Aquacultural research as a tool in international assistance

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Summary

Be it that the global production ratio fish to meat approximates 0.6, the role of fish in many developing countries is more important than this ratio suggests. Since it is more and more realized that capture fishery resources are not unlimited, emphasis has been given to enhancement of aquaculture in order to close the increasing gap between demand for and supply of fish.

Total international assistance to the aquacultural sector amounted to some 370 million US $ over the period 1978-1984. Such an investment is only justified as "a means to an end" e.g. as a means to ultimately contribute to the autonomous growth of the industry.

Against this background the role of aquacultural research is discussed. It is argued that aquacultural research should not only be production oriented, e.g. related to fish, to fish husbandry systems and to fish farming systems, but that research also should be resource oriented and take into account the market (purchasing power and consumer behaviour), the socio-economic feasibility respectively rentability, as well as the adequacy of target groups as future producers. The major challenge to the researcher lays in contributing to the development of those aquacultural operations, which are socially absorbable, economically feasible, and which have a high scope for multiplication in the target area.

Introduction

Total international assistance to fisheries over the period 1978-1984 amounted to US $ 2,566,434,000 of which 14% (US $ 368,000,000) was provided to the aquaculture sector (UNDP/NMDC/FAO, 1987). Over the same period landings from capture fisheries in developing countries increased with some 1.0 million tons per year, whereas the increase in aquacultural production in these countries attained some 0.4 million tons per year (Table 1.).

Table 1. International assistence to the fisheries sector (1978-1984).

	Capture fisheries	Aquaculture
Expenditure (x US $ million)	2,200	368
Production increase (x million tons/annum)	± 1.0	± 0.4

Sources: UNDP/MNDC/FAO, 1987
FAO Yearbooks of Fishery Statistics

Against the background of this financial effort it is stated that international assistance must be regarded as a means to ultimately realize the autonomous existence or growth of the activity concerned. This should also apply to aquacultural research, the more so since "research and development" takes a major share of the global budget allocated to international aquaculture assistance.

In view of this, the following aspects will be touched at in this contribution:

- the role of fish *,
- the role of aquaculture, and
- the role of aquacultural research in international assistance.

The role of fish in developing countries

Products of animal origin - including fish - are of major importance as human food commodities due to their relatively high amount of essential amino-acids. Moreover, a health claim is often attributed to fish consumption in view of fish having high amounts of poly-unsaturated fatty acids compared to husbandry animals.

The share of fish in the total world food production of animal origin is some 12%, the production ratio fish to meat being 0.6 ** (Table 2.). However in many developing countries fish plays a much more important role than these figures suggest, fish protein contributing 25% respectively 31% to the total animal protein consumption in Africa and the planned economies of Asia respectively the Far East, these regions being inhabited by roughly half of the world population.

* the term "fish" includes finfish, shellfish and crustaceans.

** From a consumption point of view this ratio can be set at about 0.45, since somewhat over 20 million tons of fish are processed for fish meal/oil.

Table 2. World production of feed commodities from animal origin (1986).

Milk	521 million tons
Eggs	32 million tons
Meat	155 million tons
Fish	85 million tons

Especially in low-income countries the consumption ratio fish to meat is much higher than 0.6, stressing the fact that fish represents a relatively cheap commodity. Be this the case, per capita fish consumption in these countries is also related to the average per capita income, which stresses the importance of purchasing power as a governing factor in fish consumption (see for more details: Huisman, 1986).

The role of aquaculture in developing countries

In Table 3 the relative contribution of aquaculture to the total fish consumption is given for the different world regions, which indicates that both Asia and - be it to a lesser extent - Europe can be considered as "aquaculture developed" regions, whereas aquaculture in Africa is almost neglegible. Moreover, Table 4 indicates that a major part of the "aquaculture developed" countries do have a domestic fish supply (mainly from capture fisheries) which exceeds domestic fish consumption or, in other words: countries with a high per capita aquaculture production are often net-exporters of fish products (be it fishery or aquacultural products).

Table 3. Relative contribution of the aquaculture production to the fish consumption per region (1985).

Region	Fish consumption (in kg per caput per annum)	Aquaculture production	Relative contribution of aquaculture (%)
Asia & Oceania	15.8	2.25	14.2
Latin America	9.8	0.21	2.1
Africa	10.5	0.03	0.3
North America	16.6	0.75	4.5
Europe	18.0	1.57	8.7

Source: Huisman and Machiels, 1986.

Table 4. The world's major aquaculture developed countries.

Country	Fish consumption	Fish catch	Aquaculture production
	(in kg per caput per annum)		
Taiwan	-	-	9.29
Japan	84.6	89.3	4.71
Denmark	48.2	395.2	3.34
Philippines	31.4	31.6	3.10
Israel	17.1	6.7	3.02
Bulgaria	5.5	14.2	2.58
Hungary	3.6	3.1	2.47
Norway	51.5	589.6	1.95
Romania	6.1	7.8	1.86
Hong Kong	49.5	38.2	1.57
Yugoslavia	3.1	2.6	1.31
USSR	25.5	35.7	1.28
India	3.1	3.6	1.24
Indonesia	11.6	12.4	1.24
Sri Lanka	14.1	12.6	1.16

Source: FAO, 1984
Huisman and Machiels, 1986.

Obviously, aquaculture does not serve always, nor exclusively, the objectives of domestic food security, but may have a number - or a mixture - of other objectives as well, like trade and foreign currency objectives, employment objectives and/or objectives to increase the income of rural communities. The following examples may illustrate this;

* The Indonesian shrimp exports accounted for some US $ 280 million in 1986 and government policy aims at enhancing shrimp cultivation for export: a foreign currency objective (Affandi, 1987).
* In Bangladesh shrimp forms the second important export commodity and half of it is cultivated: also a foreign currency objective.
* In Nigeria annual capture fishery landings decreased over the period 1980-1986 with about 60% (± 325,000 tons). This short-fall due to over-fishing and habitat modifications could be compensated by increased imports up to a maximum of ± 250,000 tons. However, these massive importations have ceased - and thereby fish consumption dropped - after the recently implemented monetary restructurization. In view of these developments last year a "Nation-wide Aquaculture Development Programme" has been initiated with the ambitious objective to ultimately restore fish consumption at former levels: a mixture of a food security and a foreign currency savings objective.
* In Ecuador some 100,000 new jobs were created over the past 2 decades in the fast growing shrimp culture in-

dustry: a mixture of an employment and a foreign currency objective.

Whatever the objectives may be, aquaculture development invariably needs either domestic or foreign demand for the food and/or cash crops to be produced.

Based on what has been mentioned before it can be argued that successful aquaculture development asks for a market with purchasing power (income-dependent fish consumption), but it also asks for the commodity fish being already available and accepted, since aquaculture developed countries often are also well developed in capture fisheries (Table 4.). This prerequisite concerning fish availability leads to the theory that fisheries may pave the way for aquaculture via product acceptation and trade respectively market infrastructural facilities.

As has been mentioned in the introduction (inter)national assistance to aquaculture development should ultimately realize a self-sustained and autonomous growth of the industry. In view of such an objective FAO (1984) suggests that assistance to enhance or develop an aquaculture sector should continue till a threshold production level of some 50 to 100 g production per caput per annum has been reached. If such an objective is not aimed at, the question may be asked whether aquaculture directed assistance must not be regarded as an indirect and ineffective form of food aid.

The role of aquacultural research in international assistance

It must realized that execution of aquacultural research should be the outcome of a previous decision making process. First of all on policy-level the question should be answered whether or not more fish is required and for what reason (food security, export, or otherwise). In case this question is answered positively, the strategy to obtain more fish must be decided on: by capture fisheries versus by aquaculture versus by importations. Only if aquaculture is regarded the strategic viable option aquacultural action-research - be it fundamental or applied - should be executed.

In the framework of international assistance the research challenge will often lie in the question "in which form and under what circumstances can aquaculture be implemented in such a way that both economic rentability of the production and demand and purchasing power for the product lead ultimately to an autonomous development of the industry?"

In view of this question a few aspects of aquacultural research will be touched at with emphasis on the role of aquaculture in rural areas.

Fish related research

There is a tremendous need for more knowledge concerning aquaculture species, be it established or promissing candidate species.

- Roughly some 250 different species are in a more or less controlled way cultivated by man (FAO, 1983). However, by far the majority does not reproduce in captivity and only a few can be dependably reproduced on demand throughout the year.
- The knowledge about quantitative and qualitative nutritional requirements of these species is restricted to a small number of established cultured species and this concerns mainly cool and cold water carnivorous ones.
- Research in fish health is often very limited in developing countries. The International Foundation for Science (IFS) at present has financed 196 scientists in its aquacultural programme (IFS, 1988) of whom only 13 in the fish health sector. This is already a large improvement because 2 years before this sector was only represented by 3 out of 150 grantees (Huisman, 1987).

Farming/husbandry system related research

Aquaculture - be it extensive or intensive - is carried out in many different husbandry systems (still water ponds, flow-through ponds, cages, hatcheries, enclosures) and can be encountered in different farming systems (subsistence, industrial, monoculture, polyculture, integrated culture). The choice of the system depends on the knowledge available about the species of concern, the physical-geographical characteristics of the site, the availability and "payability" of inputs, like fertilizer, feeds, capital, labour, energy and expertise.The importance of such a choice can be illustrated as follows. Total energy costs per kg product in an intensive milkfish/prawn culture can be 1,200 times as much as the energy costs of an extensive carp/tilapia polyculture, whereas the farm-gate prices of these products differ "only" by a factor 10 (Pitcher & Hart, 1982). Such differences in required inputs are important to consider in formulating aquacultural development objectives and implementation strategies.

In the framework of introduction of aquaculture in certain target areas the multiplicability of the system to be introduced must be taken into account and this asks for thorough physico-geographical surveys with respect to hydrology and soil characteristics to ensure the feasibility of a snowball-effect.

Market related research

In fact market studies should preceed any aquaculture enhancement or development action, but in reality such studies are mostly limited to declare that there is a need for fish argued on the basis of decreasing catches and/or quantitative or qualitative shortfalls in fish.

In Africa some 90% of all donor funds over the period 1972-1985 (US $ 135 million) was spent for small-scale aquaculture development with the subsistence farmer as target group and improvement of the family diet as main objective (CIFA, 1983; Euroconsult, 1985; Huisman, 1986). However, it should not be forgotten that the cost price of 1 kg cultivated tilapia or catfish almost equals an unskilled labourer's daily wage. For aquaculture development especially in rural areas, there is a major need to identify (future) target consumer groups and to assess their purchasing power, consumer behaviour and preferences.

In most cases cultivated fish will reach the consumer through more or less the same channels as captured fish. However, the market supply of the fishermen has a much wider species variability than that of the aquaculturist. From this it follows logically that a high research effort is put in "species directed husbandry technology". For instance all 196 grantees financed by the IFS-aquaculture programme sofar study over a 100 different species, and in fact many of them devote themselves to "aquaculture candidate identification research". Such a broad diversification can not only be argued from a consumer's preference point of view, but also from a number of other reasons, e.g. avoiding risks of introduction of exotic species, suitability of the species for research purposes, over-exploitation of the natural stock, enlargement of the aquaculture data-base, etc.etc. However, apart from these pro's, there are also con's as follows.
Aquaculture candidate identification asks for answers to species-specific - but often disciplinary identical - questions (e.g. easy reproduction, efficient feed conversion, handling- and disease resistence), and thereby leads to more or less similar research projects. At the same time such a broad species diversification also leads to an exponential growth of research requirements which will be difficult to meet in view of limited resources. It is, therefore, argued that the aquaculture industry would be more efficiently enhanced by limiting species diversification somewhat more in favour of disciplinary specialization.

Economy related research

Economic rentability of the production process has already been advocated as a prerequisite for continuity and autonomous development of aquaculture. In case of luxurious species, like prawns and seabass, such a prerequisite is often met. However, if aquaculture is ment to play a role in a food security strategy for rural areas, the situation is often different. The low purchasing power in many rural areas and concomitantly the low fish prices are often prohibitive to make large investments in rural aquaculture.

In the document of UNDP/NMDC/FAO, (1987) aquaculture development in the Central African Republic is often used as a positive example.However, the cost component of the expatriate experts, involved since 1973, amounts to some US $ 3 per kg cultivated product (Euroconsult, 1985).

In Nepal public funds to operate the aquaculture stations

and hatcheries are of such a magnitude that in fact they form a governmental subsidy of US $ 0.55 per kg cultivated fish, the retail price of this fish ranging from US $ 1.0 to US $ 1.5 per kg.

In the Fisheries Research Institute of Malaysia almost half of the total staff work on aquaculture, whereas aquaculture production is only some 10% of the fisheries production (UNDP/NMDC/FAO, 1987).

Such types of "investments" are not necessarily unjustified, but - the more so - they point to the need to ultimately obtain autonomous development of the industry, and at the same time they point to the long term character of such a development.

In this context a remark must be made about the often advertised small-scale approach. Construction costs of small ponds is relatively very expensive (Figure 1.) and certainly does not always justify the optimism about the economic rentability of the small-scale approach. The choice of species, of husbandry- and of farming system seems of more importance to realize economic feasibility in aquaculture operations.

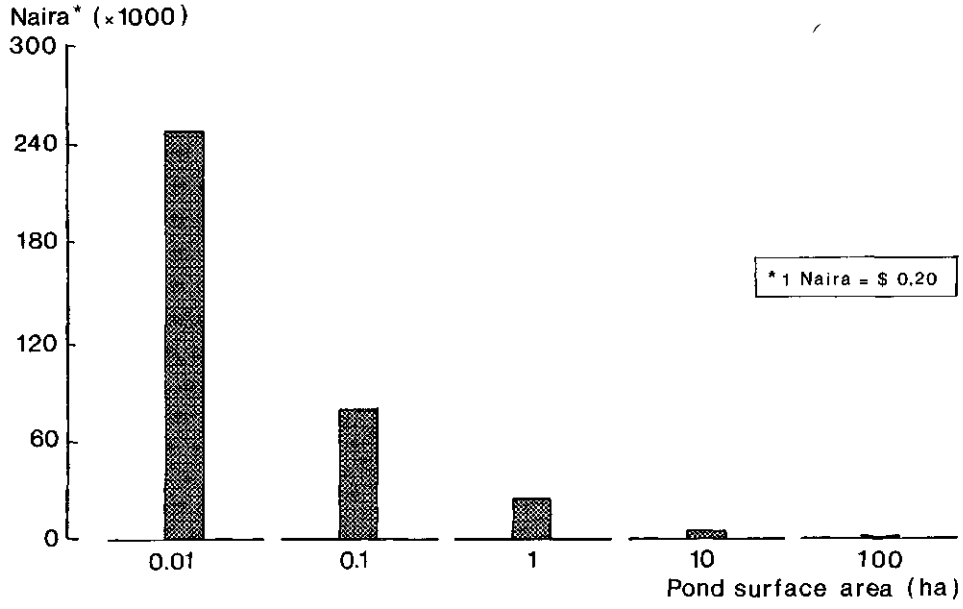

Figure 1. Costs of pond construction per ha relative to pond surface area (Nigeria, 1987).

Producer related research

A main question in aquaculture development is "who is going to culture the fish?". Concerning this a few remarks will be made based on African experiences. Rural development in Africa is mostly directed to the subsistence farmer, who has a rather

extensive land-use with relatively low inputs, a low yield per unit of surface area and a rather high diversification in crops, cultivated in a seasonal cycle. In the (semi) humid areas these farmers become fishermen in the dry season, not only because then the fish is easily captured but also because agricultural labour demand is generally low in the dry season.

Since aquaculture in Africa is to quite an extent a novelty (Table 3), a subsistence farmer, who often has an attitude of risk avoidance will not easily trust such a novelty introduction with inherent risks both in production and marketing.

Under such circumstances an aquaculture development strategy should

- include a safety net for the producer, like garanteed selling prices, credit schemes and marketing assistance.
- introduce those types of aquaculture, which can be linked to - and do not compete with - present and accepted agricultural pratices.
- be of long term character and not only have the objectives of biological and technological success but should also include a certain production volume and the economic rentability as objectives to be attained.

Concluding remarks

Based on what has been mentioned sofar it is stressed that both research in aquaculture (species and system related) and research about aquaculture are badly needed to answer the question "in which form and under what set of circumstances can aquaculture be introduced and developed successfully in rural areas?".

Such research inherently has to reconsider the often cited project objectives like family nutrition and diet improvement as well as the direct target groups of subsistence farmers, although both these objectives and target groups can be of great importance in governmental policy concerning aquaculture development.

As has been mentioned, fisheries paves the way for aquaculture. Therefore integration of certain aquacultural operations, like reproduction centers, with existing and accepted forms of fisheries, resulting in so-called "culture based fisheries" could be a better socio-economically absorbable approach in rural areas than aquacultural operations in senso stricto.

In summary, aquacultural research as a tool in international assistance should be fashioned to the needs to develop and implement such forms of aquaculture, which are socially absorbable, economically feasible, linked to - and not competing with - present activities of the target groups and have a high scope for multiplication in the target area, to ensure ultimately autonomous growth of the industry.

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