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BY : Kenneth T MacKay

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# ASIAN AQUACULTURAL RESEARCH CHALLENGES FOR 2000 A.D.

*Kenneth T. MacKay*
International Development Research Centre
Tanglin P O Box 101, Singapore 9124

## ABSTRACT

*Asian aquaculture has been expanding rapidly and is projected to double by 2000 AD to produce 18 million MT. Previous support to aquacultural research has been ad hoc and fragmentary. Current suggestions by aquaculture experts is for the creation of an International Centre to assist in coordinating research. The suggested priorities for such a centre would be to work on a few species (species, carp and catfish) and on long term basic research related to nutrition, reproduction, seed production and disease. This centre would work closely with national programs via various networks. It is not clear on the priorities for such national researchers. An alternative approach is suggested which suggests that research priorities be set by the producers. Illustrations from rice cum fish culture in N E Thailand show that the research priorities would be much different. Additional research skills from socio-economics are required to carry out this farmer-back-to-farmer research. Many of these methodologies are currently used in agricultural farming systems research and can be applied to aquaculture.*

## INTRODUCTION

The year 2000 is coming closer, it is now only 12 years away. Predicting the future is difficult. It becomes more difficult as the future becomes closer because futurist and the audience will still be alive to judge the accuracy of the predictions. In order to improve the accuracy of my predictions I will attempt to learn from ecological and evolutionary theory. In an unpredictable environment the best strategy appears to be a generalist (non-specialist) and employ a wide diversity of approaches. I can certainly claim to be a generalist and I plan to give you a diversity of views of the future (two to be precise). I will initially give you the view from the experts based on a review of a number of recent papers and then attempt to give you the view from the producer, the men, women and children who will produce the aquacultural products. Finally I will attempt to synthesize and suggest the tools and skills needed to carry out aquaculture research in 2000 AD.

## I. THE EXPERT VIEW

### Aquaculture Production

Aquaculture started in Asia well over 3000 years ago and aquaculture remains very important. Asia accounts for over 80% of the world's aquacultural production (Table 1). The value of aquacultural production in the South China Sea area in 1983 was US$1,500 million (SEAFDEC, 1985). The statistics do not allow for a breakdown to determine what aquaculture production is exported, however, it appears that the production of high value species for export has increased in recent years.

Aquacultural statistics are scarce, contraditory and often unreliable, however, attempts are currently being made to increase the accuracy of the figures (C. Nash, Pers. Comm.) The figures in Table 1 and 2 should be considered as approximations only and it is difficult to compare the 1975 and 1983 figures to obtain estimates of increased production. However, Nash (1987) using roughly comparable figures estimates that aquaculture production increased worldwide by 13% from 1983 to 1985. He also predicted that aquaculture production in all groups will more than double by the year 2000 to a total of 18.3 million tonnes for Asia and 22.2 million tonnes worldwide. This rapid increase in aquaculture production will occur in order to fill the deficit between projected demand for fisheries products and availability from the wild fisheries, In 1985 aquaculture supplied 13% of the world fisheries harvest and it is projected to supply 25% by 2000 AD.

Production for selected Asian countries is summarized in Table 2. While the previous caution on the reliability of the statistics carries for this data it is, however, apparent that considerable increases in aquacultural production have occurred in Taiwan, India, Indonesia, Malaysia, Philippines and Vietnam.

## Species

The aquacultural statistics unfortunately do not give details on species cultured. Nevertheless the number of species now cultured commercially has increased in the past ten years. This is apparent by comparing the species discussed at aquacultural meetings like this, or the Asian Fisheries Forum (Maclean et al, 1986) to previous meetings (Pillay and Dill, 1979). It should also be considered that the number of species cultured by the year 2000 will also increase even though recent documents suggest that International Research should be restricted to only a few species.

## Research and Development Priorities

There is considerable agreement on the need for much greater cooperation in aquaculture to promote long term research and development (Pullin and Neal, 1984; Idyll, 1987; Davy, 1987 and Nash, 1986). Pullin and Neal indicate that the "recent history of tropical aquacultural research is a story of diffuse, muddled efforts and limited success. Work has been conducted on well over 100 species and has therefore been poorly focused. Adequate facilities and trained scientists have been in short supply. Attention has been given to production methods and hatchery techniques without the development of an understanding of the basic biology of cultured organisms. The research has not been coordinated, and international efforts to organize research efforts have, on the whole, not been fruitful." They further indicate frequent shifts in priorities by governments and donors and emphasis on quick results which have inhibited long term research.

The alphabet soup of international organizations involved in aquaculture in Asia includes FAO/UNDP, ADCP, NACA, SCSDCP and IPFC, IDRC, IFS, ODA, GTZ, JICA, USAID, ICLARM, SEAFDEC, SEARCA, the International Banks, the World Bank and ADB. A translation for these various acronyms is presented in Table 3.

The current suggestion is that the Technical Advisor Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) consider the possibility of an International Aquacultural Centre which they have been examining since 1973. It has been proposed that such a centre would allow for a critical mass, long term funding and the ability to do long term research. Davy (1987) suggests a framework for such a centre (Figure 1) which would allow a close integration with ongoing networks and national aquacultural research programs (see ICLARM, 1987 for a more detailed description of Aquacultural Networks).

The research priorities for such an International Centre (Idyll, 1987) would be based on a few species (carp, tilapia and catfish) and concentrated on:

1. Nutrition food and feeds
2. Reproductive physiology and induced spawning
3. Genetics, selection and hybridization
4. Disease control

It is agreed that other important research should be done by National Programs and universities but few details are given. Idyll argues that engineering and socio-economics are site specific so should be carried out by National scientists while Nash stresses the need for market research. In addition there is also a suggestion that there is a lack of knowledge of basic biology of many of the cultured species. National scientists should be able to contribute knowledge on the non-priority species.

Also explicit in the experts reports is a view of what type of aquaculture they should be supporting. That is species of lower value that feed low on the food chain, reared in extensive and semi-intensive systems. They do not see the value of public support for research on high value and carnivorous species raised primarily for export. Currently research on these species is funded by the private entrepreneurs or multinational corporations. There is concern about these types of operations because of conflict for aquacultural sites, displacement of existing local food producing aquaculture eg. mullet in the Philippines, and questions about the true social costs of such operations (see ICLARM, 1985).

## II. THE VIEW FROM THE FARMER

The previous view is the view from the top, reflecting the classic approach to agriculture and fisheries research and development. Transfer of technology (TOT) illustrated in Figure 2, involves two process, technology development and technology transfer. We have so far been discussing the development process.

Recent concern about the need for increasing the efficiency of TOT has promoted particular concern for the transfer process. The World Bank has committed over 1 billion dollars in the last 10 years to support the Training and Visit System (T&V). This system has been introduced to over 40 countries. Benor et al (1984) describe the key elements: "T&V is a systematic program of training for the Village Extension Worker (VEW), combined with frequent visits to farmers' fields. In the field, the VEW teaches farmers recommended agricultural practices, shows them how to implement these practices, motivates them to adopt some on their fields, and evaluates production constraints and advises farmers how to overcome them. The system is organized to give the Village Extension Worker every fortnight intensive training in those specific agricultural practices and recommendations that relate directly to farm operations during the coming weeks, and to provide him with suitable technical and supervisory guidance to enable him to teach these recommendations well to farmers. The VEW visits once a fortnight, on a fixed day known to all farmers and his supervisors, each of the eight small groups of farmers with which he works. Other staff at the subdivision - district, zone and headquarters level - support in one way or another the work of the VEW and have similar fixed work responsibilities and training." The T&V system also encourages the strengthening of links between extension and research, and suggests that extension agents carry out adaptive research and on-farm trials. While T&V has strengthened the farmer-extension link it has also revealed other constraints to adoption of new technology such as tenure, lack of capital and institutional. Perhaps the major achievement has been to show the lack of good technology available to extension agents (Chambers and Jiggins, 1986).

If the transfer system is efficient and TOT still does not work then it must be the farmers and fishermen who are at fault. They are conservative, stubborn, they won't modernize and take risks. However, it is becoming more and more apparent that the technology is to blame - it is too costly, requires too much labour, doesn't fit into the traditional system or even the problem was wrong. Rhoades (1985) gives a classic description of the mistakes made by potato researchers at CIP trying to promote potato storage units. It was only after the researchers started asking farmers what their problems were that they realized that storage of large quantities of marketable potatoes was not a problem but storage of small quantities of seed. The resulting diffuse light storages have been rapidly adopted and adapted by farmers around the world.

There are considerable barriers between researchers and small farmers and fishermen. There are differences in education, income, culture, often language or dialect, means of transport and dress. How do you think the fishermen or farmers react to the safari suited and shoe clad city dweller complete with soft hands and long fingernail who arrives in a 4-wheel drive and proceeds to tell the farmer (in if not a foreign dialect at least in formal language that the farmers and fishermen do not use) how to grow rice or fish.

In N E Thailand, rice cum fish culture with a mix of common carp (Cyprinus carpio), Tilapia (Sarotherodon nilotica), or the hybrid S. niloticus x S. mossambica, and silver barb (Puntius gonionotus) (see MacKay et al, 1986 for more details) has expanded rapidly among small poor farmers. The techniques originated from farmers and have been spread from farmer to farmer with NGO assistance. It is only recently that researchers have become interested and involved. It is instructive to compare the research priorities as suggested by researchers to those of farmers (FSRI, 1986).

The researchers have suggested (1) pesticides, (2) stocking rates and species mix, and (3) trench design as the most appropriate areas for research. Informal surveys and farmer interviews have suggested that (1) farmers are aware of problems of pesticides and fish but cannot afford them so do not use them; (2) farmers use a rough guide of about 500 fish/rai and a species mix of 1:2:2, however, the actual rates depend on fingerlings available from own hatching or nearby commercial hatchery and carry over of fish from previous season. Farmers also vary the species mix according to eating and marketing preferences; (3) farmers use a considerable varieties of trenches, sumps, ponds, etc. Their concrns are security, labour and costs. They do try to use natural depressions and join paddies together to enable fish to move to natural low spots or ponds as water level decreases. Most rice farmers are excellent hydrologic engineers and need only rough guidelines of what is needed for fish refugee. It is obvious that the researchers high priority research would not benefit the farmers.

The farmers have suggested their own areas of interest that could benefit them and are also carrying out their own research. (1) Fish in rice paddies increase rice yields, therefore, they should be able to decrease fertilizer levels and increase their income. (2) Fish with rice reduces pest and disease abundance although weed control may be a problem. (3) Farmer fingerling production greatly increases the income received.

Researchers in Thailand are now working on some of these areas including insect and weed control by fish, backyard hatchery production. It is also interesting that the Asian Aquaculture Genetics Network is working on simple techniques to assist in broodstock selection (ICLARM, 1987; Eknath and Doyle, 1985). This farmer-research partnership has considerable potential for further expanding the rice-fish culture.

Aquaculture researchers are often concerned about marketable size. One of the criticisms of rice-fish culture in rainfed sites is the short growing season and resulting small size. In N E Thailand fish are an important part of the diet. While the farmers prefer large sized fish for sale there is no clear cut marketable size. Home consumption accounts for 35% of production and even fingerlings are eaten or fermented for fish sauce. In addition some farmers stock fish before transplanting in order to have a supply of protein to feed the transplanter and thus saving time by not having to collect wild fish for their noon meal.

This Farmer-First-Farmer-Last (FFL) model (Chambers and Ghildyal, 1985; Chambers and Jiggins, 1986) involves a paradigm shift. It requires all those involved in agriculture development and research to reorientate their thing to "put the last first" (Chambers, 1983). Farm households must be seen as rational, managing complex systems with very limited resources, constantly making decision based on risk minimization, and food and cash needs of the family. The research agenda then becomes one of learning more about the system and interaction, about the farmers' indigenous knowledge, decision making process and possible points of intervention. On-farm research is complicated as crops and planting dates do not follow an orderly sequence as decisions are often made quickly based on the onset of the rains and farming patterns may vary considerably from year to year. The traditional research methodologies are not applicable; new methodology are needed.

This Farming Systems Research approach is now being used widely in agricultural research. This approach was initiated in the early 70's at the International Rice Research Institute (IRRI) of the Philippines. The method originally called cropping systems has been expanded to include other components of the farming systems and is now known as farming systems research. This methodology is used by a number of other international centres and national programs in many countries. The terminology and methodology differ between centres, agencies and countries (CIMMYT, 1985; Gilbert et al, 1980; Shaner et al, 1982; Zandstra et al, 1981). However, the important feature of FSR is its system approach which involves interdisciplinary teams usually including a socio-economist. The elements of the approach are: (1) Site selection and description, (2) design of research which involves both examining the overall patterns and component technologies, (3) testing stressing research on farm. The results are used to design future research, (4) multi-location trials and pilot production programs closely involving researchers and extension agents.

This methodology is now used in many Asian countries. The training and coordination are centred at IRRI but are being decentralized as national programs become stronger. There are now 14 Asian countries involved in the Asian Farming Systems Network (AFSN). The network coordinates a number of international testings of cropping patterns and component technology. However, the major functions of the AFSN are sharing of information, designing methodology and research protocols, and suggesting and revising training materials. One of the major impacts of the AFSN has been to institutionalize and popularize the on-farm methodology.

The methodologies combine economic, social science and agronomy research techniques. Surveys and site descriptions are often carried out using informal interviews, group discussion and interaction. Rapid Rural Appraisal (RRA) is receiving considerable attention as a means of allowing meaningful communication between researchers and villagers (KKU/FF, 1985).

There is also a need to identify, understand and monitor indigenous research. Lightfoot (1986) gives examples from the Philippines of agricultural experiments carried out by farmers inadventently assisted by development projects. These experiments could not have been designed by researchers.

There is now considerable experience in designing and analyzing on-farm experiments (Hilderbrand and Poey, 1985; Sebillotte, 1987). In general the lower the level of researcher management the greater the reality but the greater the variability. On-farm experiments must be carefully and simply designed. Elaborate experimental designs are best done on research stations. Usually new technologies or farming patterns are compared to the existing farmers practice on the basis of their economic performance. Researchers are also encouraged to carry out ex ante analysis prior to embarking on research on new technologies to determine the potential for success (Shumway, 1983).

These methods are now starting to be applied to aquacultural projects in Thailand (MacKay, 1986) and a new ADB funded Rice-Fish joint IRRI-ICLARM project in the Philippines. It is now an appropriate time for application and adaptation of these farming systems methodology to aquaculture. This will involve increased involvement of socio-economists and the research and training of aquaculturists in FSR techniques. However, more than anything else it requires the enthusiastic cooperation of researchers willing to be challenged and willing to get off their research stations and out in the field with fishermen and farmers, and start scientists-fishermen/farmers collaboration.

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TABLE 1 - AQUACULTURE PRODUCTION 1975 TO 2000 (IN '000 TONNES)

| | 1975 (1) | | | 1983 (2) | | | (2) | |
|---|---|---|---|---|---|---|---|---|
| | Asia/Pacific | World | % | Asia/Pacific | World | % | Asia/Pacific | World |
| Finfish | 3,402 | 3,980 | 85.5 | 3,358 | 4,448 | 76 | - | 9,670 |
| Crustacea | 15 | 16 | 94 | 76 | 123 | 62 | - | 270 |
| Molluscs | 403 | 1,051 | 38 | 2,586 | 3,246 | 80 | - | 7,060 |
| Total (Animals) | 3,824 | 5,047 | 76 | 6,020 | 7,817 | 77 | - | 17,000 |
| Seaweed | 1,055 | 1,055 | 100 | 2,392 | 2,394 | 100 | - | 5,200 |
| Total (all) | 4,875 | 6,102 | 80 | 8,412 | 10,211 | 82 | 18,300 | 22,200 |

1. Source: Pillay, 1979
2. Source: Nash, 1987

TABLE 2 - AQUACULTURAL PRODUCTION (EXCLUDING SEAWEEDS) IN SELECTED COUNTRIES (IN '000 TONNES) - 1975, 1984-85 AND 1986

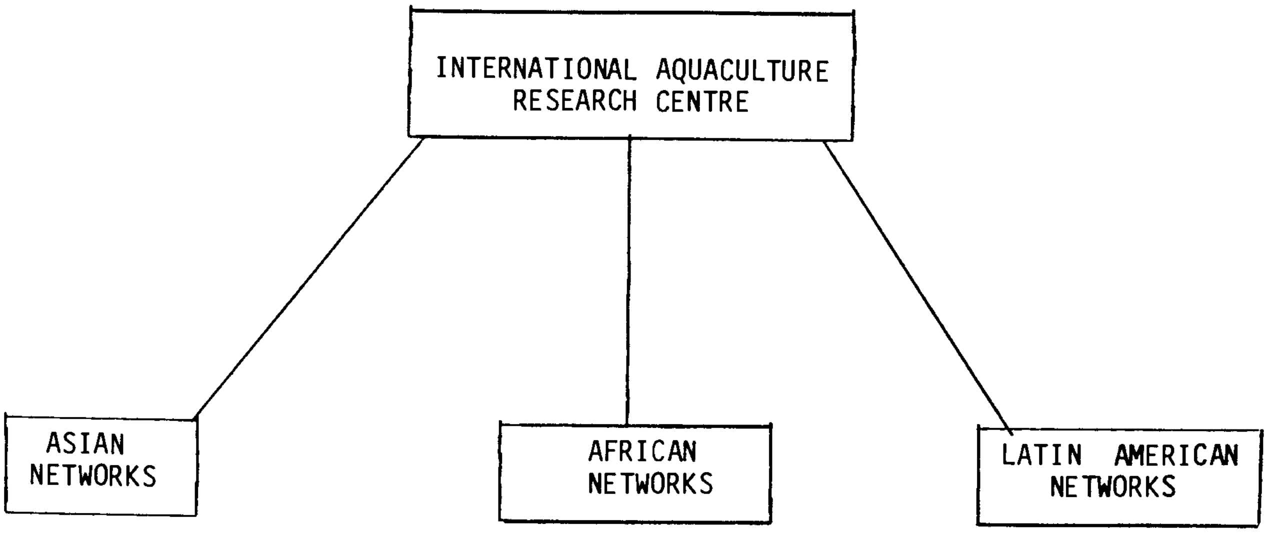
| Country | 1975 (1) | 1984-85 (2) | 1986 (3) |
|---|---|---|---|
| Bangladesh | 76.5 | 125.2 | 121.6 |
| China | 2200 | 3556 | - |
| Taiwan | 81 | 241 | - |
| India | 490 | 849 | 1095 |
| Indonesia | 140 | 282 | 267 |
| Japan | 443 | 628 | - |
| Korea (Republic) | 332 | 392 | - |
| Malaysia | 7 | 51 | 65 |
| Philippines | 124 | 312 | - |
| Singapore | 1 | 1 | 2 |
| Thailand | 106 | 111 | 100 |
| Vietnam | 30 | 205 | - |

1. Source: Individual country reports, Pillay, 1979
2. Source: Latest production data supplied by countries to FAO, Nash, 1987
3. Source: Latest production data from all sources assembled by ADCP, Nash, 1987

TABLE 3 - INTERNATIONAL ORGANIZATIONS INVOLVED IN AQUACULTURE IN ASIA

| | | |
|---|---|---|
| FAO | - | Food and Agriculture Organization |
| UNDP | - | United Nations Development Fund |
| ADCP | - | Aquaculture Development and Coordination Programme |
| NACA | - | Network of Aquaculture Centers in Asia |
| SCSDCP | - | South China Sea Fisheries Development and Coordinating Programme |
| IPFC | - | Indo-Pacific Fisheries Commission |
| IDRC | - | International Development Research Centre |
| IFS | - | International Foundation for Science |
| ODA | - | Overseas Development Administration |
| GTZ | - | Germany Agency for Technical Cooperation |
| JICA | - | Japanese International Cooperation Agency |
| USAID | - | United States Agency for International Development |
| ICLARM | - | International Center for Living Marine Resources Research |
| SEAFDEC | - | Southeast Asian Fishery Development Center |
| SEARCA | - | Southeast Asia Regional Center for Graduate Study and Research in Agriculture |
| ADB | - | Asian Development Bank |

FIGURE 1 - A FRAMEWORK FOR INTERNATIONAL AQUACULTURE RESEARCH




**ASIAN NETWORKS**

1. NUTRITION RESEARCH NETWORK
2. GENETICS RESEARCH NETWORK
3. MASS SEED PRODUCTION RESEARCH NETWORK
4. DISEASE RESEARCH NETWORK

**AFRICAN NETWORKS**

1. MASS SEED PRODUCTION RESEARCH NETWORK
2. NUTRITION RESEARCH NETWORK

**LATIN AMERICAN NETWORKS**

1. MASS SEED PRODUCTION RESEARCH NETWORK
2. NUTRITION RESEARCH NETWORK

FIGURE 2 - SCHEMATIC TRANSFER OF TECHNOLOGY APPROACH