FISHFUL THINKING FOR A COMMON FUTURE

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Fish Availability

In terms of animal protein products, fish is the second large commodity after meat, totalling some 120 million metric tonnes from both capture fisheries (two-third) and aquaculture (one-third).

Over the last 25 years, fish availability has increased in absolute terms and, globally, per caput consumption raised from some 12 to 16 kg per year, but is now stagnating. This increase in per caput consumption was made possible through a tremendous growth of the aquaculture production, whereas capture fisheries yield grew less, subsequently levelled off, decreased even in absolute terms over the recent years, and is supposed by many experts to have reached its maximum.

Fish is regarded a healthy food in view of its contents of protein (including its amino acid profile), minerals and vitamines (especially marine fish species), and, more especially, poly-unsaturated fatty acids. Because of this "health claim", fish products have become a highly sought after food commodity, especially in affluent societies that can afford to pay high prices, thereby extracting fish from poorer ones. As a consequence, developed countries became, increasingly more so, net fish importers, their imports totalling between 40 and 50 billion US $ in recent years, almost twice as much as their exports. Developing countries experienced a reciprocal situation: their imports, amounting to a close 10 billion US $, are (much) less than 50 % of their exports.
By consequence of these international trade figures, it also must be emphasized that fish and fish products constitute the most traded agricultural commodity and this fact entails inherent demands/risks in terms of meeting food safety standards and of transmission of major communicable diseases.

Taking into account that some 20 % of the world fish production is used for reduction to fish meal and fish oil, the ratio of fish to meat available for human consumption, globally approximates 0.45. However, people in low-income countries did and do often favour fish over meat for animal protein intake and in such countries the consumption ratio fish to meat is often between 0.5 and 1.0 or higher (Born, Verdegem and Huisman, 1994; Gryseels, 2001). Therefore, fish is often regarded as "poor man's animal protein". However, based on what has been mentioned before, one may question whether and how fish can continue to be within reach of that poor man. Or, in other words, (how) can we characterize the fisheries related science and technology demands of the poor in developing countries over the next decades?

In addressing this question, the following two paragraphs will focus respectively on capture fisheries and aquaculture.

Capture Fisheries

During the second half of the last century, capture fisheries experienced a pronounced change. Over the first two decades of that period, total catch increased from some 20 to some 70 million tonnes per year: a growth that was well ahead of that of the world population, sothat global per caput consumption could increase substantially. As a consequence, focus was on fisheries development by means of intensifying fishery effort. Between 1970 and 1980 total horse power of the fisheries fleet in the developed world increased by more than 50 % and in the developing world even by 450 %. However, despite this tremendous increase in effort, fisheries yield increased only by some 10 % over that period. After the 1980's, capture fisheries yield levelled off and even decreased at the end of the last millennium with "half of the world's fish stocks being fully exploited and over a quarter of them overexploited, completely exhausted or just recovering from it" (IFPRI, 1995). An additional concern stems from the fact that in many cases the composition of the fish catch constitutes an increasingly greater share of species that are lower in the food chain, which points to overexploitation by selective fishing for high-value carnivorous species for affluent markets.

It must be stressed that this bleak situation of the fish stocks reflects itself in the livelihood of some 200 million mostly poor or very poor people directly or indirectly engaged in fisheries, among them many women in post-harvest activities.

Basically, two aspects inherent to past and present-day fishery did contribute to this worsened and still worsening situation.

- In both the past and the present, fishing rights have caused conflicts and even war within and between nations. Despite the fact that in 1982 the "New Law of the Sea" changed a "mare liberum" into a "mare clausum" by giving nations jurisdiction over the aquatic resources within their Exclusive Economic Zones (EEZ's), fishing grounds essentially remained – be it on national or regional basis -"open access" resources. There, where limited access or restricted fishing is applied, proves control extremely difficult and expensive.
- Moreover, fish also remained factually a "common property" (a free-for-all-item for every – national/regional – individual fisherman) and the "tragedy of the commons" certainly applied and still applies to many fish stocks.

Although it took a while, the world is now acknowledging that the past focus on fisheries development must be replaced by a focus on sustainable management of fish stocks or even on stock conservation. The consequence of this, however, is more difficult to grasp (especially so by politicians), because it means that in order to make the fishery, also in economical terms, more sustainable, fishery efforts both in terms of manpower and boats/gear must be controlled and in many cases be decreased. It is extremely important to realize that, in order to make the fishery more sustainable, the number of jobs, the number of boats/gear and the amounts of investment in this sector, have to be reduced. (The choice is, as a director of a famous Fishery Research Institute put it recently, to fish with fewer boats in sea full with fish or to fish with many boats in an empty one).

For adequate fisheries management, expert knowledge on the interrelationships between and within fish stocks, fishing grounds, fishing gear and fishermen is indispensable.

- In order to assess the status of a fishery, data relating real fishery effort to real fishery catch are a prerequisite. So-called Catch and Effort Data Recording Systems (CEDRS's) must be in place, but too often are not due to illegal fishing/landings or by sheer lack of manpower/expertise/money. Still, worldwide implementation of effective and efficient CEDRS's at micro and macro level of the fisheries will be an essential basis for sustainable management of the fishery.
- For effective fisheries management, much more knowledge is required about the lifecycle-dependent distribution of fish/fishstocks over time and space, which asks for in-depth auto- and syn-ecological studies. Here, indeed, lays an enormous task but also a promising challenge.
- Development of more selective gear and fishing methods, fashioned to the species-specific traits including behaviour of the target species, forms an enormous challenge and will contribute to alleviate the problem of by-catches.
- It goes without saying that fishermen are not only stakeholder but they themselves are also part of the fishery equation and, therefore, co-management is often claimed to be the panacea in fisheries management. However, this asks from all those involved a concurrence of perceptions of time trends and spatial patterns in catch rates and to relate them to differences in, amongst others, fishery effort. It will be a (too?) tremendous educational and extension task to put a resource poor fisherman in the position to play this role.

Still, it should be realised that "open access to" and "common property character of" fishstocks lay at the basis of the past and present "tragedy of the commons". Therefore, one may argue a rigorous restructuring of the present fisheries in such a way that these "draw-backs" do not avail any longer.

Be it that fish is a rather fluid commodity and does not obey national boundaries or notarial agreements, it is important to realize that fish are **never** randomly distributed in any water body. To really understand the "how" and "why" of this will prove a powerful tool, because essentially such understanding enables a change from management into control, which on its turn opens new horizons for property rights and ownership. In-depth knowledge of fishing grounds and their inhabitants, in the broadest sense, may lead to put a monetary value to them in the form of long(er) term leases/ownership rights, and ownership will form the basis of rational and responsible exploitation/conduct vis à vis the resources owned.

Such a future scenario of long term lease or ownership of fishing grounds may seem far-fetched, but it is crucial to conceptualize a restructuring of the fishery because, if "common property" and "open access" continue to remain the characteristics of our aquatic resources, the future of both these resources and their end-users may remain as bleak as they were in recent past and still are at present.

(PS. It is realised that fisheries is often only one part in - what is now called – "integrated water management", but it is beyond the scope of this short note to take all these interrelationships into account. For the fisheries *per se* this realisation does not change the previous points too much.)

Aquaculture

Although the first known "treatise" on aquaculture by the Chinese Fan Lee dates already from 475 BC, aquaculture really took off after the 1950's. Since then, it proved to be an extremely fast growing agricultural sector and, at present, one-third of the fish consumed originates from a farm. One may soon expect that the monetary value of farmed fish (with a present volume of around 40 million tonnes) will equal that of the yield of capture fisheries.

A few data of the Norwegian salmon industry may illustrate this development including its adverse effects.

- In 1975, salmon production in Norway totaled 100 tonnes and 25 years later this was 400,000 tonnes with a value of 1.5 billion US $.
- Over these 25 years, the production cycle (from egg till slaughter) shortened from 3.5 to 2 years, the feed conversion (kg of feed to produce 1 kg of salmon) decreased from 4.5 to 1.2, and the use of antibiotics fell from 800 g per ton product to – as low as – 3 g per ton.
- However, total waste production at present equals the sewage production of all Norwegian households together.

On the risk of oversimplification, but to facilitate understanding, it is postulated that aquaculture is practised in essentially two different forms (be it that transition forms are many): an ecological and a physiological form.

- Ecological aquaculture is practised in ponds and focuses on the management of a pond ecosystem in such a way that energy and matter flows in the food web are steered by the farmer as efficiently as possible into the production of the species of concern. This process can be artificially strengthened through manuring/fertilization, feeding and aeration/oxygenation. Ecological aquaculture is practised worldwide with Asia in a spearheading role (over 7 million hectares in China!).
- Physiological aquaculture is practised in production units with exchange of water (sometimes recycled after purification) that serves at the same time as vehicle for oxygen inflow to facilitate the fish' combustion process and as vehicle for waste discharge. In such systems, more or less fully fledged feeds (the ingredients of them originating from food webs elsewhere) are used. This form of aquaculture is mainly found in the industrialised countries.

In general, ecological aquaculture focuses on fish species of lower trophic levels and can be considered as low-input farming, whereas physiological aquaculture focuses on high-value, often carnivorous, species in high-input production facilities.

Aquaculture, in all its various forms and ranging from extensive pond farming (not seldom fishery-based for supply of stocking material) to environmentally controlled indoor production units that facilitate the whole lifecycle of the species concerned, can be regarded as a "maturing sector". There is great need for both systems-oriented and commodity-oriented research in the four major areas of farmers' concern, viz. (a) how do we get the small ones (e.g. control of the reproduction process and product), (b) how do we grow them bigger (e.g. nutrition, foods, feeds and feeding), (c) how do we keep them healthy (e.g. health and disease control), and (d) how do we do all this in a sustainable way (e.g. technically and economical feasible, socially acceptable and environmentally sound).

Some of these research areas are elaborated below, because they are regarded crucial for further aquaculture development.

- At present, some 250 to 300 species (finfish, crayfish and shellfish) are cultured. But the majority of them can not (or hardly) be induced to reproduce in captivity, so that stocking material (mature adults and/or fry and fingerlings) is extracted from the wild, mostly in coastal areas, with concomitant damage to the small scale fishery in these areas. Research on reproductive physiology aiming to control the whole lifecycle in captivity, especially focusing on broodstock management and egg/sperm quality has to be fostered with emphasis on low-trophic tropical species.
- Qualitative and quantitative nutritional requirements are known for only some 10 – 20 – mainly carnivorous – species cultured in high-input facilities. These forms of aquaculture are fishery dependent in the sense that some 25 % of the fishmeal produced annually is used as ingredient for their feeds and this percentage could increase with growing production. In order to avoid a mutual damaging conflict between fishery and aquaculture (Naylor et al., 2000), nutritional research should focus on replacing fishmeal and fish oil in fish feeds.
- Other adverse effects of aquaculture, like pollution (waste, therapeutic residues, etc.), habitat destruction due to area expansion (mangrove forest) and genetic erosion of wild stocks due to escapees from farms, need to be addressed.
- Effective health control and maintenance of adequate sanitary standards needs a strong research commitment to develop early warning systems for aquaculture to avoid disasters as happened in the Southeast Asian region's shrimp culture during the last decade. This is the more so urgent because research in this area is hardly focused on tropical fish species low in the food chain.
- More research on and expansion of integrated agriculture-aquaculture sytems (where "waste" from one system is a "resource" for the other) and on polycultures (several species with different non-competitive food preferences in one production volume) is needed to increase the availability of "low-value" fish for the poor. With respect to the latter, potential of periphyton-based aquaculture production systems deserves special attention (Azim, 2001).
- A considerable part of research in the developing countries is devoted to "(identification of) promising local aquaculture candidate species". This is argued from a number of reasons, e.g. enormous biodiversity of fish, market preferences, to avoid risks of introductions of exotics, over-exploitation of the wild stocks, etc. However, apart from these 'pros', there are also 'cons': broad species diversification leads to an exponential growth of research needs that are difficult to meet in view of limited resources. The aquaculture industry may be more efficiently enhanced by somewhat limiting diversification in favour of specialization, the latter including

innovative fish processing techniques in order to specialise in a ranges of products originating from single species.
- In view of the above mentioned biodiversity between but also within species (genetic diversity), quantitative and molecular genetic research should be increased with a special focus on species that are low in the food chain and on traits that enhance overall fitness.
- From analyses covering the 1980's and the 1990's (very recent analyses are - to the knowledge of the author - not available), it is striking to note that the "top aquaculture producing countries" (ranked on the basis of aquaculture production per caput per year) have a national fishery catch that exceeds (sometimes even far exceeds) the domestic fish consumption. Obviously, there is no consumptive need for aquaculture in these countries, which points to the fact that aquaculture finds its "right of existence" by being an economical activity rather satisfying demands than needs. This observation is important in relation to over-optimistic views with respect to aquaculture being the 'blue revolution' for feeding the poor.

Conclusion

In the terrestrial environment, the transition from collecting and hunting to cropping and keeping is practically completed. In the aquatic environment, a similar transition is presently taking place. It is not expected that aquaculture makes fisheries to disappear but further enhancement of aquaculture production could lessen the pressure on the wild fish stocks, which on its turn, together with actions as mentioned under **Capture Fisheries**, could lead to a more sustainable capture fisheries. It is, therefore, of great importance that aquaculture is favoured on the international research agenda with the provision that this contributes to an aquaculture sector that increasingly more thrives to formulate and adopt its own "license to produce' by focusing on the three P's of People, Planet and Profit.

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