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ORGANIC AQUACULTURE

AQUACULTURE

An understanding of the principles of operation of capture and culture fisheries helps to throw light on the definition of aquaculture. The expressions capture and culture fisheries are self-explanatory. In the former, one reaps the aquatic harvest without having to sow, whereas, in the latter, one has to sow the seed, nurse it, tend it, rear it and harvest it when it grows to marketable size.

Examples of capture fisheries are the natural fisheries of the seas, estuaries, rivers, lagoons, large lakes etc.

Culture fisheries are usually carried out in small water bodies which can be manipulated, pre-prepared for stocking; which are often manured and/or fertilized before, during and after stcking; and/or where fish are fed from extraneous sources.

Pen culture, cage culture, culture in running waters, in recirculating systems and in reconditioned water are special types of aquaculture.

All shades of intermediate stages between true capture and culture fisheries exist such as in man-made-lakes, which are stocked extraneously but where no manuring, fertilizing and feeding are generally done. Stocking is often done in large water-bodies such as lagoons and rivers where natural stocks have undergone 'depletion'.

The principles of management of capture and culture fisheries are very different from each other. In the case of capture fisheries one has to attempt to harvest maximum sustainable yield by regulating fishing effort and mesh after taking into account parameters of population dynamics such as rates of recruitment, natural and fishing mortalities, fish growth and size at which recruitment occurs. Management of capture fisheries requires knowledge of the dynamics of the fish populations under exploitation. The extended exclusive economic zone of 200 miles brings into focus the national and international complexities of regulating the capture fisheries of the seas and the oceans and apportionment of the marine harvest because fish populations do not abide by man-made boundaries.

In the case of culture fisheries, no detailed knowledge of the population dynamics of the cultivated finfish or shell fish is involved. Here, one has to breed, if one technically can, the chosen fish under controlled conditions, if it does not breed naturally, and develop fish husbandry practices so as to be able to formulate economically viable technologies. For effective aquaculture, one has to gain familiarity and control water quality to enhance its biological productivity; one has to understand fish nutrition so as to be able to formulate nutritionally balanced fish diet; one has to delve deep into fish genetics so as to be able to evolve new varieties and strains which bestow commercial advantages to the product in terms of superior growth rate, nutritive value, bonelesness, taste, odour etc.; one has to prevent incidence of fish infections and diseases through prophylatics and therapeutics.

With this background information, a definition of aquaculture can be attempted.

Aquaculture has been defined by the Japanese Resource Council, Science and Technology Agency as under:

"Aquaculture is an industrial process of raising aquatic organisms upto final commercial production within properly partitioned aquatic areas, controlling the environmental factors and administering the life history of the organism positively and it has to be considered as an independent industry from the fisheries hitherto."

Aquaculture is organised production of a crop in the aquatic medium. The crop may be that of an animal or a plant. Naturally, the organism cultured has to be ordained by nature as aquatic.

Examples are:

Finfish: Tilapia, carp, trout, milkfish, bait minnow, yellow tail, mullet, cat fish.

Shellfish: Shrimps, prawns, oysters, mussels, pearl oyster for cultured pearls (eg. Japanese pearl oyster, Pinctada fucata).

Plants: Water chestnut (Trapa natans). Red alga of Japan, "Norie" (Porphyra). Red alga of Philippines & U.S.A. (Eucheuma) Brown alga of Japan, "Wakame" (Undaria).

During the last decade or so there has been noticeable a global upsurge for aquaculture. Some of the factors which have contributed to the upsurge are:

Increased and continuously rising cost of fishing operations due to steep rise of the price of fuel.

Fear of reduction in marine fish landings by countries that depend on fishing in the territorical waters of other countries as a result of the new laws of the sea of 200 miles exclusive economic zone.

Need, in some countries, for finding alternative and/or additional employment for large numbers of surplus fishermen or under-employed farmers.

A persistent demand in most developed countries for high cost species like shrimps and prawns. This has greatly promoted interest in aquaculture in countries that wish to increase their foreign exchange earnings.

The behaviour of one of the world's most productive capture fisheries viz. that of Peruvian anchovy has, I believe, given a hard blow to aquaculture on the one hand, in making scarce and increasing the cost of fishmeal, which is the ingredient of most fish feeds, and, on the other, seeing the helpnessness of man in countrolling natural causes of fluctuations of marine fish yields, has created a desire in him to acquire control on processes of production through aquaculture.

Factors which have been unfavourable to the development of aquaculture are:

Shortage of fertilizers in most developing countries and their allocation to agriculture. In this respect, there is a measure of conflict between agriculture and aquaculture.

Increasing prices and even the availability of fish meal, which, as stated earlier, is the ingredient of most fish-feeds. This is linked with the Peruvian Anchovy crisis, which, apart from aquaculture, adversely hit agriculture, through scarcity of guano and fertilizer, and poultry industry through scarcity of fish meal. This has led to search for cheaper protein substitutes in fish feeds and spurt of research activity in that direction in different countries.

While a general global environmental consciousness has ameliorated aquatic pollution and has thus helped fish culture, aquaculture itself is considered by some as a polluting agent, through release of water containing fish metabolites leading to eutrophication in the recipient waters, which may be a stream or a river or another kind of natural water-body. Discharge regulations which are applicable to aquaculture by authorities in some countries.

The basic fact is that fishes in general help to keep the aquatic environment clean through exercising biological control of vectors (eg. of water-borne diseases like malaria, filaria etc). Aquaculture water and pond bottom mud often act as fertilizers to agricultural fields. Rarely does aquaculture discharge-water cause pollution.

Authentic proof it required to establish that aquaculture is a polluter. In whichever case, if it is proved that aquaculture has polluted the environment, the discharge water from aquaculture establishment would need to be treated and rendered innocuous before release.

Aquatic pollution, through discharge of agricultural pesticides, domestic wastes, trade effluents and oil spills, has very adversely affected aquaculture. In this respect, there is a measure of conflict between agriculture, especially cultivation of high yielding varieties (HYV) of cereals, and aquaculture. E.g. cases of fish kills in streams and other water-bodies where pesticides fall or where industrial effluents are discharged and adverse effect on oyster beds off Japanese, U.S.A. and French Coasts. The well known cases of oil spills are those of the tankers: Tory Canyon (1967) and Amoco Cadiz (1978).

Absence of a constitutional provision for aquaculture as a discreet national activity and legal frame-work for governing its development and administration in most of the countries of the world are standing in the way of entrepreneurs making investment in aquaculture.

Multi-disciplinary and systems characteristics of modern aquaculture need to be especially emphasised in a lecture on definition of aquaculture. Mention has been made earlier of some of the essential components of aquaculture such as water quality control, fish breading, fish genetics, fish nutrition, fish feed formulation, fish pathology, fish parasites and predator control etc. An aquaculturiest has to successfully carry out a whole series of operations before be is able to market his produce.

Complete package of practices have to be developed which involve accomplishment of several steps such as fish multiplication, nursing, tending, and rearing the young, all of which require special food for the larvae and the young fish; then growing the young to marketable size which require special feed again and often intensive feeding for quick growth. The quality of fish feed would naturally depend on the species cultivated. All the above mentioned steps in the practice of aquaculture require rigid water quality control. The cultivated fish has to be saved from the depredations of predators all along its culture. The health of the fish has to be continuously monitored and guarded against infections and infestations which have got to be checked.

The systems approach stands in contrast with disciplinal studies where a scientist take s.up a specific problem and goes deep into it to investigate a certain phe no menon or seeks to establish cause and effect relationship. Even the latter, depending on the nature of the problem, may be multi-disciplinary but it need not always necessarily be. A biochemist, for example, can effectively study fish nutrition and feed components of fish required at different stages of its life but, for successful aquaculture, the whole system involving scores of aspects, some of which have been high-lighted above, have to be worked out.

OBJECTIVES OF AQUACULTURE

Having defined aquaculture and mentioned some of the reasons which have contributed to imparting a fillip to aquaculture in recent times, it is proper to state the objectives of aquaculture. These are:

Production of protein rich, nutritive, palatable and easily digestible human food benefiting the whole society through plentiful food supplies at low or reasonable cost.

Providing new species and strengthening stocks of existing fish in natural and man-made water-bodies through artificial recruitment and transplantation.

Production of sportfish and support to recreational fishing.

Production of bait-fish for commercial and sport fishery.

Production of ornamental fish for aesthetic appeal.

Recycling of organic waste of human and livestock origin.

Land and aquatic resource utilization: this constitutes the macro-economic point of view benefiting the whole society. It involves (a) maximum resource allocation to aquaculture and its optimal utilization; (b) increasing standard of living by maximising profitability; and (c) creation of production surplus for export (earning foreign exchange especially important to most developing countries).

Providing means of sustenance and earning livelihood and monetary profit through commercial and industrial aquaculture. This constitutes the micro-economic point of view benefiting the producer. In the case of small-scale producer, the objective is to maximise income by greatest possible difference between income and production cost and, in the case of large scale producer, by maximising return on investment.

Production of industrial fish.

Fish flesh, on the average, contains: moisture and oil, 80%; protein; 15–25%; mineral matter, 1–2%; and other constituents, 1%. Water content is known to vary inversely with fat content. Need for artificial recruitment has arisen in order to replace or augment stocks decimated by: decline of water quality and destructive fishing (e.g. pollution, poisoning, dynamiting); barrier to migration caused by execution of river valley projects (e.g. anadromous fish) and overfishing.

From the global view point, the fish which have overwhelmingly dominated artificial recruitment are: i) Oncorhynchus ii) Acipenser iii) Salmo. Artificial recruitment of carp, tilapia and mullet are also important mostly in tropical and subtropical countries.

Oncorhychus and *Salmo* transplants have contributed maximum to sport and recreational fishing. Production of livebait e.g. for skipjack tuna (*Katsuwonus pelamis*) is an example of bait production for commercial fishing. Some potential live-bait species are: Tilapia mossambica, Dorosoma petenense, Engraulis japonicus, Sardinella malanure, several species of mullets and cyprinids.

A wide variety of ornamental fish such as sword tail (*Xiphophrus helleri*); angel fish (Pterophyllum scale), siamese fighter (*Betta splendens*), goldfish, and common carp. The last mentioned supports intensive breeding of fancy carps (live jewels) of Japan.

There has come into being fish-cum-livestock culture, in the form of an integrated system especially involving cattle, pigs, ducks and poultry.

Several by-products are obtained from fish. They include fish meal used for animal feeding (in aquaculture an important component of most fish feeds) and as manure; fish flour; fish oil; leather; gelatin and glue from fish skins; imitation pearls; isinglass; adhesives; insulin from fish pancreas; sex hormones from gonads etc.

Production of industrial fish includes production for purposes of reduction to fishmeal or fertilizers. Seaweeds are cultured for marine colloids and pearl oysters for cultured pearls.

Today's consumers are much more educated, health conscious and inquisitive about the food they eat. They are interested not only in the health benefits of the food they eat but also in the environmental, social and sustainability issues surrounding how the food is produced and, of course, they want to be sure that their seafood is safe. In short, consumers want food that is clean, safe to eat and which will impact the environment as little as possible.

On the other hand, there is the trend for modern mass production, where industrial efficiency creates the cheapest product. While mass production will likely dominate the market in the near future, the methods used will gradually change in line with consumer concerns and the origin of the product. The growing awareness and concern on food safety and environmental issues worldwide has played a major role in the rise of organic produce and markets. Awareness of health and environmental issues is growing not only in the international community, but also among lower income communities. Consequently, government and private sector organizations in many countries are increasingly encouraging organic agriculture. This handbook aims to provide a guide to aquaculture farms planning to convert to organic farming. Guidelines on general organic production procedure based on quality control points are provided.

Organic aquaculture uses holistic production management systems which promote and enhance ecosystem health, including biodiversity, biological cycles and soil biological activity. Organic production systems are based on specific and precise standards of production which aim at achieving optimal production systems which are socially, ecologically and economically sustainable. Requirements for organically produced foods differ from conventional products in that production procedures are an intrinsic part of the identification and labeling of, and claim for such products. Organic farm management relies on natural or traditional production methods. Since organic aquaculture is an offshoot of organic agriculture, the definition for it is derived from that for organic agriculture. The International Federation of Organic Agriculture Movements (IFOAM) defines organic agriculture as a "... system which promotes environmentally, socially and economically sound production of food and fibers and which dramatically reduces external inputs by refraining from the use of chemo-synthetic fertilizers, pesticides and pharmaceuticals". The definition continues "... it allows the powerful laws of nature to increase agricultural yields and disease resistance".

Organic aquaculture, therefore, includes various elements which ensure that the farming activity is in harmony with nature, while keeping in mind the good health and welfare of the culture organisms.

GENERAL PRINCIPLES OF ORGANIC FARMING

Organic aquaculture involves the following general principles and practices:

- Intensive monitoring of any environmental impact of the activity to prevent adverse impact
- Integration of natural plant communities in the farm management
- Use of polyculture, where possible, in a sustainable production system
- Use of indigenous species as far as possible (care must be taken when introducing exotic species)
- Production of produce and product processing according to organic principles
- Utilization of natural breeding methods, without the use of hormones, irradiation and antibiotics
- No use of GMOs in the production chain, including in stocked animals and feed
- Stocking should be at appropriate stocking density, taking into account ecological capacity of site and species-specific behaviour of animals

Feed and fertilizer must be from certified organic agriculture. If not, then

• Use of feed ingredients which are byproducts or trimmings from processing activity or food which is in excess of human consumption needs

• Certain criteria for fish meal sources and limits on its use (e.g. at least 50% of fish in a diet shall be from byproducts, trimmings or other material)

• Limited use of additives in the production chain

• Avoiding use of synthetic growth promoters, colouring agents, etc.

• Maintaining natural biodiversity on the farm area is another basic principle of organic production.

• Restrictions on energy consumption (e.g. for aeration or pumping).

• Preference for natural medicines to treat disease

• No mishandling or mutilation of culture organisms and

• Avoiding excessive or improper use of water

• Minimizing stress and suffering connected with slaughter, where applicable.

Reference:

1. Handbook on organic Aquaculture CFC/FAO/INFOFISH Project on Organic Aquaculture in Myanmar, Thailand and Malaysia
2. http://www.fao.org/docrep/field/003/ac169e/ac169e00.htm