AN ECOLOGIST LOOKS AT AQUACULTURE

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O. Kinne, an ecologist at the Biologische Anstalt Helgoland, Hamburg, Germany, has written extensively on aquaculture and marine ecology. The following piece is paraphrased from his keynote lecture at the World Conference on Aquaculture in Venice in 1986, where he said that *'the production of food for some 8 billion people is a nightmare for an ecologist"* Today, with the current global thrust on aquacultural practices, his views on the significance and future potential of aquaculture acquire a fresh relevance.

Man not only searches for food, he produces food. And to do so, he strives for conditions which favour the survival, growth and reproduction of a few, selected organisms, hoping to reduce his dependence on the vagaries of nature.

However, two fundamental ecological fads are often ignored:

- the flow patterns of energy and matter which are basic properties in the organization and functioning of ecosystems: and
- a bias in the flow pattern in favour of a single ecosystem component, viz, Homo sapiens.

Food is produced in three principal ways: agriculture, aquaculture and fisheries. Though the fisheries do manipulate marine ecosystems, they depend heavily and directly on natural ecological processes and fluctuations. The degree of man induced control is limited, in contrast to agriculture and aquaculture.

At present, there are more favourable prerequisites for food production on land, i.e. in agriculture, than in water, i.e. in aquaculture. Production of human food from aquatic plants is negligible due to man's nutritional habits and the infeasibility of economically harvesting the greatest living natural resource on earth, the marine phytoplanktons.

Reliable figures on annual rates of food production world-wide are difficult to come by, but most food production evidently comes from agriculture, followed by fisheries. In 1979 aquaculture accounted for only about 0.21% of global food production. Of course, there are exceptions like Japan, Israel and China where aquacultures share is much higher.

Though food production by aquaculture has certainly increased over the years, *'they remain much lower than most of the often euphoric predictions had claimed'.* Limitations of area, water quality, feed, energy and seedlings make it unlikely to grow much faster.

Aquaculture has two major social aspects: to make money and to combat hunger. In order to make money, the aquaculturist tends to produce high-quality, expensive seafood. To combat hunger, on the other hand, cannot very well be the primary responsibility of the private entrepreneur. Here government support for research and operating pilot plants is required.

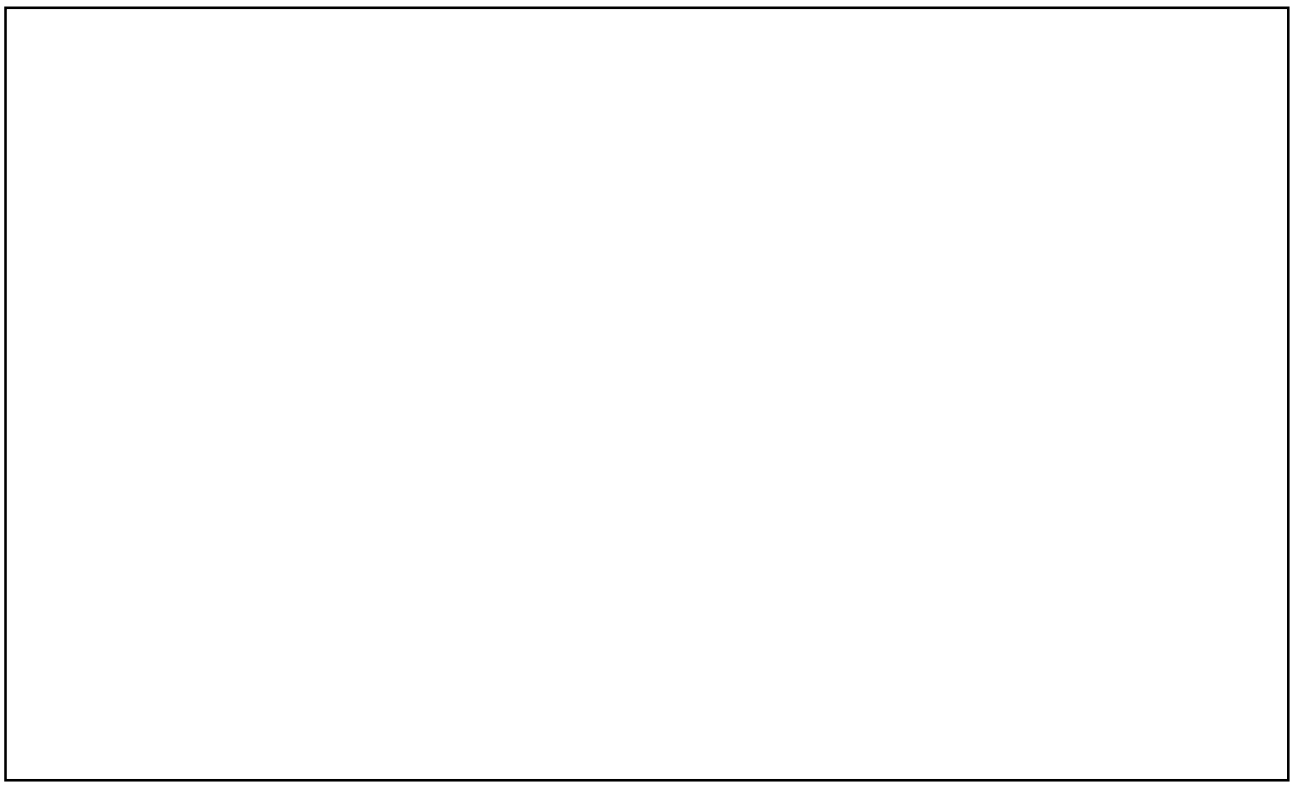
Whether in field or culture, we cannot produce food in purely technical-industrial terms, without the activities of living cells. Food is always produced as a result of ecological processes. The food producer tries to control the flow of energy and matter through the living system concerned. The aim is to obtain a maximum of well-marketable food in return for investing a minimum of effort and cost. What is good or bad for the target organism is what matters most to the producer.

It must be remembered that we do not exploit single organisms or populations, but ecosystems. (The only exceptions are axenic cultures, i.e. those consisting of individuals of a single, known species.)

Just as there is this ecological basis of food production, there are ecological limitations to food production. Man affects ecosystems in four principal ways:

- by changing the flow patterns of energy and matter, as well as the structural properties of habitats;
- by addition of system-foreign materials (waste disposal, pollution);
- by mixing components of spatially separate ecosystems; and
- by removal of system components, i.e. by harvesting selected wild organisms (fisheries) and a variety of non-living materials.

Aqua-food production contributes to all four types of ecosystem distortion. Large-scale aquaculture operations tend to deform natural ecosystem dynamics especially through construction and pollution.



Construction not only alters the landscape along the coast of a river, it modifies water-use and water-flow patterns. In the sea, for instance, artificial reefs change the density and composition of the local flora and fauna. While they normally increase the local productivity of the waters concerned, their consequences on the original ecological situation remain to be carefully investigated.

Pollution from aquaculture farms is caused by feed, metabolites, and therapeutic or prophylactic chemicals. Along a river, discharge of wastes and chemicals upstream may result in chain reactions.

There are other constraints that aquaculture operations have to face: the competitive activities of man for recreation, land-use etc.; the rising cost of energy; and the problem of feed. *"The conduct of feeding fish with fish and shrimp with shrimp in order to feed Homosapiens does not hold the right key for opening the door into the future."*

We must attempt to produce food by increasingly employing principles of ecosystem dynamics. We must learn from nature. She produces, consumes and remineralizes gigantic amounts of organic materials - thousands of times larger than those produced and utilized by man- without accumulating dangerous wastes, without distorting ecosystem dynamics, and without running short of energy or feed. The solution is re-cycling and large-scale food production from low-trophic-level organisms. There are two major levels of recycling:

- ☐ transformation of organic wastes into feed for cultured animals or into fertilizer for cultured plants; and,
- ☐ transformation of microorganism protein built from wastes directly into nutrients utilized as human food.

Agriculture is better suited to produce human food from larger-sized animals. But aquaculture is the method of choice for human nutrients produced from recycling. Some of these are simple, traditional and effective routes, e.g., the use of animal faeces and urine to fertilise fish ponds. With modern advances in sewage treatment, this could now become an aesthetically acceptable aquatic solution for synthesising a multitude of different nutritional components.

Man's nutritional traditions also serve as an obstacle to the ultimate success of recycling. The evolution of specific self-perpetuating habits of food consumption ('nutritional adaptation') largely determine the trends and ends of food production.

The necessary new role of man as partner and protector of nature-rather than her mere exploiter- requires a general, very substantial reorientation in our habits and behaviour. Within the next five decades or so, we must learn how to produce healthy foods from our organic wastes which now pollute our lands, rivers and seas—and we must learn to eat these foods with pleasure.