Editorial

With much of the main section of this issue of the *Naga* focused on global issues of sustainability and ecology, *Aquabyte* adds to this theme a personal view of the future of aquaculture, by yours truly the Editor, and a further ecological note by Peter Dalsgaard and Bert Oficial. Comments from NTAS members would be very welcome. The Members Write Section has been almost empty recently.

This issue of *Aquabyte* has contributions that range from conservation of freshwater fish genetic resources in India to semi-intensive shrimp culture, also in India, and experimental culture of marine copepods in Indonesia. There is also a mixed bag of News Items, but no Photosection because insufficient materials have been received.

It's now 'Directory Time' again. The first full NTAS Directory was published in 1993. Feedback received from members was that they found it useful for information exchange, particularly among scientists with common research interests. The NTAS plans to publish another Directory early in 1996. Members are urged to notify the NTAS Secretary of any changes (i.e., addresses, contact numbers [telephone, fax and e-mail], and major and minor fields of research interests) from those published in the 1993 Directory and from later communications to the Secretary. Members are also encouraged to send suggestions for improving the contents, presentation, format of the new Directory. We need to receive changes and suggestions by 30 November 1995, so as to allow sufficient time for publication. ***R.S.V. Pullin***

Growth and Sustainability of Aquaculture

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Recent Expansion: a New Frontier

According to FAO statistics, aquaculture, the farming of fish, shellfish and seaweeds, grew rapidly from 1984 to 1992, with average compound rates of increase of 9% per year by weight and 14% per year by value, and in 1993 accounted for 16% of total world fish production and 23% of food fish supplies. What do these figures mean for growth and sustainability of aquaculture and for its future contributions to the global supply of aquatic produce?

Apart from the small number of developing countries in Asia such as China, India, Indonesia, the Philippines, Thailand and Vietnam that produce over 80% of the world's farmed aquatic products, and some significant operations in a few developed countries (e.g., Japan, Norway, USA), most countries still have very few aquatic farms. Aquaculture remains a new frontier and continues to experience some of the ups and downs that typify frontier situations.

The FAO statistics reflect expansion of some long established operations, particularly freshwater farming of carps in China. Some other developments, such as coastal shrimp farming, have enjoyed rapid and unregulated growth, but have suffered from failures and conflicts as competition for markets and resources has intensified and as negative environmental and social impacts and disease problems have increased.

Scope for Growth: Asking the Right Questions

The vast majority of policymakers and developers, agencies, researchers, producers and consumers, ask questions about the future of aquaculture based on a single premise: how can enough farmed fish be produced to fill the gap between supply from stagnating or declining capture fisheries and the increasing demand in developed and developing countries? This is usually followed by more questions and rosy estimates of how many hectares, gallons, person-hours, etc., are available for this purpose.

Are these really the right questions? Most of those asking them would say 'yes', as their counterparts in other sectors frame similar questions for agricultural and forest products. However, such questions address a limited part of the issues for aquaculture and reveal the very limited progress made so far, in the post-UNCED/Agenda 21 world, towards *intersectoral* perspectives and actions. If production of fish, or indeed of anything, costs 'too much of the earth', then it will ultimately not be sustainable and related policies

and consumption and production patterns will have to change sooner or later. A sector-specific approach *lowers* rather than raises the limits of growth to production of any commodity because: 1) it increases the possibilities of resource use conflict; 2) it misses opportunities for intersectoral synergy; and 3) it increases the likelihood of exhaustion of resources.

Most aquaculturists have tended to pursue the development of *fish* farms, and those whose work on cereals, livestock, trees, etc., have done likewise for these commodities. The sustainability of the increasingly intensive monocropping systems that result from this approach is questionable. They tend to be more polluting than mixed enterprise, integrated systems, and are inherently more risky.

For stand-alone fish farms, a farmer might expect a total loss or at least serious loss of profits at least once in 10 years and perhaps, on average, twice in 10 years (from disease, equipment failure, adverse climatic conditions, red tides, theft, etc.). This would mean bankruptcy for some commercial operators and life-threatening situations for some resource-poor farmers in developing regions. Mixed enterprise, integrated systems, that involve *some* aquaculture are less risky and should (coincidentally) produce more fish because they can be more widely adopted.

Those hoping for a bright and beautiful future for aquaculture need to view resource systems in a wider context than that of fish production. This requires more than superficial assessments of resource sharing. It needs the fully integrated expertise of those working in agriculture, aquaculture, fisheries, forestry and in other relevant sectors, such as waste management; and the participation of farmers, fishers and foresters in research and development efforts *from the outset*. The right questions about the future of aquaculture could then be asked and answered.

Research Needs

For aquaculture to expand and to become more productive and *sustainable*, as well as having the 'evolvability' to change with changing circumstances and to avoid untenable environmental and social problems, new knowledge and skills are essential. This means substantially more investment in research and education: targeted not only at the current low status of domestication, husbandry methods and performance of most farmed aquatic plants and animals, but also at the design and improvement of *integrated* production systems, so that aquaculture becomes a pivotal component in the sustainable use of natural resources and complements rather than competes with other sectors.

Aquaculture can become a *routine* component of farming and forestry, not only for fish production, but also for the environmental and ecological 'services' provided by farmed fish and their aquatic surroundings; e.g., waste recycling, provision of fertile waters and pond muds, and contributions to pest and disease control. Such benefits can and should be evaluated in monetary terms.

Beyond the farm level, integrated systems that include aquaculture can also make contributions to environmental restoration across degraded catchments and coastal areas, by assisting forestry, helping to reestablish vegetation, and improving water management and soil conservation. These exciting possibilities have yet to be adequately researched.

Forecasts

That aquaculture contributed 16% to world fisheries production in 1993 compared with only 8.3% in 1984 is probably not a reliable basis from which to extrapolate its future expansion. These data reflect only a few examples of sustainable development and a diverse array of new starts, short-term gains, and failures.

The good news is that, over the next few decades, global aquaculture can probably at least double its current production. The even better news is that the ultimate scope for growth of aquaculture may be much higher still, but only if it can: 1) become an integral part of food and fiber production systems that use natural resources efficiently and sustainably, particularly increasingly scarce resources such as unpolluted freshwaters and coastal waters; and 2) complement environmental restoration and conservation efforts. If this can be accomplished, millions more farmers throughout the developed and developing world could become new producers of fish as well as of other produce, and aquaculture would become a much greater contributor to many national economies.

The key word throughout this paper is 'sustainable'. Without getting into circular debates about the ecological and socioeconomic dimensions of aquatic sustainability, it is enough to cite here the estimate by Huntley (1995) that to the 8% of global aquatic primary production required to support capture fisheries (see Christensen and Pauly, p. 34; and Pauly and Christensen 1995), the demand from aquaculture will probably add a further 2% by the early 21st century, and that most of this will be in coastal regions that are already "stressed". Huntley (1995) proposes mass culture of microalgae as aquaculture feed. The economic and ecological pros and cons of this remain to be seen. It *is* clear, however, that as Huntley puts it, "aquaculture, as currently practised, may become increasingly unsustainable"; and that this unsustainability will be most serious for fish farmed at higher trophic levels. As Imre Csavas has pointed out, all major commercial livestock are herbivores or omnivores not carnivores. For aquaculture, all intensive culture (of herbivores, omnivores and carnivores) is likely to be less sustainable than the mixed enterprise, integrated systems as proposed here.

Further Reading

Csavas, I. 1995. The status and outlook of world aquaculture. Paper presented at the Symposium on Sustainable Aquaculture '95, Public Policy, Financing and Technology for Economically and Environmentally Sustainable Aquaculture, 11-14 June 1995, Honolulu, Hawaii; PACON International, Honolulu, Hawaii.

Huntley, M. 1995. Microalgae as a source of feeds in commercial aquaculture. Paper presented at the Symposium on Sustainable Aquaculture '95, Public Policy, Financing and Technology for Economically and Environmentally Sustainable Aquaculture, 11-14 June 1995, Honolulu, Hawaii; PACON International, Honolulu, Hawaii.

Pauly, D. and V. Christensen. 1995. Primary production to sustain global fisheries. Nature 374:235-257.

Pullin, R.S.V. 1994. Aquaculture, integrated resources management and the environment. Paper presented at the International Workshop on Integrated Fish Farming, 11-15 October 1994, Wu-Xi, China.

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