AQUACULTURE SESSIONS

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Some Experiences in Aquaculture Development

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RESUMEN

Como industria joven que emerge, la acuacultura confronta muchos problemas y limitaciones. La naturaleza y magnitud de estos difieren considerablemente entre regiones y países. En esta ponencia se examina la experiencia ganada al vencer algunas de las limitaciones en los países escogidos. La industria italiana de cultivo de truchas provee un ejemplo de expansión rápida mediante la acción bien planeada del sector privado de un país desarollado. La introducción del cultivo rural de peces, en pequeña escala, en la República de Africa Central, constituye un ejemplo único del éxito alcanzado por el sector público de un país en desarrollo mediante la ayuda esencial de las diversas agencias directa o indirectamente concernidas. La acuacultura se ha convertido en una empresa significativa en las Filipinas como resultado de la política de apoyo del gobierno combinada con las iniciativas del sector privado. Aunque estas experiencias justifican optimismo, los enfoques y soluciones usados en otros sitios no necesariamente tienen que ser aplicables a los países del Golfo y el Caribe. Tendrán que desarrollarse y adoptarse normas, estrategias y technologías apropiadas para las condiciones y requerimientos locales.

INTRODUCTION

I was invited to speak at this conference to describe some instances where constraints to development of aquaculture have been overcome. In most aquaculture meetings various constraints facing the industry are reviewed, but few cases of success in overcoming constraints are reported. There is no doubt that problems are being solved and successes achieved in aquaculture production. World production through aquaculture has increased about 42% in the last 5 years. From about 6.1 million tons in 1975, it has risen to above 8.7 million tons in 1980. In many countries, aquaculture is contributing to the food and nutrition of the people and generating full- or part-time employment in rural areas. Surely these achievements are being made in the face of numerous problems and constraints. Although many of these continue, some of them must have been at least partially solved to reach the present state. Detailed information on these is not so readily available.

It was further suggested that my talk should be in the nature of an overview, if possible, with some reference to the Caribbean region. This made my task

a little more difficult. However, I decided that the best I can do is to attempt an overview of selected successful aquaculture programs—unfortunately, none of them from the Caribbean region—and leave it to you to judge whether they contain any lessons of value to this region. I decided to talk about one successful aquaculture program each, from an industrially advanced country in Europe, a least-developed country in Africa, and a developing country in Asia. Before doing so, however, I would like to go over very briefly the major constraints that are considered to hamper aquaculture development in general.

MAJOR CONSTRAINTS TO AQUACULTURE DEVELOPMENT

Planning and Legislative Support.—Despite its antiquity, aquaculture is very much a new industry in most countries of the world. Very few of them have an established policy or strategy for its development; no agreed national plans, delineation of priority or appropriate legislative support. One could legitimately ask the question: what comes first, the chicken or the egg? Would it be reasonable to expect national policies and legislation before the industry assumes national significance? Conversely, in the absence of such support can one justifiably expect the expansion of the industry to assume the required significance?

Technological Deficiencies.—Technological deficiencies and inappropriateness of technologies are often major constraints. Solutions to these are somewhat more easily found, although not easily implemented. Multi-disciplinary systems-oriented research is now increasingly recognized as essential to the development of viable aquaculture technologies. Pilot operations and adaptive research to modify or improve technologies have been found to be the most efficient means of solving these problems. The need to concentrate on a small number of farming systems, rather than a large variety of species and methods of culture, in order to obtain rapid results, is also fairly well recognized.

Trained Personnel.—Probably the greatest constraint of all is the scarcity of adequately trained aquaculturists with hands-on experience. This, I believe, is a problem in most countries of the world, both developed and developing. The absence of effective extension services is also often cited as a major constraint. The importance of such services depends to a large extent on the organization of the industry. The effectiveness of these services depends on a number of factors, including personal qualities, training and experience of extension workers, and linkage with development support such as credit, subsidies, supply of inputs, and others. The socio-political system in the country can have a decisive role on extension services. This is well illustrated by the role of extension workers in the communes in China and the Kibbutzim in Israel.

Availability of Inputs.—The production and distribution of the major inputs necessary to aquaculture, such as seed, feed and fertilizer, are constraints in many developing countries. Methods adopted for overcoming these differ

among countries. Production of seed or stocking material of carps at the farm level has been very successful in China. On the other hand, in India, centralized production in a small number of hatcheries and nursery farms in each State is being undertaken to meet the national scarcity of seed. When it comes to feed, the problem in most developing countries is the absence of a fish feed industry and appropriate formulations of low-cost feeds based on locally available ingredients. While much basic work has been started, including surveys of feed ingredients, formulation, preparation and testing of feeds, the majority of developing countries still use whatever inexpensive feedstuffs are readily available. Many industrially advanced countries have established fish feed manufacturing facilities to meet national needs, as well as for export.

Use of fertilizers is limited to certain types of cultures only, but in countries where the fertilizer industry is not well developed, there are obvious conflicts with other competing uses, such as agriculture. Only in countries with very strong aquaculture industry has it been possible to obtain allocation of fertilizer quotas for aquaculture. In others, a very successful solution has been the integration of crop, livestock and fish production, enabling the re-cycling of wastes and full utilization of production capacities.

Marketing.—Marketing, as a constraint, generally occurs only when the product is for export, or when the species produced have low consumer preference. As will be illustrated by one of the examples I shall be describing later, product promotion and cooperative arrangements with importing countries to regulate the quality and volume of production, have paid dividends.

Research Support.—Despite widespread interest in aquaculture research and the increasing number of institutions involved in research on one or more problems related to the science, development of viable technologies for farming has not yet been very substantial. The multidisciplinary nature of the science and, as I mentioned earlier, the need for systems-oriented research to develop appropriate technologies for relevant farming conditions, have now begun to be recognized. This is the rationale for FAO's establishment of six regional aquaculture centers in Asia, Africa and Latin America in the last 3 years, for multidisciplinary systems-oriented research and training.

Information.—The last constraint I want to refer to is access to aquaculture data of importance to development planning. These are generally not published in scientific journals; if they are, the detailed data are omitted. Such data are generally available only from unconventional sources. In order to facilitate the wide distribution and use of such information, along with conventional types of information that may be useful for research, FAO has recently developed a computerized information system. We call the system AQUIS; it will initially function through the network of six regional aquaculture centers. It is our hope that eventually these can be linked to centers in other parts of the world, making it a truly global system.

TROUT CULTURE IN ITALY

The trout culture industry in Italy is, by any standard, a remarkable success. Italy was until 15 years ago a major importer of trout, and it was mainly Danish trout that one could buy in the fish stalls and supermarkets. Now Italy is the largest producer of rainbow trout in Western Europe and the current production is over 20,500 tons. How was this achieved? Almost entirely by the efforts of the private sector!

First, there was a change in the farm sites. In Italy, trout (mainly rainbow trout) culture originated in the mountainous areas of Trentino in northern Italy. It was believed that high altitude, cold climate and water supply from mountain streams were essential for trout culture. The limitations of water and land prevented expansion of the industry in this area. From around 1960, the progressive trout culturists started operations at lower altitudes in the plains south of the Alps, where there is a plentiful supply of spring water of 12° to 13°C in marshy areas not utilized for agriculture or other purposes. Springs with flows of 2,000 to 3,000 l/sec could be found in many places. Since adequate land and good quality water were available, and a fairly well-developed technology was at hand, development was rapid. There were, and still are, other constraints. Although fish farming is not licensed, a permit has to be obtained for extraction of spring water for farming. This involves a complex and time-consuming procedure, but it is overcome in a very unorthodox way. The application is turned in and the operations are started, in the hope that the permit will come in due course, maybe in 4 to 5 years! In course of time, the small producers have phased out and the industry is now in the hands of farmers with necessary financial resources of their own. So finance and credit do not pose a problem. More than 90% of the farmers have organized themselves into an association known as the Italian Fish Farmers' Association (Associazione Piscicoltori Italiani) which meets regularly to discuss common problems, particularly those of production and marketing, and to find appropriate solutions. The Italian association is linked to the European Federation of Salmonoid Breeders, which through its Marketing, Diseases and Environmental Committees, endeavors to find solutions for problems of a regional nature. Both the national association and the Federation help in the transfer of useful technological and other information among members, through regular meetings and publications. The most significant role of this linkage, insofar as Italian trout culture is concerned, is to determine realistic export possibilities, and to regulate production accordingly, so as to maintain supplies at the optimum level without affecting prices adversely. At the national level, the Association launched an aggressive promotional program to increase home consumption. The home market for trout increased about 21% in 4 years; the 1980 consumption was about 17,000 tons. Exports have been maintained at about the same level since 1974, when they reached a peak of 3,800 tons.

On the technological side, minor improvements were made in the hatchery incubators. Plastic jars of 45- to 60-l capacity with vertical upward water flow are now used for bulk incubation to the eyed stage. Afterwards, eggs are

moved to troughs or small concrete raceways for hatching in mesh baskets. The newly hatched alevins fall into the trough and are separated from dead eggs and debris. Twice weekly treatment with malachite green serves to prevent fungal growth. About 500,000 eggs are obtained in less than 3 weeks from each incubator. Production of alevins is often separated from the rearing of marketable fish. The mountain sites, which were formerly used for growing adult fish, are now often used for production of alevins.

In earlier days, trout feeds used to be imported into Italy. By establishing manufacture of feeds locally, the relative cost of feeds has been greatly reduced, although the industry has still to depend on imported ingredients. The introduction of mechanization of farm operations, including grading, feeding and water management, has resulted in greater labor efficiency, to the extent of around 80 tons of fish being produced by about six workers. The necessary equipment is manufactured locally.

By cutting production costs, the market price of trout has been maintained at a steady level. Comparatively speaking, trout has now become a low-value fish, but the margin of profit of the producers has not been reduced. The major constraint that still remains with no immediate prospects of solution is disease, particularly viral hemorrhagic septicemia (V.H.S.), which accounts for 20–30% loss of stock. Vaccination against V.H.S. and infectious pancreatic necrosis (I.P.N.) is being tried, and has shown some promise.

RURAL FISH FARMING IN THE CENTRAL AFRICAN REPUBLIC

Now I would like to tell you about a fairly successful rural fish farming project in what is usually referred to in U.N. parlance as "a least developed country" (L.D.C.) in Africa—the Central African Republic. During 1952–60, the French colonial administration introduced small-scale rural fish farming in this country, as in some of their other colonies, mainly for the improvement of the nutrition of the local populations. Some 12,000 to 20,000 homestead type ponds were constructed during this period and tilapia culture was popularized. The termination of the colonial rule in 1959 was followed by a period of rapid decline in fish farming, largely due to the lack of technical know-how among the local population, the scarcity of essential inputs and deficiencies of the techniques adopted. As in other African countries, the ponds were too small and no effective means of controlling over-population or stunting of populations were adopted.

Recognizing the important role that properly organized fish farming can have in the Central African Republic, as well as its neighboring countries, FAO with UNDP funding support, initiated a regional project in 1968 for training of personnel and for adaptive research to improve the technologies. The headquarters of the project were based in Bangui, with sub-centers in Gabon, Congo and Cameroon. The project conducted training courses for middle-level aquaculturists (cadre moyens) and lower-level extension workers (moniteurs) at its headquarters for candidates from all the four participating countries. By the end of the regional project, the Central African Republic

had trained six middle-level personnel and 28 moniteurs. A national fish culture station was established in Landjia in the suburbs of Bangui. A fairly simple technology for the production of 4 to 10 tons/ha of tilapia, mainly *Tilapia nilotica*, was developed. Besides this, useful investigations on the breeding and culture of the African catfish *Clarias lazera* and integration of pig raising with fish farming were also carried out.

On the expiry of the regional project, a UNDP/FAO country project was started in 1973 with the purpose of introducing improved rural fish farming in Central African Republic. This project, which is still operational, has attracted support from many other donors, including USAID, UNICEF, the Government of the Netherlands, FED, and others.

The simple technology considered most suitable for extension under local conditions consisted of intensive feeding of fry or fingerlings of *T. nilotica* with locally available feedstuffs, including beer draff and cotton seed cakes or pelleted feeds where possible, made with local agricultural and industrial waste products.

By proper feeding, the fish could be grown to a weight of about 150 to 200 g in 3 to 4 months' time. Harvesting is done by draining the ponds before peak breeding occurs. Fry or fingerlings recovered are used for re-stocking the ponds after preparation. Some 10 fingerling production and distribution centers were established which functioned also as the centers for extension assistance. Extension workers assigned to work from each of these centers functioned as focal points for technical guidance and provision of essential inputs. Pond construction was done on sites selected and according to designs prepared with the assistance of the extension workers. Labor was contributed by the farmer and his family, sometimes assisted by friends and neighbors. The extension agent arranges for the supply of fry or fingerlings if needed. All assistance is contingent on the extension worker being satisfied that his advice and instructions are being followed. During the first phase of the national project (1973–76), the project covered more than 900 farmers and some 1,200 ponds. Over 30% of the production is used for home consumption, some 50% is sold, and 20% restocked for further growing. At present there are some 4,300 ponds (about 5,400 ares) and 3,300 farmers involved in tilapia farming in the project area. More extension and fry production centers have been established. Some 26 more moniteurs and about 90 village-level workers were trained to cope with the increased requirements of extension services. The total estimated marketed production is not too large, only about 50 tons, but its impact on the rural economy is very significant in terms of nutrition of the people, part-time employment to the farmer and his family members, supplement to their meager income, etc. The consumption of fish has increased up to 20–44% or 4.3 to 7.3 kg per caput/annum on a national basis, and almost 100% in the areas covered by the project.

The elements of the project that have contributed to its success are the low-level appropriate technology developed, the training of required personnel and organization of suitable extension services. There are new areas of work being developed, such as the establishment of a modern hatchery for increased production of tilapia and catfish fry, polyculture and popularization of pig

raising with fish production. However, from the point of view of the solution of constraints, the successful reintroduction of small-scale tilapia farming is the most significant.

BRACKISHWATER AQUACULTURE IN THE PHILIPPINES

Now, I shall try to describe briefly the successful development of aquaculture through the combined efforts of the private sector and the government. Trout culture in Italy illustrates the achievement of the private sector. Tilapia culture in the Central African Republic is an example of the achievement of the public sector with international assistance. Combined and concerted efforts can have a much greater impact on a national scale.

Brackishwater aquaculture, more precisely milkfish farming, has been in existence in the Philippines for almost three centuries. The traditional practices concentrate on pond management for the growth of blue-green and green algae, and stocking the ponds with fry caught from the wild, producing on an average 150 to 200 kg of fish/ha/year. It was in the year 1965 that a concerted effort was made to introduce more intensive farming, based largely on Taiwanese experience, under a UNDP/FAO project. Even early tests showed that production up to 3 tons/ha/year can be obtained. The techniques adopted included: (a) improved water management, adequate fertilization of pond soil and eradication of pests in order to maintain an optimum algal pasture, (b) intensive stocking and some supplemental feeding followed by (c) selective harvesting to thin populations or remove larger fish and (d) repeated stocking and harvesting. Wider application of these practices raised the national average production to about 1,000 kg/ha/year and this gave rise to a new awareness of the potential for aquaculture development, both in the government and the private sector.

The Presidential Decree 704 of 1975 which includes a statement on the national policy on fisheries and aquaculture, constituted a very explicit expression of the government's commitment to this sector. After the Philippines became self-sufficient in rice production, President Marcos exhorted his countrymen to devote their attention to making the country self-sufficient in fish. This provided the essential government backing, the lack of which is often a major constraint in many countries. Due to reasons that I shall refer to later, the major part of the aquaculture industry came into the hands of the well-to-do progressive farmers or entrepreneurs. They have the clout to influence government policies and have the capability for acquiring by themselves the skills, information and inputs needed. This ensured both private and public sector support for the industry.

Brackishwater aquaculture is carried out on inter-tidal lands which are owned by the government. By law, lands suitable for aquaculture cannot be allocated for other purposes. They are leased to qualified applicants on yearly renewable permits or on long-term leases for 25 years, renewable for another 25 years. To be qualified, the applicant needs to show that he will be able to develop at least half of the land into aquafarms within 3 years, the other half within 5 years. He has to provide evidence of financial resources to meet the

sizable costs involved. If government inspectors are not satisfied that the conditions are fulfilled, the lease can be revoked.

Costs of construction of brackishwater farms vary, but they may be up to US$ 6,000 or more per ha. The average size of holdings in the Philippines is about 40 ha—about 20 ha being considered the minimum economic size. This would indicate the magnitude of investments needed for a farm, and partly explain why the industry has gone into the hands of the well-to-do.

Loans used to be available only to persons with hard collateral. However the government has introduced certain relaxations for obtaining credit from the Development Bank of the Philippines. Now a fish farmer can get a loan if he: (a) has a 25-year lease agreement, (b) has started development work, (c) has the necessary equity or counterpart funds, and (d) has an acceptable program for development. Consequently, only genuine and deserving investors can expect to get the necessary loans.

The fish farm operators, as they are referred to in the Philippines, generally employ what are called "caretakers" to operate their farms. The owner-operator tries to obtain as much information and expertise as possible from research and development agencies in the country and elsewhere, and give the caretakers the necessary training and guidance. The owner-operators or fish farmers have joined together to form The Philippine Federation of Fish Farmers with regional and provincial groups all over the country. Besides trying to find solutions for both technical and organizational problems, the Federation is able to bring pressure on governmental as well as non-governmental agencies, to respond to the needs of the industry as they see them. They organize seminars and training courses for their members. At the monthly and yearly meetings of the Association at national, regional and provincial levels, aquaculture scientists and other specialists are invited to give talks and participate in discussions on current problems. Some of the associations publish abstracts of information on latest technologies for the benefit of their members. The small holders in the country also get some benefits through personal contacts with the association members. The Farmers Federation has negotiated rebates with fertilizer manufacturers and also arranged collection and distribution of organic manures at cost. It participates, along with government institutions, in locating new milkfish fry sources to augment the present insufficient supplies. Research institutions have intensified their investigations on controlled breeding of milkfish. Some small-scale shrimp hatcheries have already been established and are producing fair numbers of post-larvae for farming.

I do not wish to suggest that all constraints to aquaculture have been overcome in the Philippines, but there is no doubt that many of them are now of the past. Aquaculture has established itself as the most economic way of fishery production. A recent comparative study made by the Development Academy of the Philippines, the Philippines School of Economics and the University of the Philippines Population Institute, showed that the average return on investment in fish culture is about 68% as compared to 11% for large-scale commercial fishing and 21% for small-scale coastal fishing. In 1979 Philippine aquaculture production was about 285.5 thousand tons valued at

about US$ 146.6 million. In the national fishery plans, projected annual growth in the sector is 10.8%.

CONCLUSIONS

I do not know whether the means adopted in these three countries to develop aquaculture have any direct relevance in the Gulf and Caribbean countries. But I think they clearly demonstrate that constraints can be, and have been, overcome.

Experience so far seems to indicate that public and private sector support is essential for rapid development. Such support can more easily be attracted when the industry assumes some national significance. In countries where aquaculture is new, reaching that stage often presents very serious difficulties. This is why FAO has been advocating the wider application of a small number of known technologies, despite their deficiencies, in order to achieve a sizable production at an acceptable cost. This, I think, will counter arguments that the relatively small volume of present-day world production from aquaculture does not justify the investments required to develop aquaculture to its full potential. Whether this is a sound argument or not, it is one to be contended with when decisions are made on the allocation of scarce resources.