the investor and sometimes due to adversities caused by coastal floods, many people are naturally not inclined to invest huge sums in this kind of venture. Considering the existing cost of artificial fertilizers in our country, the maintenance of the farm is likely to be somewhat high in the beginning, but the yield in a properly managed farm will more than justify the expenditure thus involved. Inasmuch as private enterprise is not readily forthcoming in such ventures, the governments concerned should give a lead and impetus to organised co-operatives by placing such low-lying lands at their

disposal so as to encourage them to utilize these areas with the technical know-how furnished by the fisheries research departments. If necessary, a small subsidy in the initial stages may be given to these co-operative organisations which alone would be able to manage things at a low cost. Fallow lands can thus be brought under organised fish culture. Besides augmenting our fish production, the industry will also provide a healthy occupation to the fishermen during their off-seasons. Subsidiary activities like the fish fry trade also will flourish around such places of fish farming.

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