RESEARCH PRIORITIES IN SUBSAHARAN SMALLHOLDER FRESHWATER AQUACULTURE

Barry A. Costa-Pierce

International Center for Living Aquatic Resources Management (ICLARM), ICLARM/GTZ Africa Aquaculture Project, P. O. Box 229, Zomba, Malawi

INTRODUCTION

Subsaharan Africa is an enormously diverse region. To generalise about aquaculture development across this huge environmental and cultural expanse is virtually impossible. In addition, the available fish species, climatic and water fertilities are so varied as to make any such generalisations of limited use.

Given this, I would like to trim the huge diversity of possibilities and give a highly personal assessment of priority research areas for Africa in a very narrow area of focus that could be valuable over the next ten years. This personal assessment is derived from research and development efforts ICLARM/GTZ are conducting in southern Malawi, where smallholder aquaculture is growing rapidly and is biased towards an assessment of research areas where I feel the probability of success may be high.

This is not the first assessment of research needs for African aquaculture, nor will it be the last. I encourage all the participants to also examine research recommendations put forth by the 1985 IFS African Seminar on Aquaculture held in Kisumu, Kenya (Huisman, 1986) and by the ICLARM Africa Aquaculture conference held in April, 1990 in Zomba, Malawi (Coasta-Pierce *et al.*, 1990).

AQUACULTURE DEVELOPMENT IN AFRICA

The International Center for Living Aquatic Resources Management (ICLARM) began studying aquaculture in Africa just recently, in 1985. Traditionally ICLARM is a small organisation based in Southeast Asia, but with a global mandate aimed at "resolving critical technical and socio-economic constraints to increased production, improved resource management and equitable distribution of benefits in economically developing countries" (Maclean and Dizon, 1990).

In 1985, the German Agency for Technical Cooperation (GTZ) funded ICLARM to conduct an analysis of the reasons why African aquaculture production, despite the large amount of foreign assistance given (Table 1), had lagged far behind the rest of the world (Table 2).

As ICLARM looked from afar, it noticed our aquaculture colleagues in Africa faced an entirely different development scenario from what we had experienced in Southeast Asia. While no means an exhaustive list, ICLARM found some of the recurring reasons hindering smallholder aquaculture development in Africa to be:

1. Aquaculture had no continuous tradition in much of Africa. No traditional aquaculture knowledge systems existed among farmers and the practice had little historical roots.

2. Numerous foreign aid programmes were organised on a "top down" basis with inconsistent, short-term goals. Reviews of previous research by African nationals was unavailable or not used and creation of long-term national capacities in aquaculture were few.

3. Aquaculture development was viewed as a separate entity from aquaculture. Few studies reviewed traditional agricultural knowledge systems, innovation in agriculture, seasonal cropping calendars, uses of scarce on-farm resources and the resource flows between households and farm enterprises as they related to the adoption and sustainability of aquaculture by the smallholder farmer.

4.An overemphasis on the technical aspects of aquaculture development was prevalent rather than examining aquaculture development as an integral part of natural resources management and rural development.

5. There was a lack of concern for social, cultural and household economic factors and labour supply/demand considerations that influenced decision-making and adoption of innovations in rural African households.

Given these and other reasons, ICLARM decided to choose Malawi as a "test bed" for a modest approach to assist in the development and establishment of smallholder aquaculture in rural Africa (Costa-Pierce and Pullin, 1990). Malawi was chosen due to the nation's special role as SADCC regional coordinator for fisheries and wildlife and because of the urgent need to develop new sources of fish to meet rising demand.

ICLARM/GTZ AFRICA AQUACULTURE PROJECT

From 1987- 1989, ICLARM/GTZ sponsored a number of collaborative, interdisciplinary studies to understand better the smallholder farmer in rural Malawi. These studies examined the following:

1. the maize-based farming system in Malawi and its relation to aquaculture, animal husbandry and agroforestry systems;

2. flows and seasonalities of on-farm and off-farm resources on smallholder farms;

3. the scope for integration of aquaculture into smallholder farms and technical problems existing in smallholder aquaculture;

4. gender roles, tribal, land tenure and other social and political factors influencing adoption of aquaculture;

5. household economics and entrepeneurship;

6. the history of aquaculture in Malawi;

7. biological and environmental constraints on the adoption of aquaculture.

Research summaries of these and other studies in Malawi are detailed in Costa-Pierce *et al.* (1990) and ICLARM and GTZ (1990).

To carry out such diverse tasks ICLARM designed a flexible administrative structure to:

1. create national capacity at a highly technical level. One Ph.D. and eight M. Sc students will have graduated, all supervised by ICLARM/GTZ staff who have joint academic appointments at the University of Malawi.

2. create institutional linkages. Link agreements with the Malawi Department of Fisheries and the University of Malawi were negotiated. Informal linkages with the Malawi Department of Agriculture and international organisations exist and are encouraged.

3. foster national linkages between projects and the government. All fish farming projects in Malawi meet quarterly at national aquaculture coordination meetings. Recently, the projects decided to jointly sponsor yearly national aquaculture workshops.

4. create regional and international linkages and south-south technology transfer. ICLARM/GTZ staff originate from the Pacific Basin, North America and Europe. Most staff have extensive experience in Southeast Asian aquaculture.

RESEARCH PRIORITIES IN SMALLHOLDER AQUACULTURE

I'd now like to detail how I see the research priorities shaping up, but first I need to reorient you to our short-term goal; that is, the establishment and sustainability of smallholder aquaculture in Malawi.

There is growing consensus among experts that smallholder aquaculture in Malawi is established. If this is true, then our research programmes and goals are to:

1. increase fish production from smallholder fish farms;

2. ensure the sustainability of smallholder aquaculture;

3. integrate aquaculture into the traditional agriculture system to increase household food security; and

4. increase national fish production.

If smallholder aquaculture is not established, however, or is not sustainable without subsidies, research priorities will be different. In general, in Subsaharan Africa, where smallholder aquaculture is new or not well established, I see four research areas of particular importance, given experiences in Malawi (ICLARM and GTZ 1990), namely:

1. Household factors. Social and cultural factors inhibiting the adoption of aquaculture where good freshwater resources are available, especially:

gender roles; land tenure; household decision-making; analysis of nutritional factors; entrepeneurship studies; analyses of the informal economy and labour supply/demand.

There is no way one project can recruit all the professionals necessary for these studies, so collaboration with international and national consultants in economics, sociology, nutrition and rural development is essential.

2. Agroecological studies. Studies of African agroecosystems and traditional knowledge and management systems, especially:

Applied or systems ecology; agronomic studies of crop cycles; resource ecology; seasonal cropping calendars; seasonal availabilities of on-farm agricultural residues; farm labour supply/demand where ponds/no ponds;? subsistence economics.

We have found these studies of utmost importance to judge the resource base available for aquaculture (Noble and Chimatiro, 1990 in Costa-Pierce *et al*,. 1990). For example, in southern Malawi, maize bran is the universal pond input. During the cold, dry season (April to September) it was available on smallholder farms at 48-674 kg/ha. However, during the hot, wet season it was virtually unavailable, being diverted into the household as human food to stretch the family's supplies of maize meal.

A resource conundrum existed. When fish grew slowly (the cold season), lots of fish feeds were available; when they grew fast, the pond was, more often than not, left unfed! These findings led to the development of napier grass as a pond input to be used during the hot, wet season (Chikafumbwa, 1990).

African farmers are remarkable survivors. For centuries they have used indigenous knowledge systems to populate a continent unique in its sharp seasonalities, climatic vagaries and environmental adversity. Farmers have different agendas from scientists, extensionists and development workers. They choose to minimise risk and maximise output per unit of labour invested rather than invest in costly inputs. Traditional economic balance sheets are rarely applicable to African smallholder farming systems.

3. Biotechnical Research. Research has shown approximately 80% of the smallholder farmers we work with are off the cash eceonomy and have no access

to off-farm resources (ICLARM and GTZ 1990). We have therefore focused our biotechnical research at the Domasi Experimental Fish Farm on four areas:

a. Low-cost, on-farm feed alternatives, especially the use of maize bran; terrestial grasses such as napier grass; composts; vegetable wastes;

b. Pond dynamics to understand the pond system and use simple stirring to assist in management or enhance the production of heterotrophic food webs;

c. Integrated farming systems appropriate to rural Africa, primarily crop/fish; chicken/fish and mixed farming systems (trees-crop-fish).

d. Species-specific research, primarily research with existing species in aquaculture (*Oreochromis shiranus*; *Tilapia rendalli*) and their improvement; and research with new indigenous species of promise (*O. karongae*; *Bathyclarias* spp.).

4. Farming Systems Research. ICLARM/GTZ have taken a farmer participatory approach to involve target groups (in this case, rural African farmers) in the process of technology development and dissemination (extension). ICLARM is testing this low-cost extension approach in collaboration with the Malawi Department of Fisheries and the Malawi-German Fisheries and Aquaculture Development Project (MAGFAD).

An important characteristic of the approach is that suggested changes to traditional farming systems are gradual. A new technology is an addition to or a modification of an existing system, so that adoption is not a big step. Rather than developing one fixed set of techniques that is supposed to be adopted by farmers, a basket of technologies is proposed. Farmers are invited at the beginning stages of technology development to take part in the developments and testing. Farmers comment on and criticise as much as they want. They can test new technologies on their own farms and they can modify technologies to suit their own situation. The approach is evolutionary rather than revolutionary.

Techniques developed by ICLARM to understand rural farmers, their traditional knowledge systems, ecological settings and farm management scenarios better, are described in detail in Lightfoot (1989 a,b); Noble *et al.* (1990) and Rashidi (1991).

AQUACULTURE POLICY CONSIDERATIONS

If the route to increasing fish production in Africa is through semi-intensification of smallholder aquaculture, then government policies could be as important as farm economics in fostering such a transition.

It must be emphasised that the benefits of smallholder aquaculture are many and that projects emphasising commercial aquaculture in Africa have been largely unsuccessful, mainly due to severe competition from the continent's still abundant capture fisheries. Some of the benefits of smallholder aquacuture in Africa are:

a. There is little need for middlemen, so the benefits accrue more directly to the producer, the rural farmer.

b. In a small village, aquaculture is only one part of rural development and its direct benefits to women and children from a nutritional perspective are obvious.

c. In the majority of Malawian villages, small fish are acceptable (in many cases preferred), since all family members can have their own fish. Technologically-speaking, short cropping cycles and simple aquaculture technologies to produce abundant numbers of small fish are within the means of many rural farmers. These technologies would probably provide more direct benefits for the rural poor than intensive technologies producing large-size fish that are often sold for cash to urban buyers.

As a result, there is a possibility aquaculture projects promoting the development of semi-intensive aquaculture systems in rural Africa (and production of large-size fish for sale) would not increase protein supplies for the most vulnerable groups in the villages, thereby missing their target group altogether.

Smallholder aquaculture, however, will not meet the pressing national needs of most Subsaharan African nations to increase farmer incomes and get more fish to urban populations. Therein lies the hope for a native species African polyculture technology - ponds could produce small fish that would stay in the village and large fish that would generate income.

Subsaharan Africa will need in the near future much more than the sustainable development of smallholder aquaculture, since population growth, pressing national food needs and trends towards increased urbanisation will create large demands for fish. Research oriented towards the best methods for appropriate, sustainable, semi-intensive aquaculture will need to be done in order to evolve aquaculture production systems capable of raising national aquaculture production levels dramatically. If the historical examples from Asia have any relevance, government subsidies and long-term donor commitments will be necessary.

ACKNOWLEDGEMENTS

Funding for the ICLARM project has been provided solely by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), GmbH. I would like to thank Dr. Martin Bilio of GTZ for his valuable comments on aquaculture development that led to some of the thoughts expressed here.

I would like to acknowledge the vital professional input of ICLARM staff in Malawi, Reg Noble and Anne vn Dam, and in Manilla, Clive Lightfoot for their commitment, vision and hard-working contributions to the project. Dr. Roger Pulin designed the ICLARM, Malawi project in 1984-85 and has actively contributed to its development since that time. His efforts on our behalf deserve special recognition.

REFERENCES

Chikafumbwa, F. J., 1980. Studies on napier grass (*Pennisetum purpureum*) as a pond input for the culture of *Tilapia rendalli* and *Oreochromis shiranus*. M. Sc. Thesis, University of Malawi, Zomba, Malawi. 177p

Costa-Pierce, B. A. and Pullin, R. S. V., 1990. Development of smallholder aquaculture in Malawi: The program of the International Center for Living Aquatic Resources Management (ICLARM), World Aquaculture (in press)

Costa-Pierce, B. A., Lightfoot, C. W., Ruddle, K. and Pullin, R. S. V.(eds), 1990. Aquaculture research and development in rural Africa. ICLARM Conference Proceedings 27, GTZ, Eschborn, Germany and ICLARM, Manila, Philippines, 71p

Ferlin, A., 1989. Foreign aid to aquaculture development. Aqua Revue 25: 1-3

Huisman, E. A. (ed), 1985. Aquaculture research in the Africa region, Pudoc, Wageningen, Netherlands, 274p

Huisman, E. A., 1990. Aquacultual research as a tool in international assistance, Ambio 19: 400-403

ICLARM and GTZ, 1990. The development of small-scale aquaculture and integrated farming systems in Malawi. ICLARM Technical Report (in press)

King, H. R. and Ibrahim, K. H. (eds), 1988. Village level aquaculture development in Africa. Commonwealth Secretariat, London, U. K., 170p

Lightfoot, C. W., Bottrall, A., Axinn, N., Conway, G. and Singh, P., 1989a. Training resource book for agro-ecosystem mapping. International Rice Research Institute (IRRI), Manila, Philippines, 105p

Maclean, J. L. and Dizon, L. B. (eds), 1990. ICLARM Report, 1989, ICLARM, Manila, Philippines, 167p

Noble, R. P., Lightfoot, C. W. and Bage, J., 1990. Training notes to accompany a video on pictorial modelling: a farmer participatory method for modelling bio-resource flows in farming systems. ICLARM, Naila, Philippines, 12

Noble, R. P. and Rasidi, B., 1991. Aquaculture technology transfer to small-scale farmers in Malawi. Naga, The ICLARM Quarterly (in press)

Region	Total	Percent
Asia/Pacific	171	46
Subsaharan Africa	73	20
Latin America/Caribbean	66	18
Middle East/North Africa	39	11
Interregion	34	5
Total	368	100

Table 1. Foreign assistance to aquaculture from 1983 to 1987 in millions of USD (Ferlin, 1989)

Region	Finfish	Crustaceans	Molluscs	Seaweeds	Others	Total
Asia	4 363 735	311 789	1 488 170	2 724 008	30 123	8 919 825
Percent	80	76	64	99	99	81
Oceania	979	11 603	9 440	2 368	137	24 527
Percent	0	3	0	0	0	0
America/ Caribbean	262 149	50 215	186 659	10 235	0	509 258
Percent	5	12	8	0	0	5
S. America	61 734	36 756	2 834	5 332	0	106 476
Percent	1	9	0	0	0	1
Africa	60 930	39	418	20	50	61 457
Percent	1	0	0	0	0	1
Europe	399 453	98	643 636	0	0	1 043 187
Percent	7	0	28	0	0	10
USSR	305 000	0	0	0	0	3
Percent	6	0	0	0	0	3
Total	5 455 980	410 320	2 331 157	2 741 963	30 310	10 969 730
Percent	100	100	100	100	100	100

Table 2. World aquaculture production in 1986 (FAO, 1989 in Huisman, 1990)