AQUACULTURE MANAGEMENT

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Keywords: aquaculture management, development, regulatory framework, sustainability, social equity

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Summary

Aquaculture, the farming of aquatic organisms whether they are fish, crustaceans, or plants has clearly a significant potential for growth.

Whether it will actually become a major food producing system depends essentially on the sustainability of production systems and on attracting significant numbers of new producers.

Sustainability will be improved by limiting interactions with surrounding ecosystems. This can be achieved either by improving the productivity of inputs such as water and feeds in intensive systems, or by integrating aquaculture with other food productions systems into so-called integrated resource management systems.

Integrated resource management systems are likely to be more labor intensive but requiring less capital outlay may be affordable by a greater number of people.

The verdict on what will ultimately dominate the aquaculture scene is still out. It will depend to a large extent on how externalities will be treated.

1. Introduction

Seas, rivers and lakes have always played an important role in human history. To early mankind they have provided food and been ways of communication. They still do. Food was originally gathered or hunted from nature. Gradually man has learned to cultivate crops and to keep animals. Foraging and hunting lost their significance as food supply systems. But this process has been mostly limited to land. Admittedly, aquatic production has increased dramatically. It was estimated at 5 million metric tons at the beginning of the century, at 15 million metric tons in the 1940s, at 70 million tons in the 1970s. At the end of this century, it stands at around 120 million tons. But aquaculture, which is the farming of aquatic organisms, contributes less than a quarter to these production figures. On our seas and rivers and lakes we are still essentially hunters albeit highly technological ones.

Fishing is in crisis. Experts tend to agree that most ecosystems have been over fished or are dangerously close of being so. Fishing is now so intensive that there is a trend for a replacement of long-lived and large predators species by short-lived and small ones feeding lower on the food web, a trend, which has been called fishing down the food web. But this will not necessarily lead to a long-term increase in production because of the structural role the large species play in ecosystems.

Production from fishing is condemned to stagnate or may even decrease. Could aquaculture prove to be to capture fisheries what agriculture turned out to be to hunting and foraging? In trying to answer this question, the following observations may be considered. Aquaculture is, with an annualized growth rate at or above 10% per year, one of the fastest growing food production sectors. The FAO estimated that in 1995 aquaculture production represented over US$40 thousands million and reached a record 28 million tons. However, production is highly concentrated geographically. The bulk of the production occurs in Asia (90%) and most of that in China. But even in Asia, probably less than one percent of the food producers are actually engaged in some form of aquaculture. All this points to a substantial development potential.

Aquaculture is the farming of aquatic organisms whether fish, crustaceans, mollusks or plants, farming implying some form of human intervention to increase production. The term covers a very wide range of cultured species and farming techniques and several forms of classification have been proposed. Though aquaculture management is looked upon here from the economic and social not technical or financial point of view, the most useful classification is felt as being into extensive, semi-intensive and intensive systems depending on the amount of external inputs, mainly feeds, needed to sustain the operation. On one end of the spectrum there are systems essentially dependent on the natural production of the marine or inland water systems. On the other end there are industries transforming feeds into high value, low volume species under a controlled environment. These feeds have typically a high content of fishmeal made from high volume low value species.

Discussing management raises questions of objectives and of instruments. In other words what is to be achieved or avoided and how will it actually be done? Objectives commonly cited tend to be targets such as filling a growing gap between demand and

supply for fishery products, food self-sufficiency, improved nutritional status, hard currency earnings, creating job opportunities, and sustaining the economy in depressed regions. However, in practice much of the effort at managing aquaculture must be attributed to a desire to reduce environmental impact, conflicts over access to resources, or social disruptions. Stating that the objective(s) must be sustainable often incorporates a time horizon.

Instruments available for sector management are of two kinds. They are either intended to promote or to control the development of the sector. Credit and subsidy schemes, research and extension programs are used for promotion. Control is mostly done through hard and soft laws. Hard laws are established and formalized outside the sector by a formally described process. They ought to be enforceable in the appropriate courts. Soft laws are mostly voluntary codes of practice or guidelines, which the sector imposes on it. They may be associated with schemes to encourage compliance.

In 1995, the Food and Agriculture Organization of the United Nations (FAO) Conference endorsed unanimously a Code of Conduct for Responsible Fisheries. The present article is essentially structure around that Code. In it, the term fisheries are taken as applying "equally to the capture fisheries and aquaculture". Article 6 defines the general principles on which it is based. Of major importance are the conservation and management of the resources, food security and poverty alleviation. The precautionary approach is strongly recommended. Article 7.2.1 states that the "overriding objective of conservation and management is the long-term sustainable use of fisheries resources". Other codes or guidelines exist and could have been used. But they are generally more limited in scope, treating only specific aspects such as industrial fish farming or environmental management.

To cover capture fisheries and aquaculture in the same Code of Conduct makes sense as there is no clear defining line between fisheries and aquaculture. However, one needs to take care that it does not limit the scope of the debate. As an activity much aquaculture is often more akin to agriculture than fisheries. It raises a whole set of similar questions. Aquaculturist scientists or technicians tend to view the continued development of fish (or shrimp) farms just in the same way as the agricultural specialist view the development of coffee plantations or feedlots. The sustainability of such increasingly intensive mono-cropping systems, whether land or water based, is questionable.

2. The Concept of Sustainability

Sustainable development or sustainability is concepts fairly difficult to define exactly. Most definitions suggest as core concepts:

- Futurity: A concern for the well-being of future generations (inter-generational welfare) and very much linked with the precautionary approach
- Equity: The concern for future generations should extend to equity for the present generation (intra-generational) welfare
- Environment: A greater emphasis is laid on the environment

In the FAO Technical Guidelines for Responsible Fisheries—Aquaculture

Development, these three concepts are present. Sustainable development is defined as "the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations. Such sustainable development (in agriculture, forestry, and fisheries sectors) conserves land, water, plant, and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable". In practice, the terms sustainable and sustainability imply there are limits to development. But these limits are not absolute.

Any human activity is bound to have an environmental impact. Most often development will have a degrading impact since one implicit aim will be to direct a bigger share of natural production towards satisfying human needs. The only exception is probably when that increase is achieved by reducing waste. Indeed there seems to be a general agreement that aquaculture practices wasteful of natural resources will not be sustainable. However, resource management issues are not easily resolved.

One way could be to compare the ecological footprints and/or energy flows of different production systems. The footprints represent the area needed to support the systems considered. The rational is that the smaller that area the less the system draws on inputs from outside, the less it influences the surrounding ecosystem and there for the more environmentally sustainable it is. Energy flows link the different components of a farm between them and with the surrounding systems.

The smaller the flows into the farm, the more sustainable its operations. It may therefore be better to speak of degrees of sustainability rather then putting the question in terms of sustainable or not. On this account the most sustainable systems are those who rely on natural production such as seaweed and shellfish culture and culture-based fisheries. Foot printing also points to two possible strategies to increase sustainability. The first one is to increase productivity particularly of water and feeds. The second is to look beyond the narrow and to combine production systems such that the waste generated by one is used as a resource in another. So-called integrated resource management systems.

Another way might be to value environmental effects and include them in the cost benefit or cost effectiveness analysis. This approach has been tried for instance on Swedish sea farms and for shrimps farms in South India. In both cases the costs were found to exceed the benefits. It should however, be noted that the valuation of environmental goods and services is fraught with theoretical and practical problems and that no consensus has yet been achieved on this.

Technical appropriateness, economical viability and social acceptability are all to a large degree subjective concepts defined within a framework of social values which is continuously evolving. Changing perceptions of proper landscape uses are increasingly important. For instance, trout culture operations in Danish streams may be condemned to disappear, not because they are damaging to the environment, of some technical problem or are loss-making, but because the sites are becoming more valuable to the public as nature reserves then as production sites.

3. National Aspects

3.1 Regulatory Framework

Attention for a regulatory framework has increased significantly over the last decade. There are several reasons for this. The potential contribution of aquaculture to national or regional economic development has become clearer and so has the awareness of the constraints inappropriate laws and institutions put on the development of the sector. This extends to land tenure and use rights and of access to water in traditional subsistence communities and which are rarely well equipped to deal with aquaculture issues. Environmental damage, changing perceptions as to how the landscape should be used and social disruptions caused by some very rapid and uncontrolled forms of aquaculture development have also led to increased demands for regulation and protection.

Aquaculture touches on a series of issues such as the environment, the use of and access to natural resources, animal and public health. While capture fisheries are usually regulated by a single (fisheries) department or agency, aquaculture typically involves many. As a result, developing a comprehensive regulatory framework for aquaculture is often legally and institutionally complex. The need must therefore be carefully assessed. Implementation uses relatively scarce regulatory and management resources from the public sector. These resources are best used where there is a clear failure. Considerable political will is necessary to mobilize them.

In practice it is possible to distinguish four basic responses. The first is a comprehensive set of regulations devoted to aquaculture or at least to certain forms of it. In other cases some specific legislation is enacted to attend a very precise need such as regulating the access to water and public land. Sometimes an enabling law sets a number of principles or invests a given authority with the power to regulate aquaculture. However, aquaculture is often dealt with in a number of different legal instruments few of which, if any, are specific to aquaculture.

It is interesting to note that some states such as France and Spain have a quite different regime for freshwater and marine/brackish water aquaculture. This seems to reflect the idea that freshwater aquaculture can be more readily assimilated into traditional rural activities such as land based animal husbandry. Such a different regime is also justified by the different ownership patterns (public or private) of land and water resources being used. Aquaculture operations cited on private land need only a license while the use of public domain normally requires also the granting of a concession.

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Ruddle, K. (1993). The impacts of aquaculture development on socio-economic environments in developing countries: towards a paradigm for assessment, pp 20-41. *In*: R.S.V. Pullin, H. Rosenthal and J.L. MacLean (eds.) Environment and aquaculture in developing countries. ICLARM Conf. Proc. **31**, 359 pp. [The paper proposes a framework for analysing the consequences of aquaculture development particularly, small scale pond aquaculture in developing countries. It does stress that aquaculture must fit the society. Policy makers and planners often fail to recognise that aquaculture is only one dimension of a much larger human ecological system.]

Web sites of interest

The web is an obvious place to look for information on aquaculture. The following are some of the most interesting sites maintained by non-commercial or profit inspired institutions. Most of them will offer links to many other sites.

European Aquaculture Society: http://www.easonline.org/ [The European Aquaculture Society is an international non-profit association counting members worldwide working in any field related to aquaculture (research, farming, education, provision of services, manufacturing, and consultancy)].

Food and Agriculture Organization of the United Nations (FAO) Fisheries Department: http://www.fao.org/WAICENT/FAOINFO/FISHERY/fishery.htm [The web site of the FAO Fisheries Department gives access to some of the latest official information on aquaculture (and fisheries). Some of it is accessible online or can be downloaded].

International Center for Living Aquatic Resources Management (ICLARM): http://www.cgiar.org/iclarm/ [ICLARM is an international research organization devoted to improving the productivity, management and conservation of aquatic resources for the benefit of users and consumers in developing countries. Aquaculture is one of its main areas of activity].

IUCN—World Conservation Union: http://www.iucn.org/ [IUCN—The World Conservation Union, is one of the world's oldest international conservation organizations. Today it is a union of governments,

government agencies, and non-governmental organizations working at the field and policy levels, together with scientists and experts, to protect nature].

Network of Aquaculture Centers in Asia: http://naca.fisheries.go.th/ [NACA is an intergovernmental organization of a coordinated and interlinked system of aquaculture and related institutions working in close cooperation on the development of technology, manpower and information required to increase the contribution of aquaculture to national development goals and to expand sustainable aquaculture development in the region].

The Shrimp Sentinel: http://www.earthsummitwatch.org/shrimp/ [The Shrimp Sentinel Online is an Internet forum for discussion and dialogue on the serious environmental and social impacts of increased global production of shrimp].

World Aquaculture Society: http://ag.ansc.purdue.edu/aquanic/was/was.htm [The World Aquaculture Society is an association promoting the advancement of aquaculture throughout the world]

Biographical Sketches

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