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Aquaculture Policy Options for Integrated Resource Management in SubSaharan Africa

Extended Abstracts and Discussions

Proceedings of a Workshop Held in Zomba, Malaŵi
22-25 February 1994, Zomba, Malaŵi

Edited by

Randall E. Brummett

1994

ICLARM
International Center for Living Aquatic Resources Management

GTZ
Deutsche Gesellshaft für Technische Zusammenarbeit

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Preface

As increasing population and environmental degradation erode the sustainability of low-input farming, the situation of the rural African smallholder steadily declines. New research must be conducted, new development policies implemented and new extension methodologies identified if a human and environmental disaster is to be avoided in subSaharan Africa. An Integrated Resource Management (IRM) approach may offer solutions to some of the problems facing Africa's smallholding farmers.

IRM maximizes the use of on-farm resources by producing an integrated array of crops. In theory, the wastes from one crop are used to fuel another, synergistically improving the efficiency of both. If sufficient levels of integration can be achieved, the system should produce more, pollute less, be less destructive of the natural resource base, be less dependent upon outside inputs, and improve household nutrition. Research has shown that aquaculture, integrated into the farming system, can play a crucial role in improving farm efficiency through IRM.

To understand better the potential role of integrated aquaculture in rural development, the Deutsche Gesellshaft für Technische Zusammenarbeit (GTZ) and the International Center for Living Aquatic Resources Management (ICLARM) recently held a workshop in Zomba, Malaŵi, entitled Aquaculture Policy Options for Integrated Resource Management in SubSaharan Africa. Twenty-two regional and international policy planners, extension specialists and researchers met at Chancellor College of the University of Malaŵi to present findings of research, experiences from the field and constraints to the formulation and implementation of policy. The main objectives were not to influence policy directly by generating a policy statement, but to widen the scope of IRM thinking by giving professionals involved in rural development an opportunity to exchange views and experiences. National and international policy might be influenced to the extent that the participants are involved in the decisionmaking and planning within their respective institutions.

The workshop was sponsored by the Malaŵi-based GTZ/ICLARM project on Aquaculture Development in Africa: Learning from the Past and Implementing Research Results on Small-scale Farms. This project is a collaborative one with several Malaŵian and regional organizations, most of which were represented at the workshop.

The papers presented have been condensed and edited to suit a summary proceedings. We thank the authors for their presentations and for allowing them to be published in condensed form.

It is the organizers' hope that the papers presented and the discussion that followed have stimulated our colleagues and that the summaries herein will encourage readers to investigate the role that an Integrated Resource Management approach could have in the future of African aquaculture.

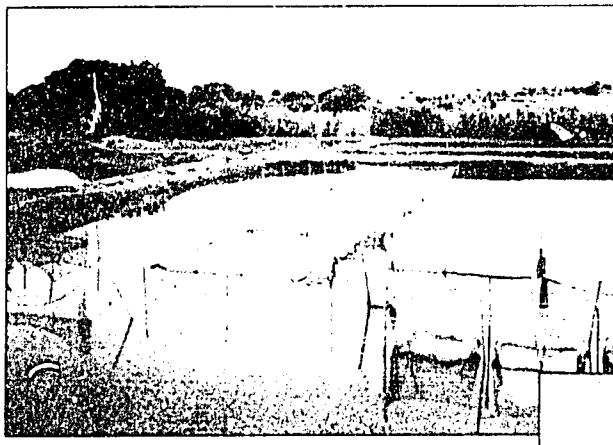
R.E. Brummett

Abstract

This volume contains brief papers which review the socioeconomic and biophysical environment in which integrated aquaculture must function in subSaharan Africa; presentations of experiences from research and the field, including both biotechnical and anthropological studies; and a summary of discussions and conclusions about integrated aquaculture's potential role in African rural development.

It was concluded that the potential for integrated resource management to improve economic and ecological sustainability of smallholding farming systems is substantial. However, further research is needed to clarify its role and limits.

Development of Integrated Aquaculture Farming Systems in Malaŵi



The Malaŵi Fisheries Department is comparing growth rates of several Oreochromis shiranus *strains.*

Polycultures of indigenous species offer wider options for Malaŵian smallholders than systems which depend upon hatchery-produced exotics.

Workshop participants examine the results of research conducted in systems designed to simulate actual smallholder farm conditions.

ICLARM/GTZ's "traditional ponds" offer unique opportunities to study and demonstrate integrated farming systems.

Opening Addresses

Professor Brown Chimphamba
Vice Chancellor
University of Malaŵi

I am pleased to welcome you all to Chancellor College on the occasion of the opening ceremony of the workshop on Aquaculture Policy Options for Integrated Resource Management in SubSaharan Africa. The theme of the conference is relevant because it is common knowledge that rising human population is putting pressure on our limited resources. We have witnessed, of late, unprecedented environmental degradation which would seriously threaten survival of humankind if no efforts are made to redress the situation. We know that, in an attempt to alleviate chronic shortage of primary protein for the rising population, agricultural projects in Africa, and in Malaŵi in particular, will need to concentrate more on the improvement of water resource management and exploitation.

The use of aquaculture is one innovative approach to increase sustainable productivity of water resources by production of fish in areas where fish are not naturally found. Most areas further away from the lake are poorly supplied with fish due to insufficient quantities reaching these areas as a result of dwindling stocks from the lake and the rising transportation costs. It is in this respect that a meeting today of experts on aquaculture is befitting to address problems that hinder sustainable fish productivity. I have been told that this workshop will address the following objectives:

- improving the economic and ecological sustainability of small farm production systems;
- diversifying household nutrition and increasing food security in rural areas; and
- stabilizing and enhancing all farm productivity and profitability.

It is interesting to note that the objectives emphasize improvement of all farm productivity. This is so because integrating fish culture with agricultural enterprises best fits our target group, the Malaŵian smallholder farmer. Malaŵians are traditionally agriculturists and do not have a culture of fish farming and therefore fish farming has to fit within the agriculture setting, if progress is to be made.

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Any research and extension policy made in this workshop must be guided by the complexity of a smallholder farm system, as manifested by:

- dominance of consumption and survival aims, over a commercial one;
- a closed farm system with few bought inputs like fertilizer, or fish feeds; and
- little difference between the farm as an enterprise as well as a household. Similarly, there is little difference between the farmers as a producer and a consumer.

As a result, classical theories of economics, such as supply and demand, or internal rate of return, might not necessarily apply, in their strict sense, to smallholder farmers.

It should be appreciated that security aspects are likely to dominate decisionmaking in smallholder farming systems, where people often encounter food shortages. Therefore, new ideas that aim at improving household food and income security, like fish farming, might be rejected by farmers, if the benefits are not apparent.

It is for this reason that researchers and extensionists in fish farming need to adopt new concepts of farming systems research and extension. Farmers need to participate in technology development. Using such approaches where researchers, extensionists and farmers work together, solutions to the biophysical and socioeconomic constraints faced by the farmers will be easily resolved. In the end, technologies developed will be tailor-made for the specific farmer's environment and thus reduce the usual frustration experienced by researchers and extensionists in the traditional "Transfer-of-Technology" approach.

Allow me to remind research and extension experts that policy formulation must always have a built-in component of gender issues. The role of women in food security in Africa can not be over-emphasized because they contribute an estimated 70% of the labor involved in food production and close to 100% in food processing. Recent studies in the fisheries sector have revealed that about 30% of fish processors along Lake Malaŵi are women and about 21% of the fish farmers in Malaŵi are women.

Involvement of women in fish farming is therefore vital, considering that about 30% of the households in Malaŵi are headed by single mothers. Constrained by the poor resource endowment, and unequal representation in rural development committees, these vulnerable groups have usually been left out in the mainstream rural development endeavors.

At this juncture, I wish to echo the remarks already made in commending ICLARM for interacting with our institutions in a positive manner. I have been told that ICLARM staff have assisted in the teaching at Chancellor College when the Department of Biology was in dire need of a Freshwater and Fisheries Biologist. Through ICLARM, a number of research projects for students and staff have been sponsored and successfully executed.

Also, a special M.Sc. program mounted by the Biology Department in conjunction with ICLARM produced seasoned graduates who are now working for the Fisheries Department and ICLARM itself. I would also like to extend our appreciation for the fishponds constructed at Bunda College which will provide research facilities for the staff and students at Bunda.

Permit me to end my presentation with a quotation from *Naga, the ICLARM Quarterly*, October 1990: "Food production is a major human preoccupation. Nevertheless, the natural resources on which food production depends should be preserved." In short, this quotation is about sustainable production and at this point, it is my pleasure to declare this conference officially open.

A

Mr. Boniface Mkoko
Chief Fisheries Officer
Malaŵi Fisheries Department

On behalf of the Fisheries Department, I am pleased to welcome you to this important workshop. It is important in the sense that it is going to discuss policy options for integrated resource management on smallholder farms. The smallholder is the largest, and most important sector in Malaŵi. It is important that from time to time we review our development policies so that our plans are in line with the smallholders' aspirations.

In its commitment towards promoting fish farming, the government of Malaŵi formulated a policy which aims at:

- optimizing fish self-sufficiency in rural and urban areas by increasing sustainable aquaculture productivity;
- optimizing use of rural resources, in terms of land, water farm by-products and labor, to produce fish;
- improving the health status of the rural population by providing protein-rich diets;
- diversifying farm production and income, and improving the well-being of the smallholder farmers.

Allow me to remind the delegates that aside from the opportunity Malaŵi has in hosting this policy formulation workshop, she has a major role to play in sharing whatever knowledge she gains from research activities or experience as part of her various regional responsibilities:

- Malaŵi is coordinating the SADC Inland Fisheries Sector.
- Malaŵi has been assigned responsibilities during the last CIFA meeting at Harare, in September 1993, as lead center for aquaculture information, including socioeconomics of aquaculture.
- Malaŵi is also the current regional center for Africa for the ICLARM/GTZ Aquaculture Project.

At this juncture, I am pleased to inform you that since the ICLARM/GTZ project was established in Malaŵi in 1986, it has contributed considerably to the country's aquaculture development. The aquaculture section of the fisheries department is manned by staff who were trained to a Master's level in the biology department of Chancellor College, through ICLARM/GTZ scholarships. Our researchers and extensionists have been the primary beneficiaries of the knowledge and skills gained through collaborative activities with the ICLARM/GTZ project.

Smallholder fish farmers in the country have greatly benefited from the technologies developed by the project. I am informed that already a number of farmers in Zomba, Machinga, Mwanza and Mulanje districts have improved their overall farm productivity through the adoption of technologies developed by the ICLARM program.

Subject to the availability of resources, it is my sincere hope that ICLARM will continue making more positive contributions towards the whole fisheries sector, not

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only aquaculture. I am aware that ICLARM has a coastal management program which is developing a lot of models and technologies which might have an application to the management of our lake resources.

Permit me to inform the participants that an International Network of Genetics in Aquaculture was established following the recommendation of a UNDP-sponsored workshop held in Manila, Philippines in July 1993. At this workshop I represented the Fisheries Department and the university research coordinator represented the University of Malaŵi. There will be a continued collaboration between the Fisheries Department, the University of Malaŵi and ICLARM in the activities of this network. We feel Malaŵi is privileged to be a member of this network because the establishment of the network will assist in increased production from aquaculture through improved breeds of fish.

I wish to thank GTZ for their financial support to the Fisheries Department. Such assistance in these days of meager resources is not taken for granted and we are indeed very grateful. Be assured that we, on our part, will try our best to make sure that the resources given to us are used efficiently and effectively.

I also wish to take this opportunity to thank all of you who have spared time from your busy schedules. Your presence itself assures us that we are not alone in our effort to improve the standard of living of our rural fish farmers.

Dr. Roger S.V. Pullin
Director
Inland Aquatic Resource Systems Program
International Center for Living Aquatic Resources Management

This workshop is sponsored by the ICLARM/GTZ Africa Aquaculture Project. This project has been supported continuously from 1985 by Germany, with supplementation from ICLARM core funds whenever possible. During this period, ICLARM, GTZ and our collaborators in Malaŵi have learned much about how small-scale aquaculture might be integrated with other farm enterprises. But we have also come to realize how little we know about the socioeconomic and ecological constraints to adoption of integrated farming systems, and we still do not know how to make such systems work *sustainably*. We started out researching how to grow fish but our research agenda has now broadened from this biotechnical focus to a much wider systems approach.

Parallel to this, the global view of the potential role of aquaculture in rural development has also been changing - from a focus on specialized, stand-alone fish farms to the adoption by the rural poor of aquaculture as an integral part of farming systems. In other words, many very small "piles of fish" can improve the livelihood and nutrition of many people, and can also improve the productivity and sustainability of other farm enterprises.

Against this shift in emphasis and perspective, and against a history of many failures in farming systems research and development in Africa, we have come here to discuss and to clarify future directions. This is very timely. Many countries in subSaharan Africa are watching the progress being made here in Malaŵi. They can see some pointers towards success in smallholder aquaculture and integrated farming. But we will need more support to build upon this. The ICLARM/GTZ Africa Aquaculture Project, as currently structured and funded, will finish in October. We are looking for support for future activities. This is most likely to be secured if we all work more closely together and prioritize clearly, in these difficult times for financial support, what new knowledge is needed - through partnerships among farmers and scientists.

I am sure that this meeting will be an important stepping stone towards expansion of smallholder aquaculture and integrated farming in this region. I wish you all success with your presentations and deliberations and pledge ICLARM's continued efforts to help, wherever possible, with aquaculture research and development activities.

WORKSHOP DISCUSSIONS AND CONCLUSIONS

Each presentation at the workshop was followed by extensive discussion. Using the information arising, the participants held a roundtable discussion on integrated aquaculture's potential role in African rural development.

Discussion revolved around the role of integrated resources management (IRM) and aquaculture in three major aspects of rural development:

- Food security and household nutrition;
- Rural income generation and capitalization; and
- Environmental rehabilitation and preservation.

As a means of increasing the quantity and quality of food available for rural households, there was general agreement that any production system which increases overall farm output offers people the opportunity to improve their nutritional status. Certainly, increased vegetable and fish production in integrated aquaculture systems improves the availability of protein and essential vitamins. Evidence was presented from Ghana which found that both vegetable and fish consumption increased on integrated farms. Whether, in general, there is any positive impact on nutrition appears to depend upon how food resources are allocated within the household, and why farmers decide to take up integrated aquaculture. New methods and research about the motives of farmers who adopt IRM are needed.

In general, aquaculture has been viewed as a means of producing fish and, subsequently, cash. The workshop participants agreed that this use of aquaculture, as a means of improving the lives of potential users, most of whom are resource-poor, is flawed. Smallholder aquaculture is expanding despite economic analyses (based only on fish production) which have found aquaculture to be largely uneconomical. Evaluation of the performance of integrated aquaculture must therefore include all farm and household enterprises, not just the pond.

Aquaculture integrated into the whole farming system theoretically offers a variety of benefits, other than just fish, to the smallholder. A few examples:

- Water can be used for emergency irrigation of vegetable gardens and livestock.
- Nutrients released during mineralization of organic matter in the pond might be more valuable to plants than simple mulches.
- Composting in ponds reduces the danger of harboring pests.

The participants at the workshop hypothesized that these fringe benefits might add up to increased farm efficiency and economic performance. However, for these to be realized, policy needs to be modified to support integrated aquaculture, and extension

services need to be upgraded and diversified so as to be able to utilize farmer-participatory methodologies and a broader range of agriculture technology. Many participants felt that more closely linking agriculture and aquaculture extension services might be useful in this regard. Research is needed on how IRM could be optimally implemented and evaluated.

Although estimating the overall impact of widespread adoption of integrated aquaculture will require systematic investigation, there is evidence that IRM systems generate less waste and can actually improve the capital value of smallholdings by improving soil structure, capturing water and reducing erosion. Data from Ghana and Malaŵi showed that IRM can increase tree cover, improve water management, and reduce soil loss. These benefits might be more important to farmers and rural communities than any amount of fish which might be produced.

The workshop concluded that the theoretical potential for IRM to improve the economic and ecological sustainability of smallholding farming systems is substantial. Research is urgently needed to collect the anthropological, socioeconomic and ecological information necessary for improving uptake and functioning of IRM systems among smallholders, defining the environmental limits within which adoption is feasible, and predicting the impact of widespread implementation of IRM on rural and national economies.

SOCIOECONOMIC AND BIOPHYSICAL REVIEWS

The Context of Smallholding Integrated Aquaculture in Malaŵi

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Brummett, R.E. 1994. The context of smallholding integrated aquaculture in Malaŵi, p. 3-5. *In* R.E. Brummett (ed.) Aquaculture policy options for integrated resource management in subSaharan Africa. ICLARM Conf. Proc. 46, 38 p.

By the year 2000, nine million smallholding farmers will live on Malaŵi's 1.5 million hectares of arable land. Right now, only 45% of these farmers can produce enough to feed their families. Overuse and poor management of soil guarantee that the ability of the land to feed people will decrease, while population growth insures that the number of people to feed will increase. Social, economic and environmental turmoil are almost inevitable.

What are the rural development options? Should we attempt to build industrial capacity as rapidly as possible and hope that the government will be able to create quickly the necessary institutions to distribute resources and food to the population? Or should we work with the rural poor directly to increase local financial and food security and hope that economic growth in small farming communities will somehow be able to build infrastructure for future generations?

Industrialized agriculture may lead to the greatest accumulation of capital in the shortest amount of time but, rather than providing job opportunities, most modern agricultural technology actually reduces the need for human labor. As land and employment opportunities are diverted from smallholders to industrialists, government must provide, from industrial tax revenues, new housing, education and job opportunities. Otherwise, urban slums, filled to bursting with unemployed refugees from the villages, become breeding grounds of disillusionment, despair and, ultimately, violence.

Efforts to directly improve the lot of rural smallholders *in situ* have also faced problems. Even when the right economic or technological solutions to a problem can be identified, there are often strong social constraints to their adoption. These constraints tend to be highly idiosyncratic between cultures and therefore not amenable to generalized remedies. Millions

of dollars and person-years have been spent trying to find ways around these constraints. Most of these efforts have failed.

A compromise combining the best elements of the purely industrial and purely grassroot approaches will probably be that which is the most useful in solving real rural development problems. For such a strategy to evolve, we need a clear description of what we hope to do and a precise characterization of the target group. The case of the relatively well-documented Malaŵian smallholder might serve as a useful starting point from which can be built a deeper and more general understanding of how smallhold farming communities operate.

Land and Food

In 1993, Malaŵi had approximately 1.3 million farms directly supporting 6.8 million people. The vast majority of these farms are very small, averaging 1.2 ha. Farms this small are not reliable food production units. Farmers with less than one hectare of land cannot feed their families. Farmers with less than 0.5 ha of land under cultivation are only able to produce 30% of what they need. This food security shortfall of land has immediate ramifications for household nutrition. Nationwide, 43% of children under five years of age are more than 20% underweight, and 56% are stunted. In an effort to meet basic food requirements, over 93% of smallholding land is used to grow edible crops, and almost 70% of the product is consumed on the farm.

Improving Farm Productivity

The imbalance between farm output and food requirement must be corrected. The most commonly proposed solution is to intensify land use by adopting new crop varieties and applying fertilizers and pesticides. Unfortunately, the resources with which to access these technologies is severely limited among smallholders. By current guidelines, less than 30% of farmers qualify for agricultural credit and then only for maize and rice. As a result, inorganic fertilizer supplies less than 30% of needed nitrogen on smallholder farms.

Another way to increase agricultural output is by cultivating previously unused land. If all the unused cultivable land in Malaŵi were distributed among the existing smallholders, the average landholding would only go up to two hectares per farm. At current population growth rates, average landholding would be below one hectare within 20 years.

Two things are clear: population growth must be brought under control, and any sustainable improvement of farm production must rely on the resource base which already exists on smallholdings. Integrated farming systems might be part of the solution.

Integrated Aquaculture Farming Systems

An integrated aquaculture farming system is one in which waste material from one enterprise is used to improve production on another, thus increasing the efficiency of both. Several benefits accrue to the integrated farmer:

- minimized waste, leading to locally improved environmental quality;
- reduced need for fertilizer, leading to increased profitability;
- improved soil structure, leading to increased fertility;
- increased fish and vegetable production, leading to improved household nutrition;
- reduced dependence upon outside inputs, leading to increased stability; and
- increased overall farm productivity and efficiency.

Taken together, these add up to a more economically and environmentally sustainable farming system. If the findings of small-scale trials can be replicated on a large scale, integrated aquaculture farming systems have clear potential to improve food and economic security in rural farming populations. The big question which remains is whether the socioeconomic and cultural constraints to its adoption can be overcome. Integrated aquaculture will certainly not solve all the problems faced by rural farmers. Coupled with effective population control, however, more sustainable integrated farming may well provide shorter and medium-term relief to poor smallholders, and give developing-country governments the breathing room needed to develop the necessary infrastructure and institutions that will lead to long-term prosperity.

Aquaculture in Malaŵi: The Past, Present and Future - A Brief Overview

EMMANUEL K. KAUNDA
Malawi National Aquaculture Center
P.O. Box 44, Domasi, Malaŵi

Kaunda, E.K. 1994. Aquaculture in Malaŵi: the past, present and future - a brief overview, p. 5-6. *In* R.E. Brummett (ed.) Aquaculture policy options for integrated resource management in subSaharan Africa. ICLARM Conf. Proc. 46, 38 p.

Fish production in lakes and/or aquaculture of Malaŵi is under the government's fisheries department. It is widely known that fish provides an estimated 70% of the available animal protein to the nation. Despite such an enormous contribution, the fisheries department has always been marginalized in terms of financial resources.

Figures from the 1973/74 revenue account allocations show that Livestock (Veterinary Services) got MK622,826 (MK3.5 = US$1) while the Fisheries Department was allocated MK128,048. The trend did not change in the nineties. In the 1990, 1991 and 1992 fiscal years, the Livestock Department was allocated MK8,569,290, MK8,247,299 and MK6,124,051, while the Fisheries Department was allocated MK2,354,205, MK2,999,303 and MK3,155,753. According to Eccles (1985),[1] failure by government to recognize the due importance of the fisheries sector is due to the fact that administrators seldom see a fishery, and when they do, they see a port with a few days' catch rather than what is below the surface, unlike agriculture or livestock where a stock which may represent production of several years is seen.

Aquaculture, which forms but a small activity of the Fisheries Department, was also marginalized by the department. In

[1]Eccles, D.H. 1985. Lake flies and sardines - a cautionary note. Biological Conservation 33:309-333.

the 1973 annual plan, aquaculture did not even appear in the priority list. This is the most probable reason for the poor development of aquaculture from 1973 (when the Fisheries Act was instituted to empower the Fisheries Department to have responsibility over fisheries and aquaculture in the country) to 1988. This period (15 years) was characterized by few trained personnel (only two were trained up to MSc level), few farmers (about 1,000), poor geographical coverage (only the southern region of Malaŵi) and low total fish production (about 40 t from small-scale aquaculture).

The five years which, in this paper, is considered as current (1988-1993) is remarkably better than the period (1973-1988) considered above. The number of personnel trained up to M.Sc. level rose to 14; the number of farmers almost doubled to about 2,000; all three regions (Southern, Central and Northern) were covered in terms of extension and research; and total fish production in the small-scale subsector rose from 40 t in 1988 to about 140 t in 1993.

The "success" story in the five-year period (1988-1993) is probably due to the inception of three complementary projects in the country. A project entitled "Research for the Development of Tropical Aquaculture Technology for Implementation in Rural Africa" funded by GTZ and executed by the International Center for Living Aquatic Resources Management (ICLARM) commenced in 1986. The project was involved in training of Malaŵians and research in rural technology. The project trained 70% of the trained nationals and came up with about 80% of research achievements.

The Malaŵi-German Fisheries and Aquaculture Project (MAGFAD) was the second project. This bilateral cooperation between the Malaŵi and German governments started in 1988. The project complemented ICLARM effort by carrying the technology to the farming community. It was responsible for extension in the Southern Region of Malaŵi and trained about 10% of existing personnel.

The third project was the Central and Northern Region Fish Farming Project (CNRFFP), with the bulk of the funding from the European Economic Community (EEC), which was started in 1989. The project carried out small-scale aquaculture extension in the Central and Northern Regions of Malaŵi. Aquaculture research was also undertaken by the project. Ten per cent of trained personnel came out of the project.

The period 1988-1993 saw a closely complementary aquaculture development effort by the three stated projects. A glimpse into the future (1993-1998) indicates uncertainty, unless the funding situation and Malaŵi government's participation in terms of financial contribution improves. Funding for the ICLARM/GTZ and the CNRFF projects comes to an end in 1994, and that of MAGFAD is scheduled for 1995. It is doubtful that the government can immediately take over responsibilities of research and extension for the whole country. In the next five years, one may see: 1) a group of trained Fisheries Department personnel with nothing to do as a result of lack of resources, and 2) a large number of disappointed farmers.

Why an Integrated Resource Management Approach?

CLIVE LIGHTFOOT AND ROGER S.V. PULLIN
International Center for Living Aquatic Resources Management
MCPO Box 2631, 0718 Makati, Metro Manila, Philippines

Lightfoot, C. and R.S.V. Pullin. 1994. Why an integrated resource management approach?, p. 7-9. *In* R.E. Brummett (ed.) Aquaculture policy options for integrated resource management in subSaharan Africa. ICLARM Conf. Proc. 46, 38 p.

Dissatisfaction with the adoption rates by smallholders of conventionally developed integrated aquaculture farming drove ICLARM to develop an alternative approach. The factors that we believe are largely responsible for this and the response of an Integrated Resource Mangement (IRM) approach are given in Table 1.

The IRM approach seeks to transform existing farming systems to integrated aquaculture farming systems through a farmer participatory research protocol that is guided by ecological and economic modeling and socioeconomic studies to ensure that it is ecologically, economically and socially sustainable by smallholders.

Table 1. Comparison of conventional and IRM approaches to integrated aquaculture research and development.

Conventional approach	IRM approach
High external input	Low external input
Fish production objective	Sustainable resource management objective
Pond as unit of analysis	Whole farm as unit of analysis
Commodity perspective	Systems perspective
Researcher-designed and evaluated	Farmer-designed and evaluated
Improving yields of fish farmers	Introducing fish farming to new entrants

The farmer-participatory research protocol involves four main steps:

i) Identification of natural resources. Local classes of natural resource types are chosen as the point of departure for research because these classes base the research in indigenous knowledge and lead to discussion about how water resources can be rehabilitated. Rehabilitation of water resources is often required before fish can be cultured. Moreover, natural resource types may provide a common framework for comparing systems across regions.

ii) Modeling of experimental bioresource flows. The heart of the process is bioresource flow modeling. These models bring farmers and scientists together to discuss ways and means to rehabilitate water resources and integrate aquaculture, and other enterprises, into ongoing farming systems (Fig. 1).

iii) Monitoring of bioresource flows, natural resource rehabilitation, enterprise additions. The experimental models are designed and implemented by farmers with appropriate research and extension support and the resulting transformation is monitored and evaluated.

iv) Evaluation of economic and sustainability performance. Evaluation covers both economic and sustainability indicators such as species diversity, bioresource recycling, productive capacity of the natural resource base and economic efficiency.

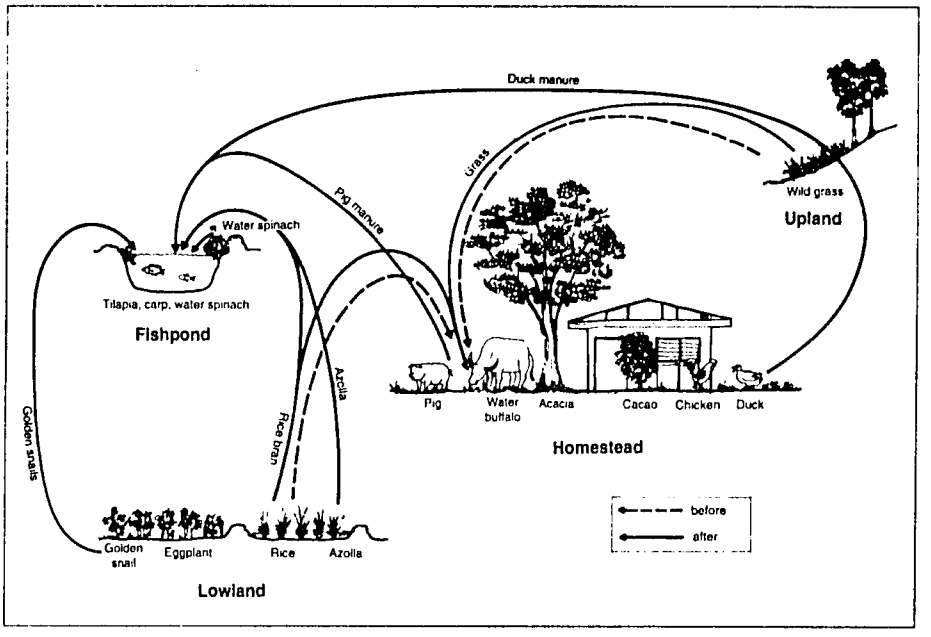


Fig. 1. Resource flows before and after integration of a smallholding in the Philippines.

Superimposed on the population of farmers involved in system transformation are socioeconomic studies to understand why farmers participate and why they do not. Similarly, ecological and bioeconomic data gathering permits the construction and testing of mathematical models of integrated farming systems. These models allow an array of ecological and bioeconomic impact assessment to be made at household, watershed and higher geographical levels. Through a combination of farmer participatory research, modeling and indepth socioeconomic studies of the IRM approach will answer basic questions about how integrated aquaculture farms function and how they can be improved. The most critical of these questions might be:

- Are integrated aquaculture systems ecologically sustainable?
- How much is ecological sustainability going to cost relative to the cost of nonsustainable farming?
- What factors constrain the adoption of integrated aquaculture (labor, marketing, or fingerling supply)?
- What factors promote the adoption of integrated aquaculture (improved incomes, nutrition, environments)?

Potential Impact of IRM

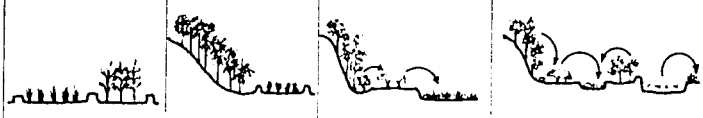
While we have not been able to test the IRM approach, fully recent results from some of ICLARM's farmer participatory research in Malaŵi, Ghana and the Philippines suggest that integrating aquaculture into existing farming systems using the protocol described may improve economic and ecological sustainability of the farming system (Table 2). Economic performance in terms of net income increased and all four sustainability indicators (bioresource recycling, species diversity, productive capacity and profit:cost ratios) improved after integration of aquaculture. While these are only preliminary results from three case studies, they do suggest that the farmer participatory research protocol might work.

Implications for the Future

The question facing us as we work for the next century is not what kind of

Table 2. Economic and ecological sustainability indicators on case-study farms in Malaŵi, Ghana and the Philippines before and after integration of aquaculture.

Country		Net income (in US$)	Recycling (number)	Diversity (number)	Capacity (t/ha)	Profit: cost
Malawi	Before	400	0	21	0.98	2.0
	After	462	5	26	1.12	2.6
Ghana	Before	1,447	5	20	1.18	6.1
	After	2,243	16	23	1.25	8.0
Philippines	Before	520	2	8	13.3	0.8
	After	879	9	15	16.3	1.2



	Sustainability: Low	Medium		High
Farming system	Monocropping	Multiple cropping	Corn-livestock-tree system	Integrated resource management system
Natural resource type	Single	Few	Multiple	Multiple
Enterprise assemblage examples	Rice or corn	Rice-wheat or corn-cassava cereal-legume	Cattle, poultry vegetables, cereals, legumes fruit trees	Livestock, poultry, fish vegetables cereals, legumes aquatic plants fruit trees multipurpose trees
Species diversity	Low	Low	Medium	High
Bioresource recycling	Low	Low	Medium	High
Economic efficiency	Low	Low	Medium	High
Natural resource capacity	Low	Medium	High	High

Fig. 2. Theoretical stages in the transformation of farming systems and their relative sustainability.

integrated aquaculture systems can scientists develop, but how to get fish on smallholder farms as part of a strategy to develop sustainable farming systems. As resource poor farmers are the new target, and as exceedingly few of them culture fish, ways must be devised to gain new entrants into aquaculture rather than increase the fish production on the few existing farms.

What one is looking for is a farmer participatory research protocol that brings farmers and scientists together to transform the existing smallholder farming systems into integrated aquaculture farming systems. In theory, one can imagine stages of transformation from monocropping systems with low sustainability through farming systems of medium sustainability like crop-livestock systems, to fully integrated systems (Fig. 2).

New directions for development suggest that farming system transformation should not pursue maximum commodity productivity, but give way to sustainable management of natural resources. Similarly, the concentration on research station developed systems should now give way to farmer participation in technology development.

Socioeconomic Assessment of Smallholder Aquaculture: A Case Study of Smallholder Farmers in Mwanza and Zomba Districts

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Methodology

The study was carried out in Zomba and Mwanza districts of southern Malaŵi, between July and September 1991. A random sample of 150 fish farmers was selected, representing 35% of the total fish farming population of these areas. Quantitative and qualitative socioeconomic data were collected with a questionnaire administered by local extension agents. Gross margins and return to labor were used to assess the viability of fish farming operations.

Social Characteristics

The study found that 65% of fish farmers in Mwanza were aged between 20 and 40 years, while 64% of those in Zomba were over 40 years old. The exact reason for this is not clear, but one might speculate that older folks have more attachment to the land and access to greater resources than younger people.

Average annual cash income from the 1990/91 harvest was lower in Mwanza (US$113.85) than in Zomba ($123.08). About 94% of those interviewed in Mwanza generated most of their cash income from farming, compared to 76% in Zomba. Of these, 74% in Mwanza and 54% in Zomba had no other source of cash income. One Mwanza farmer remarked:

> *There are limited opportunities to generate cash in this area, because there are not many government offices or estates at which to be employed. Even the commodities we get from farming, such as Irish potatoes, maize and fish do not fetch much money since people do not have much cash. If I want to get more money for my fish, I have to carry them 25 km to Mwanza Boma to sell at the market.*

Over 86% of Mwanza fish farmers had landholdings of more than one hectare, compared to 80% in Zomba. Fish farmers in these districts have considerably larger landholdings than nonfish farmers. On average, only 42 and 30% of all farmers in Mwanza and Zomba, respectively, had more than one hectare of land. Although the majority of farmers adopting fish culture were the less resource-poor, a significant percentage (14 and 20%) of farmers had productive fishponds on farms of less than one hectare (the subsistence threshold).

Asked what the land had been used for before digging the ponds, over 60% of the farmers in both districts reported that they had been growing vegetables. About 20% of Mwanza farmers had developed previously unused, waterlogged, land.

Economic Evaluation

Over 60% of farmers in both districts reported to have used only family labor to build their ponds. Only 33% in Zomba and 24% in Mwanza hired labor. Larger ponds tended to be owned by farmers who could afford hired labor.

Average pond sizes were 560 m^2 in Zomba and 140 m^2 in Mwanza. Although not always assessed in cash, average construction costs were $167.02 and 41.75 in resources and labor, respectively. Depreciation is normally calculated over 10 years.

Fingerlings were assumed to be reserved from the previous harvest. On average, farmers will only need to renew completely their stock once every three years following drought or flood. Fingerlings presently cost $0.007 each and are stocked at a rate of two per m^2.

Farmers use mostly farm by-products as inputs. Some materials (e.g., maize bran and chemical fertilizers) are purchased. These inputs averaged $9.62 in Zomba and $2.69 in Mwanza.

Daily labor was regarded as the normal obligation of every family member. Walking distance from the house to the pond is generally greater in Mwanza than in Zomba. Consequently, farmers spent an average of 16.7 and 9.7 person-days per year in Mwanza and Zomba, respectively, on pond-related activities.

An interest rate of 20% was charged on variable costs, over the average production periods of 6.5 and 9.0 months in Zomba and Mwanza, respectively. No interest was charged on capital costs.

Gross margin analyses are shown in Table 1. The major risk factors in southern Malaŵi are flooding, drought, theft and predators. Total loss of stock occurs, on average, once every six crops. Sensitivity analyses are shown in Table 2.

Farmers got more money per day for their labor by producing fish ($1.36 on average) than being employed for day wages ($0.80). Even though the fishpond represented a small proportion of the total farm area, 12 and 39% of the total annual farm incomes came from fish in Mwanza and Zomba, respectively. Compared to gross margin guidelines prepared by the Malaŵi Ministry of Agriculture, fish farming is more profitable and more productive per hectare, person-day and unit variable costs than other crops.

Asked how much money they expected to get from fish farming, Mwanza and Zomba farmers said $23.85 and $110.77, respectively. The farmer's expectations were thus not far from the gross incomes calculated from the study.

Table 1. Gross margin analyses (all values in US dollars).

Parameter	Mwanza	Zomba
Gross income	23.46	84.23
Gross margin	20.04	71.58
Depreciation	4.29	17.16
Interest	0.68	2.50
Net gross margin	15.07	51.92
Gross margin/person-day	1.82	11.01
Net gross margin/person-day	1.37	7.99
Gross margin/hectare	1,431.43	1,278.21
Net gross margin/hectare	1,076.43	927.14
Gross margin/variable costs	5.88	5.73
Net gross margin/variable Costs	4.42	4.16
Return to labor	1.21	2.47
Net return to labor	0.91	1.80

Table 2. Sensitivity analyses (all values in US dollars).

Parameter	Mwanza	Zomba
Loss due to risk	4.35	25.92
Gross margin	15.70	45.66
Net gross margin	10.73	26.00
Gross margin per hectare	1,121.07	815.36
Net gross margin per hectare	766.07	464.29
Return to labor	0.95	1.58
Net return to labor	0.91	0.90

Digging Fishponds: Perspectives on Motivation

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Introduction

For the promoters of fish farming, a common indicator of project success is that people dig fishponds. Quantified objectives in project documentation tend to concern a combination of numbers of fish farmers and extrapolated figures on production. It is widely suggested that the principal factor signifying the success or failure of any extension program or project is the extent to which it is adopted and supported by the "target" population. Frequently though, the digging of fishponds is not accompanied by sustained management. A familiar pattern emerges: adoption following promotion by outsiders, low productivity, reduced interest, and eventual abandonment.

Of all the factors which affect sustained adoption of aquaculture, the question of farmer motivation is usually treated the most simplistically. If considered at all, it is assumed that farmers dig fishponds following an informed assessment of the costs and likely gains. In this paper, it is suggested that a more subtle analysis of farmer motivation is required. Three assumptions which underlie many discussions of farmer motivation are questioned:

- The assumption that the interests and motivations of all members of fish farming households are equal. There is seldom any critical examination of whether the needs, interests and priorities of all household members can be equated with those of the (male) household head.
- The assumption that the decisionmaking process of individual farmers is always an informed weighing of costs, benefits, and risks - with a completed outcome. Where constraints and benefits are clear, this may be the case. There are, however, many occasions when action is less the result of such calculation and more part of a continuing process of response and adaptation to new information.
- The assumption that production of many fish is the most important expected output of pond construction. For the people who dig ponds, pond digging may have other associations.

Based on research conducted in Luapula Province, Zambia, these assumptions are examined in the light of possible motives for digging ponds. These range from the most obvious and frequently discussed: the acquisition of cash income and fish for food, to more nebulous influences of security and responses to development interventions.

Perspectives on Motivation

Obviously, motives for adoption are not easily separable from ability. Ability

reflects both material circumstances and the belief that fish farming is a feasible option. These in turn reinforce each other. In Luapula, there is perceived abundance of the resources required to start fish farming. There are, however, seasonally determined shortages and stresses which inhibit uptake of fish farming and which are felt most strongly by vulnerable groups such as older women, the sick and those with few assets. Adopters are more likely to be men, to be slightly better off, to be slightly better educated, and much more likely to be active participants in social and political activity. These facts are closely connected with one another and to some extent causally associated.

Decisions taken by the head of household do not necessarily reflect the priorities of the entire household. Furthermore, unstable marriages and frequent temporary migration mean that the family unit is changeable. Men and women often adopt different economic strategies, or at least devise contingencies for a change in marital status. Of the 24 households in the Luapula case study, 17 had both a husband and a wife. Of these, 10 operated a flexible division of labor in which both partners contributed to fish farming. In two households, the wife did the majority of the work. Of the five households in which the men did all the work, four were the most cash-oriented in the study. In general, in more cash-oriented situations men and women were more likely to have separate activities and budgets.

In Luapula, fish are produced for food and to diversify the diet, but might also be saved for special occasions, guests or as insurance against hard times. For people with access to cash, having a pond might provide opportunities to eat fish when they might not otherwise be able to do so. For more vulnerable groups, the marginal benefits of adopting fish farming are greater. The least productive farmers are often extremely poor and the few fish they grow represent the only source of fish consumed.

Two areas were studied to determine the degree to which fish are grown for cash income in Luapula. In Chibote, less than 9% of farmers sold any fish. In Monga, 50% sold some fish or fingerlings. Earnings were generally low. As a motivator, the promise of cash is important. However, the influence of the social context within which fish are sold or bartered means that the kind of production and business planning envisioned by developers does not take place. Nonetheless, some farmers, keen to identify themselves with "progressiveness", are happy to adopt the language of "business" associated with developers.

Fishponds have a significance to farmers as forms of asset or security which may be greater than their immediate usefulness as sources of fish for food or cash. Fish might be regarded as security against emergencies, as mentioned above, but the pond itself also is regarded as an asset. For example, a man who owned nine ponds, but lacked inputs felt that: "The food for the fish will come later, but it may not be so easy to dig a pond later (when I am old)." Men sometimes dig ponds to provide for the future welfare of their children. However, relative insecurity of tenure is a disincentive to women having ponds in their own right.

An aspect of the permanence of fishponds and the security of tenure currently associated with them is their role in claiming land which then may be used for other purposes. This phenomenon took place where there were localized pockets of land shortage. For example, one farmer partially constructed eight ponds in order to claim access to land for vegetable growing and another claimed land with shallow ponds which were used to irrigate vegetables rather than grow fish.

Aquaculture development activities are not introduced into a vacuum, or into

communities which have in some way been isolated from external influences. The legacy of previous interventions, whether colonial or government- or donor-supported development projects, has a profound influence on the way local people respond to the latest one. Such institutional interventions combine with changing market conditions to effect adoption practices - and people's behavior once they have adopted a new technology.

Whatever the measurable benefits of past development activities, one thing is clear: the mass of the population of Luapula are now swift to associate external projects with money. Farmers will frequently adopt strategies, including digging ponds, to attract the prestige and financial fringe benefits of association with external projects.

Rethinking Motivation

Based on statements of fish farmers who were asked why they adopted aquaculture, Wijkstrom (1991)[2] argues that it is solely undertaken for the purpose of increasing household income and that: "Other purposes for engaging in fish culture are entirely subsidiary in nature and can be forgotten by the public planner and international aid official." Obviously, few respondents would be likely to answer in terms of the conceivable less obvious grounds for adoption: to claim land, as a long-term asset or security, or as a signal of being more "developed" and thus gaining access to project and government funds and assistance. These motives are not subsidiary. Their existence has a major effect on the way in which the technology develops.

In thinking about motivation, it is important to take full account of the context within which people act. The meanings to which they attach their actions will vary according to the situation of the individual, and according to relationships with others both within the household and in the wider community.

Attempts to understand and take into consideration this wider context are apparent in recent farming systems work, including that carried out by ICLARM. It is acknowledged that decisions concerning fish farming are only one aspect of a wider and more complex decisionmaking process regarding, for example, resource allocation. As a result, maximum production of fish may not be the best strategy for the farmer. However, the tendency to assume systems and hence, predictability, carries with it its own problems. The "farmer" may be treated as an isolated decisionmaker, choosing from a range of options with both freedom and knowledge. The political and social contexts within which decisions are made are obscured. In fact, such social and political influences can be of central importance.

The finding that people dig fishponds for reasons which are more complex than simple income generation and are not necessarily primarily about producing fish has worrying implication for monitoring and evaluation. The widespread inaccuracies in attempting to measure a crop which is only partially commoditized are increasingly noted. Furthermore, where the rational for fish farming promotion is expressed in terms of food security and poverty alleviation, there is no obvious connection between these objectives and indicators such as numbers of ponds or numbers of fish farmers. Evidence indicates that the resource poorest are unlikely to benefit from fish farming. Lastly, in the light of the discussion above, a fundamental problem exists. Where the reasons that people dig ponds are not just about producing fish, does it make sense to suggest that their low or nonproduction of fish constitutes a failure? For whom is it a failure?

[2]Wijkstrom, U. 1991. How fish culture can stimulate economic growth: conclusions from fish farmer surveys in Zambia. ALCOM GCP/INT/436/REP/9. Food and Agriculture Organization of the United Nations, Rome.

What do these findings imply for support to rural fish farming? First, greater clarity concerning the objectives of such support is needed. If the aim is really one of improved nutrition for the poorest, then fish farming is unlikely to be the best option. If the concern is sustainable production of fish in ponds, then a number of issues arise. On a practical level, close attention needs to be paid to the marketing and resource availability of any particular area. Also, the promoters of fish farming should not assume they are merely "technical agents", whether delivering "packages" or responding neutrally to farmers. They are part of a social and political environment in which their own and farmers' behavior is formed. Understanding this environment—such as the effects of previous development interventions and how decisions are made within households—may give a more accurate picture of motivation. It may also improve predictability of the results of particular actions; for example whether or not they are likely to inculcate or perpetuate farmers' perception of their own dependence on the government or donors.

Issues in Aquaculture Policy for Malaŵi and Proposals for the Future

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Rashidi, B.B.A. 1994. Issues in aquaculture policy for Malaŵi and proposals for the future, p. 15-17. *In* R.E. Brummett (ed.) Aquaculture policy options for integrated resource management in subSaharan Africa. ICLARM Conf. Proc. 46, 38 p.

There are many issues that need to be considered when formulating policy. From the available information, the main issues for aquaculture policy in Malaŵi include the following:

1. Fish production from the many natural waters (lakes and rivers) has stagnated at 70,000 t (fluctuating between 60,000 and 90,000 t) per year.

2. Population is increasing at a high rate of 3.2% per annum. The population of Malaŵi is now estimated at 9.8 million. As a result, per capita fish consumption has declined from 12.3 kg in 1972 to 7.5 kg in 1992.

3. Fish represents 70% of total animal protein in the Malaŵi diet.

4. In Malaŵi, 86% of the population are in rural areas; 53% are female and 63% are children under 15 years of age; the majority of the population is therefore vulnerable to poverty and malnutrition.

5. Past policy promoted "investment in viable rural fish farming...as a means of raising rural farm incomes and increasing the supply of fresh fish in rural areas."

6. Fish farming at the smallholder level has expanded only in the past few years (since the 1980s) as a result of the many development projects that have been implemented during this period. The number of smallhold fish farmers is now over 2,000 and it continues to increase.

7. Aquaculture expansion in the smallholder sector has not resulted in any significant increase in fish supply. Total production in 1992 was 37% higher than in 1991, but was still only 53.25 t. Smallholder aquaculture seems unlikely to significantly supplement declining capture fisheries. Aquaculture policy should therefore promote fish farming as a source of income, high value protein and as a source of employment for the rural poor.

8. Results obtained so far indicate that fish farming is economically viable at the smallholder level, and could be profitable at semi-intensive to commercial levels if prices of inputs were reduced, and productivity increased.

9. There is need to know what motivates farmers to take up fish farming; the role of gender is especially important in this regard.

For the purposes of this presentation, the following issues are presented for consideration in future policy:

1. For smallholder farmers, viable fish farming can only be achieved when the farmer considers the fishpond as an integral part of his whole farm where the resources (in terms of inputs, labor and land) flow in the management of the whole farm. Presently the pond is poorly managed probably because the farmer considers it as a separate entity where he has to allocate resources separately.

2. Research findings have shown that fish farming is more profitable or more viable among those farmers who already own other farming enterprises such as livestock (mostly chicken and pigs) and the fishponds are added to these units.

3. The role of women in fish farming has been highlighted in all socioeconomic studies that have been conducted in the country. The review missions for both the Central and Northern Regions Fish Farming Project and the MAGFAD[3] project also mentioned the important role that women play in fish farming.

4. As has already been developed in agriculture, the establishment of women clubs has been recognized as one way in which women can be involved actively in the development of fish farming.

5. The absence of women extensionists in fish farming has been highlighted as one reason

[3]Malaŵi-German Fisheries and Aquaculture Development Project.

women have been sidelined in fish farming. Women must be included in aquaculture policy.

6. Research should continue to pursue the issue of introducing into aquaculture some more suitable indigenous species. It is hoped that this will also contribute to increased fish production from aquaculture.

7. As it is government policy to alleviate poverty and expand employment opportunities for the rural population, the only way aquaculture can contribute to this is by a significant increase in fish production from aquaculture. Government policy and strategies should therefore emphasize the promotion of aquaculture production at all levels (smallholder, semi-intensive and commercial).

8. Aquaculture development in Malaŵi can take place when adequately trained and motivated people are available. Since it is also government policy to increase expenditure for human resources development, aquaculture development policies must include aspects of staff development in terms of training and promotional opportunities.

9. The need for the Department of Fisheries (DOF) to involve itself in international cooperation cannot be over-emphasized. The DOF is already coordinating inland fisheries activities for SADC[4] and is a member of FAO[5]/CIFA[6]. The department is also cooperating with other international organizations all of which shall continue to play an important role in the development of aquaculture in this country. For this purpose therefore the aquaculture policies for the future should highlight this as an important issue.

10. As aquaculture develops, more farmers dig ponds and probably estate type (commercial) fish farming gets developed, the issues of the environment shall become very important. The future policy should include this issue.

[4]Southern Africa Development Community: Angola, Botswana, Lesotho, Malaŵi, Mozambique, Namibia, Swaziland, Tanzania, Zambia and Zimbabwe.
[5]Food and Agriculture Organization of the United Nations.
[6]Committee for the Inland Fisheries of Africa.

FIELD AND RESEARCH EXPERIENCES

Farmer Participatory Development of Integrated Agriculture-Aquaculture Systems for Natural Resource Management in Ghana

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A research collaboration between ICLARM and the Institute of Aquatic Biology, Accra, began in 1991 to investigate viable options for aquaculture development on smallholder farms in Ghana. Within the research framework a partnership was planned among scientists, a local NGO and smallholder farmers who were not performing any form of aquaculture. Scientists were from the Institute of Aquatic Biology (IAB) and ICLARM, and the NGO was the Ghana Rural Reconstruction Movement (GhRRM). The field work was conducted in the operational area of GhRRM, in the Mampong Valley of the Eastern Region, which is 30 km north of Accra.

The Mampong Valley is characteristic of an environment formed by destructive agricultural practices through intensified use of the traditional management system. Hills are entirely denuded, maize and cassava fields are placed on steep slopes up to the hilltops, leading to erosion. Low water availability in the dry season affects crops, livestock and man, particularly as annual rainfall is inconsistent. Fallow periods have been shortened. Based on these characteristics, the area was highly suitable to investigate and test new approaches to the transformation of farming systems towards integration through a farmer-participatory approach.

In this setting, the project's approach was to involve scientists, extensionists and, most important, the farmers themselves, to study, discuss and learn from each other. This framework involved several steps of interaction. The initial step involved a village-level rapid appraisal of natural resources, social groups and agricultural activities.

Maps and transects were produced representing the information gathered. Through group sessions and map drawing sessions together with the villagers, combined with scientist's knowledge of requirements for pond aquaculture (e.g., soil quality, topography and water availability), the sites with potential for success were located and agreed upon. In follow-up visits, these were surveyed and a final evaluation on their adequacy made, together with the farmers.

Workshops were conducted involving groups of 10 to 15 farmers who had expressed interest in adopting aquaculture as a new enterprise on their farms and for whom potential sites were identified. The workshops were a combination of talks and open discussions with the aim of providing knowledge about two main subjects: basic aquaculture technology (pond design, construction, operation, maintenance) and integration (identifying unused or underutilized resources from existing on-farm activities as nutrient inputs for other enterprises; and possibilities for new enterprises, such as vegetable gardening in the dry season with pond water). The differences of drainable *vs.* undrainable ponds were discussed, together with simple-technology construction options. The necessity to regularly add nutrients to the pond was further discussed. As external inputs such as fertilizers and feeds were to be avoided, the discussions concentrated almost entirely on available on-farm resources. The only inputs given to the farmers by the project were a small number of pond-digging tools (lent to the farmers one after the other) and fingerlings for the initial stocking.

The next step was a farm/household-level appraisal through bioresource-flow diagrams. The best results were achieved in group sessions enabling interaction among the farmers to discuss options for integration. Farmers were encouraged to draw pictures of their respective farms: the status quo and, on a separate map, possible future enterprises and bioresource flows. Aside from adding a fishpond, most farmers added vegetable growing, which they had not practiced before, due to lack of water. A pond enables this in the dry season. Some farmers planned other activities such as orange-growing, bee-keeping, and additional livestock species. All decided to make more use of existing resources such as livestock manures and crop residues. Some farmers had woodlots for fuelwood and alley-cropping fields to avoid fallow periods. These were located in the midlands, yet close enough to be linked to the fishponds in the lowlands. The farmers generally did not use inorganic fertilizers.

Considerable discussions among the farmers themselves, especially concerning approaches to individual constraints, are a key component of the overall process. Within a few months, depending on labor availability, a dozen farmers constructed fishponds and grew vegetables on dikes and adjacent beds. After the first fish growing cycle, which ranged from 5 to 10 months, depending upon the decisions of the farmers when to harvest, usually about half of the fish were sold at the pond site to neighbors who were anxious to inspect the product and try the fresh fish, which is otherwise unavailable in the area. The rest were consumed in-house and some were given away. Some farmers decided to apply the nutritious pond mud to adjacent staple-crop fields to test if this would enhance production. Economic indicators (gross income, total cost, net income, and net cash income) all increased through integration of a fishpond and vegetables both for the whole farm and for the individual enterprises. Of the additional income from the fishpond-vegetable bed "unit", 95% came from the vegetables, and only 5% from the fish. The nutritional benefits of fish and vegetables were considerable.

Ecological indicators such as enterprise diversity, number of recycling flows on-farm, together with total farm production (capacity, t/ha) and economic efficiency ($ gained per $ invested) were presented in graphic form either as time series or as kite diagrams in a before/after scenario. All indicators increased upon integration.

An example is shown in Fig. 1. Through the addition of the fishpond, eight new flows recycled available nutrients (seven to the pond, one from the pond). The pond provided mud and fertile water for the vegetables. These nutrient transfers required only minor amounts of on-farm labor. The pond acts as a digester for the raw nutrients added to it, enabling the farmer to reclaim these for reuse. Farmers opted to use the green pond water instead of the clear stream water flowing just adjacent to the pond. Aquaculture is now spreading in the area, in most cases in form of fishpond-vegetable plots integrated into existing farms.

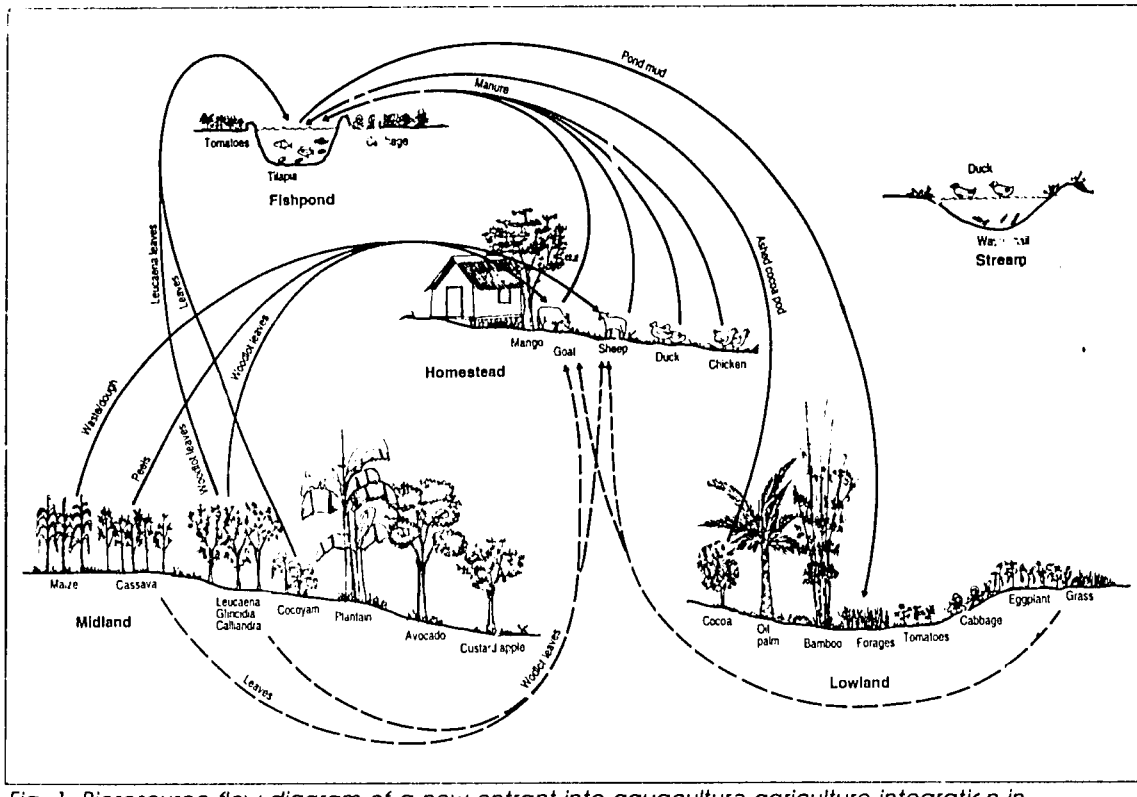

Fig. 1. Bioresource flow diagram of a new entrant into aquaculture-agriculture integration in Mampong Valley, Akuapem, Eastern Region, Ghana. The five resource types accessed by the farm household are shown as individual transects. External inputs, outputs to market and household consumption are not shown. Interrupted lines show flows already existing before integration.

The Central and Northern Regions Fish Farming Project: A Case Study in Technology Development and Transfer

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Results of the research unit of the Central and Northern Regions Fish Farming Project, carried out from 1990 to 1993, show that the growing of tilapia (*Oreochromis karongae*, *O. shiranus* and *Tilapia rendalli*) in monoculture yields 3.36, 3.83 and 2.57 $t \cdot ha^{-1} \cdot year^{-1}$, respectively, when the ponds are well fertilized with either chicken/pig manure or DAP[7] fertilizer and the stocking density is 4 $fish \cdot m^{-2}$. This level of production gives highest economic returns. *O. karongae* exhibits faster growth rate than *O. shiranus* when the stocking body weights are at 50 g. This means that there is no advantage when replacing *O. shiranus* with *O. karongae* by small-scale farmers who barely grow fish above 60 g. Monoculture of *O. karongae* is suited to those farmers who have enough pond inputs and would like to grow larger-sized fish (above 100 g). The polyculture option, using *Clarias gariepinus* with either *O. shiranus* or *O. karongae* gives fish yields exceeding 5 $t \cdot ha^{-1} \cdot year^{-1}$, making investment in semi-intensive fish farming economically viable, provided the stocking density is 4 $fish \cdot m^{-2}$, there are enough fertilizers, the stocking ratio is 1:1 (catfish:tilapia) and the catfish are smaller (2 g) than tilapias (20 g) at stocking.

[7]Diammonium phosphate.

Implication of These Research Findings to Farmers

In the project area, two categories of fish farmers exist, the low and high resource farmers. Most farmers in the project area fit into the low resource category. They are categorized by having insufficient on-farm resources. A fishpond is supposed to complement the availability of resources; however, this is quite often not the case because the farmers' decision to construct a pond is not based on the resources available. The style of pond management tends to be *ad hoc* without adhering to schedules or production cycles. These farmers apply a range of materials into the pond whenever available, at no fixed periods. During the on-farm monitoring study, farmers applied a total of 11 materials with no discernible pattern of application except coinciding with crop seasons. Yields are characteristically low with these farmers, and the project database shows that the net yields were 0.82 $t \cdot ha^{-1} \cdot year^{-1}$ from 167 harvests. These farmers rarely buy inputs off-farm and, consequently, always realize a net positive return in terms of return to labor, land or investment. Despite the fact that these farmers never lose money, over time, they tend to become less interested in this marginal activity and are most likely to abandon fish farming. To improve fish

yields, the extension message to these farmers should emphasize management of off-farm resources.

High resource farmers have more on-farm resources that meet the requirements of the pond for satisfactory yields. In the project area, 61% of the farmers are satisfied with their yields. Generally, landholding will be higher with these farmers, there are livestock on the farm and better access to labor than the former category. These farmers are able to amplify their operations by applying organic manures instead of the time consuming and labor intensive compost preparation. Often, these farmers tend to have off-farm income in the form of part-time work or permanent employment which reduces time spent with the fishpond and usually marginalizes the income from the pond when considered as a percentage contribution to household income. Yields are better than the low-resource farmers (above 2 $t \cdot ha^{-1} \cdot year^{-1}$). Profitability is mixed in this category. Those farmers spending money on inputs occasionally realize a negative net margin, but those making full use of their resources tend to derive greater benefits. These farmers are unlikely to abandon their ponds and controlled trials on the station would benefit them if well presented, perhaps with a farmer-participatory approach and field days. This is the category that is most likely able to develop fish farming activities to more intensive levels with proper management of resources.

Options for Extension of Small-scale Fish Farming Technologies in SubSaharan Africa

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Access to extension services is often cited as a key to the adoption and improvement of fish culture practices. In simple terms, extension is the iterative process of turning information into knowledge and knowledge into practice. Extension advice turns information into knowledge by the farmer, the farmer turns knowledge into practice, and research evaluates the results of practice to generate new information.

Extension can be considered at two different levels: a) extension methods, which are the techniques for transferring information (e.g., one-on-one, group, participatory, demonstration); and b) extension services, which comprise a system of methods and the means for their delivery.

Most interesting from the policy point of view are extension services, which can be characterized by six main elements and their aquaculture-related issues. At a time when researchers are making more complex information available about the biological and socioeconomic aspects of aquaculture, extension services can be seen as a major limiting factor in aquaculture development. They should attract more attention from

[8]Aquaculture for Local Community Development Programme.

policymakers because of their high cost and visibility, because they are about people, and because they are the means to deliver improved information about farming systems. The situation in the SADC countries points out the existing weaknesses in aquaculture extension services (see Box).

Policy should be aimed at alleviating the weaknesses in the six basic elements of extension services. Within countries, attention should be paid to the limited geographical locations where aquaculture can be practiced. The options available are part of a process, not discrete packages.

In situations where the potential and/or practice of fish farming is strong and widespread, there may be justification for a dedicated aquaculture extension service. In most places, potential is limited and found in isolated pockets in the large rural areas with relatively low population densities.

Under these circumstances, aquaculture information should be provided through collaboration and integration with existing field-level agriculture extension services, whether they are run by the government or NGOs. Integration of services will facilitate the promotion of aquaculture as an activity which has the most impact when integrated with agriculture.

The form of extension service integration will depend on local circumstances with respect to the elements of extension. The following issues need attention:

- Does agriculture extension provide information in terms of commodity crops or as a whole farming system? If seen as commodities, integration will be at a functional level, with aquaculture competing for limited resources (staff, time, mobility) and likely not receiving much attention as a low-priority crop. If seen as part of the farming system, aquaculture researchers should look for commonalities with agriculture

Element	Issues	SADC Situation
Institution	How is aquaculture prioritized? What extension resources should be allocated to aquaculture?	Most located in Ministry of Agriculture as specialized department. Some active NGOs.
Target group	Who should be targeted? How broad should categories be? How can subgroups be identified? What should be the spatial relationship between targets?	Small-scale farmers are the main target group, but there are many subgroups with different needs.
Subject matter	How specific should material be? Are cultured fish a commodity? Is aquaculture rural development? Can it improve food security? Does it generate cash income?	Agriculture extension has a broad mandate, but limited resources go mostly to major commodities, little to aquaculture. Integrated or multi-disciplinary approaches are rare.
System of methods	Should methods be context and location-specific, or more general?	Varies within and among countries, some methods adapted to fish.
Material assistance	Does aid affect sustainability?	Fingerling supply is the main aid.
Field worker	Are extension agents well-trained, motivated and mobile? Do they have a well-rounded view of development?	Agents have low education level, limited didactic and no multi-disciplinary training. Low motivation and mobility.

in the integrated resource approach and tailor their information accordingly (rather than build up separate analytic systems).

- Integration means aquaculture technicians will likely take a supporting role to more general agriculture extension (e.g., subject matter specialists in the T&V system). This means aquaculture technicians must be trained as trainers, able to instruct their agriculture colleagues in fish farming.
- With the integrated resource approach, both aquaculture technicians and farmers will need training in participatory extension methods. They must be able to use these methods to provide the information that farmers need to evaluate the use of their on-farm resources for productive activities, including aquaculture. With this kind of training, they will be able to work directly with farmers or with local community groups who have direct contact with farmers.
- General agriculture extension serves a wide and diverse audience, while aquaculture focuses on a target group selected for the physical potential for fish farming and then for likelihood of adoption. Research should provide clear indicators for adoption which can be used by extension services.
- Specific subgroups (e.g., specialized farmers and some socioeconomic classes) require special attention. A residual extension capacity, in terms of technicians trained in extension methods, is needed to provide advance aquaculture information. However, the targeting of specific socioeconomic subgroups should be the responsibility of the agriculture extension services.
- Agriculture extension services often use methods which are considered cost effective for reaching a wide group of farmers. Some of these methods may be suitable for aquaculture, such as extensionist-community group-farmer contacts while others may be less suitable, such as the training and visit system.

There are several issues to consider concerning the sustainability of extension services with respect to aquaculture:

- Staff training and field experience is a long-term exercise which needs commitment by development agencies and attention to conditions of service (esprit de corps, promotion, remuneration, housing, mobility, etc.) which motivate field workers to do their best.
- Material assistance to farmers, such as fingerling supply, may be necessary at the start of aquaculture development efforts, but should be phased out in favor of supply by farmers. Privatization of material inputs may lay the foundation for privatization of technical inputs.
- Depending on the technical level of aquaculture practices, there may come a time when the aquaculture knowledge base for the local circumstances is solid and there is no more need for technical advice.

Successful extension services (agriculture, including aquaculture) depend on a long-term continuous view of developing each extension service element, especially the human resource.

Bilharzia in Small Fishponds: Implications for Rural Development

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Because of the present enthusiasm of fish farming in the country, it is crucial to reflect on the significance of fishponds in schistosomiasis transmission. The discussion should assist in the planning of fish farms in a manner that would minimize the health risks from schistosomiasis. The belief that an additional body of water in an endemic area does not make the health risk any worse has already been challenged. Also, schistosomiasis is quantitative and the seriousness of the disease depends on worm load which, in turn, depends on frequency of contact with vector snail-infested waters. Pond construction leads to ecological change which might create conditions favorable for organisms, including snails, that never existed before.

Snail Survey and Collection of Epidemiological Data

To test the significance of fishponds in the epidemiology of schistosomiasis, forty-five ponds in Zomba and Machinga districts of southern Malaŵi were surveyed for vector snails. This was done by first looking for snails on the water surface, particularly along the edges of ponds for not less than 15 minutes. Aquatic vegetation and floating objects were also examined for snails. Twenty random scoops were made per pond along the edge to get an idea of relative snail density.

The snail survey above showed if vector snails were present in the ponds or not. If they were found, they were tested for infection in the laboratory. This was done by first putting 10 snails in a small beaker of water and exposing them to light for a few hours. A maximum of 50 randomly selected snails were tested in this manner for each pond. If cercariae were seen swimming in the water, the snails were placed individually in smaller beakers or test tubes to determine the proportion of infected snails. If none of the snails shed cercariae, the snails were crushed and examined under the microscope to see if they had the early stages of the parasite.

The collection of human epidemiological data involved observing the sections of the population (age and sex) most frequently in contact with water in the fishponds. The activities that require water contact were noted.

Survey Findings

Of the 45 ponds surveyed, 69% (i.e., 31 ponds) contained the vector snail *Bulinus globosus*. Only three ponds contained vector snails which shed cercariae. The rest also lacked developmental stages of the parasite

when examined under the microscope. This would seem to suggest that the risk of infection is probably low from these ponds because among the many factors that define the level of transmission in a community, cercarial density appears to be one of the primary factors.

The size of snail population varied remarkably among the ponds surveyed. However, fishponds appeared to have higher snail populations than the canals supplying the ponds or nearby swamps. Ponds seem to create favorable conditions for snails. The practices of improving food supply of the fish may also improve food supply for the snails. High snail number in fishponds increases the likelihood of snails becoming infected by miracidia.

Aquatic plants have been described as the natural homes of snails. In this study, ponds overgrown with weeds appeared to have more snails than those with few marginal weeds, but this needs to be verified quantitatively.

Newly constructed ponds (6 months) had few or no snails. This could be that snails had not yet invaded the ponds. However, it could also have been that conditions favorable to snails had not yet become established.

Several aquaculture practices in the study area involved water contact. Perhaps of greater interest was the finding that not all water contact with pond water is related to the raising of fish. Where ponds are near houses, the water is also used for domestic jobs which sometimes take place within the pond itself. Other than the use of pond water for domestic jobs, the involvement of women in other pond activities appears minimal. Adult males and boys are involved to a greater extent in the activities that involve water contact.

Conclusion

This study has demonstrated that the presence of fishponds has increased snail habitats. Since most of the activities not related to fish farming require contact with these snail-infested habitats, there is a need for assertive action to minimize the risk of bilharzia without compromising fish production.

From the results of this study and many others before, it is clear that removal of weeds would reduce the snail population considerably. This practice is being carried out by farmers and should be encouraged. The use of weed-eating fish such as *Tilapia rendalli* is mentioned in literature and may probably be tried to a greater extent. There is evidence that when herbivorous fish are used and the ponds are fertilized properly, weeds are rarely found. Ducks may also be useful in integrated fish farming because they clear weeds remarkably well, especially in small-scale fishponds. Also, if the ponds are well constructed, fringing vegetation is minimized. This can be achieved, for example, by ensuring that shallow parts are at least 45 cm deep.

The use of snail-eating fish has been proposed as a means of biological control. At present, research is in progress on the possibility of using such fish from Lake Malaŵi.

Contamination of pond water or its surroundings by urine and/or fecal material should be avoided. This is particularly crucial for ponds near houses. A program of health education, perhaps through primary health care on all aspects of the disease would help. A program of regular test and threat of the high-risk groups would be desirable.

Research Challenges in Integrated Resource Management (IRM) in Rural Africa

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Rehabilitating and transforming poor, degraded, African farms into ecologically diverse and highly integrated ones is a major goal of the Integrated Resource Management (IRM) program. Such objectives can only be successful and self-sustaining if farmers participate fully in IRM research. Participation ensures that local social, cultural and economic factors which influence farmers, the natural resource managers, are incorporated into the research agenda.

Sustainable improvements in natural resource management also require that new systems designed by farmers are ecologically sound. In natural communities, increased species richness and internal recycling of resources usually enhance community efficiency and stability of production. On farms, increased crop and livestock diversity makes better use of diverse soil and water resources, particularly in marginal areas and ensures at least some enterprises succeed in a poor year. Increased recycling of crop and livestock residues ensures maintenance of soil fertility and efficient utilization of waste resources. Both increased diversity and internal recycling should improve rehabilitation of degraded farm environments.

Ponds can provide a focus for integration and recycling of farm resources. Crop and livestock residues used as inputs for fishponds will not only produce a fish crop but also provide rich pond mud to fertilize vegetables. Pond water can help extend the growing period for vegetables during dry season months. Such synergistic, crop-pond links should improve overall farm performance.

Knowledge of local environmental conditions is essential to develop appropriate integrated crop-pond systems for small farms. Farmers' knowledge is presented through their drawings of village maps, transects and models of farms to show how resources are classified and managed. This information combined with technical input from researchers enables farmers to design their own crop-pond systems. The same drawing tools can also aid farmers in monitoring and analyzing impact of their experiments in integration on farm performance. Such information allows farmers to modify their systems to improve overall effect on the farming environment. The end result is hopefully an increase in farmer's skills in managing natural resources.

Challenges in Implementation

Mapping resource access and use

Using maps and transects to understand resource management has some problems. Most small African farms usually consist of noncontiguous plots of land so farmers have difficulty in conceptualizing and drawing maps and transects of their whole farm. Therefore, farmers should be allowed

to use whichever visual representation they feel they are comfortable with. Seasons may affect distribution of resources and their utilization. So maps and transects need to be done more than once a year to appreciate the full range of natural resources which are available. If there is gender separation in resource management, it is essential to include such information on maps to obtain an accurate picture of natural resource management by a farming family.

Ensuring everyone participates

A major challenge in any participatory exercise such as village mapping is to gain access to a broad cross-section of the village community to ensure that resource-poor members as well as their richer neighbors are included. Often, the more visible and vocal villagers tend to be those with access to major resources and influence within the community. To obtain a reasonably accurate measure of village resources and people's access to them, poor members of the community must be included in mapping sessions.

Illiterate farmers are at a particular disadvantage and need to be encouraged to devise their own systems of symbolization for use in drawing farm models and designing crop-fish systems. For example, when attempting to quantify amounts of materials recycling between enterprises on farms, symbols such as drawings of bags of maize, strokes of the pen, etc., can be used. It is important to let the farmers compose their own symbols for the process to be effective.

Assessing access to and utilization of natural resources

Researchers often assume that rural African households operate their farms as integrated units where resources and responsibilities for managing them are shared within a "nuclear" family. In practice, access to and management of natural resources is highly complex and varies between household members. Rarely, on marriage, is a single joint fund or common conjugal property established and so there is often a striking separation in domestic budgets of men and women.

With such separation in resource management, it may prove difficult to efficiently integrate pond and crop systems. If men own and operate ponds whereas women manage vegetable gardens, then integrating vegetables with fish may prove difficult if local tradition dictates women and men to manage their resources separately. Division in management of farm resources does not preclude integration if both sides perceive benefit in recycling materials between each other's systems. Hence, when initial designs are constructed for integrated crop-pond systems, all family members should contribute to ensure account is taken of separation of resources within farming families.

Participatory evaluation of impact of integrated crop-pond systems on farms

Effective monitoring and evaluation of impact is extremely important if farmers and researchers are to develop appropriate crop-pond systems for small farms with limited resources. Gender inequalities based on local traditions may affect these efforts. Often, men come forward first to map resources and measure impact of crop-pond experiments. This may provide very misleading results as women are the major resource managers on farms. Generally, men know little about management on women's plots. Conversely, women are usually knowledgeable about management on men's plots because local customs often oblige women to help men manage their land. For example, to obtain an accurate measure of opportunity costs and distribution of labor on farms requires that all family members are consulted. If only

husbands are asked to measure impact on labor resources, then they will often underestimate its effect on women's labor.

Indicators of farm performance

To accurately assess impact of farmer's experiments in IRM, simple indicators of farm performance are needed. Four indicators are being used: a) capacity (total farm production, t/ha); b) recycling (total number of internal bioresource flows); c) diversity (total number of different crops and livestock on farm); and d) economic efficiency (a simple cost/benefit analysis of total farm performance). The assumption is that if these indicators increase in value then the farm is improving. Indicators (b) and (c) are rough ecological measures of resource use and environmental complexity and are easy to measure. Indicators (a) and (d) are more problematic and prone to inaccuracies.

Measuring production for major food or cash crops is usually not difficult as farmers have their own methods for quantification (e.g. bags of maize). However, African farms are diverse environments with often 25 to 30 different kinds of produce being grown. Trying to obtain an accurate picture of their production is very difficult. What is needed is a ranking index rather than an absolute measure of farm production. This index could consist of measures of presence or absence of plant and/or animal species which indicate soil rehabilitation and environmental improvement combined with farmer's production measurements for a few major food or cash crops. The objective would be to have indicator species which can be easily identified and crops where production can be measured with reasonable accuracy.

Indicators of economic efficiency are problematic. Individuals within farming families will often give varying estimates of cash output for the farm. Men may undervalue crops grown by women particularly if women are responsible for marketing farm produce. Of course the reverse is true as well. If men manage ponds and have sole responsibility for production and sale of fish, then women will not know the value of the fish crop. Cash estimates for home-grown produce consumed on farm is best made by women as they have responsibility for meals. Evaluation of economic impact therefore requires that all household members are consulted, otherwise indicator (d) has little meaning particularly where division occurs in resource use and management.

Problems occur in estimating cash values for farm produce and activities which do not normally involve cash. Valuing family labor is problematic and puzzling to farmers. Likewise valuing recycled bioresources such as manure or crop waste is difficult if they have no sales value in markets. Simple methods of valuation which are meaningful to farmers are needed, otherwise they simply think of spurious values to please researchers. Again maybe a ranking index rather than an absolute cash value may be required for noncash resources.

Conclusion

Although there appear to be many problems in collecting IRM data, many of these can be dealt with by ensuring that farmers fully participate in the research process. Farmers must be involved in setting research objectives, in determining how IRM experiments are organized and how data are collected. In particular, farmers must decide which indicators of farm performance will best suit their needs in assessing impact of their crop-pond experiments on farm rehabilitation.

Farmer Participation in Technology Development and Transfer in Malaŵi: A Rice-Fish Example

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Introduction

To be sustainably adopted, technology for development requires the active participation of the target group. Although farmer's knowledge has its limitation and scientific methods and knowledge remain enormously powerful, it is evident that farmers have access to information that is available to scientists only at high costs. Scientists and extensionists realize that farmers' capabilities extend far beyond mere knowledge, they have always observed, experimented, adapted, improved and even performed and they know what might work and what won't. Farmers have expert knowledge of their local resources and the skills to manage a range of innovations which can be integrated within their farming systems. Furthermore, to be adoptable, technologies must complement the existing production and consumption objectives of smallholder farmers. Farmers participation in technology development and/or modification is therefore vital for it to be integrated and sustained within their existing farming system.

Technology Development and Transfer

Farmer-participation in technological modification and transfer was demonstrated on rice-fish integration at the National Aquaculture Center (NAC), Zomba, Malaŵi, from 1990 to 1993. Farmers were invited to different open days from Zomba (1990), Mulanje (1991) and Mangochi (1991). The three groups responded differently to demonstration plots of integrated rice-fish farming (Table 1).

Fish farmers from Zomba, where rice is widely grown, were very excited upon seeing the rice and fish being grown together. They asked a lot of questions on rice-fish integration, and criticized the set up of fish refuge position in the ricefield in relation to the slope of the ricefield and advised on the proper setting. They suggested a wide range of designs. This indicated that they understood the technology presented to them although it was their first time to see integrated rice-fish.

Within one year, 65% of the farmers from Zomba who attended the open day had started rice-fish integration. More remarkably, within two years, at least 40 other farmers who had not attended an open day and had never been to NAC were also practicing rice-fish integration. Rice-fish integration is gradually spreading in Zomba through farmer-to-farmer dissemination.

Fish farmers from Mulanje and Mangochi, where rice is seldom grown, were not as excited as their counterparts from Zomba. Rice-fish integration looked new and farmers were unable to pinpoint the weaknesses in the set up. The questions asked were more for learning rice-fish integration. Mangochi farmers thought that rice cultivation was somehow related to

the leprosy disease and were therefore reluctant to plant this crop.

By 1993, 30% of the fish farmers from Mulanje and 37% fish farmers from Mangochi had started rice-fish integration. No farmers who had not attended the open day at NAC started rice-fish integration.

Table 1. Adoption of rice-fish integration by farmers who did and did not attend open days.

Open day (year)	District	Farmers attending	Farmers adopting after one year	Farmers adopting after two years
1990	Zomba	17	11	51
1991	Mulanje	8	3	3
1991	Mangochi	10	3	3

Discussion

The adoption of rice-fish integration among farmers from Zomba, Mulanje and Mangochi indicated two different responses to the technology. In Zomba, farmers whose farms were adjacent to each other grew both rice and fish. The idea of growing rice and fish together was very exciting for them. Farmers understood the integration and how it fit within their farming system. It didn't require major changes in their farming system. It did not require introduction of new external inputs for the technology to work.This made the idea attractive and farmers knew that it was going to work in their own system.

The technology was extended to neighboring farmers who had not attended the open day. Farmers explained the technological management practices to them, including the benefits of the system. Neighboring farmers were satisfied, and soon started practicing it. This suggests that farmers adopt technologies which they are sure of, understand, and perceive to have immediate benefits and which fit within their farming systems. Such technologies may require minimum extension effort to succeed and trickle down to other farmers.

In Mulanje and Mangochi, however, rice-fish integration required changes in existing farming systems. It required introduction of both rice and fish in most households. This led to low adoption of the technology, compared to Zomba. In addition, the technology did not self-disseminate. Since they held only a fragmentary understanding themselves, farmers could not properly explain to other farmers who hadn't attended the open day.

The response of farmers to rice-fish integration suggests that researchers need to understand the existing resources and farming systems of the area to which new technologies will be extended. Farmers participating in research design and implementation will understand the management practices and results better than those who don't. Successful results will make farmers implement the technology and assist in the spread of the idea to other farmers with confidence.

Conclusion

Farmer participation in technological development and/or modification is important for immediate benefits to the farmers. Technologies developed without farmer participation take longer to be adopted and may not self-disseminate. Understanding of the existing resources and farming systems may help in designing research (introducing technologies) which will fit in the existing resource and farming systems. Technologies which complement the existing production systems and objectives and do not depend much on external inputs are more acceptable and sustainable by farmers.

Privatization of Fingerling Production and Extension: a New Approach for Aquaculture Development in Madagascar

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Introduction

In most African countries, aquaculture development is directly related to the degree of government involvement. Fingerlings are produced at government fish stations, and extension activities are organized and executed by the Fisheries Department. Unfortunately, the implementation of governmental development programs are often hampered by the lack of essential human and financial resources. This was also the case in Madagascar until 1989 when a new approach for the development of the aquaculture sector was adopted with promising results. The "Hauts-Plateaux", the highlands of Madagascar, which are characterized by rice farming, were selected as a pilot area to work out this new approach. Now, five years later, an abundance of fingerlings is available, produced by private farmers and these farmers are even taking over the extension activities formerly carried out by the government.

History

In Madagascar, freshwater aquaculture was launched in the 1950s with the introduction of several tilapia species and common carp (*Cyprinus carpio*). Common carp turned out to be the most popular fish, especially for rice-fish farming. In the beginning, similar to other African countries where fish culture has been introduced, fish farming was taken up with great enthusiasm by farmers. For the production of the necessary fingerlings, the government possessed 12 major and 30 minor fish stations. Unfortunately, the initial success was mainly based on an enthusiasm which could not be maintained. Over the years, a severe decline in the practice of freshwater aquaculture was observed. The main reasons were found to be the lack of knowledge of basic fish farming at the farmer level, lack of skilled extension officers and, most of all, a lack of fingerlings caused by problems of production and distribution.

From 1985 onwards, the government of Madagascar, with the support of UNDP/FAO, put a special effort into the development of the freshwater aquaculture sector. Initially, the approach was classical:

- The Fisheries Department developed their own extension service with the recruitment and training of 60 field officers for the extension of (rice-) fish culture.[9]
- Two government fish stations were rehabilitated and reserved as the main breeding centers for fingerling production.
- A plan was made for the distribution of fingerlings in which fingerlings were transported annually, from October to December, into the rural areas.

[9](Rice-) fish culture concerns both rice-fish culture and fish culture in ponds.

At first, the approach was very successful. In the first year (1986), the government, with the assistance of FAO, distributed 350,000 fingerlings, three times more than the year before. This increased to 850,000 by 1989. However, even by 1988, it was realized that continued expansion would not be sustainable once FAO assistance was withdrawn. Fingerling production and transport put an enormous strain on meager human resources, logistical support and finances. An alternative approach had to be developed.

Privatization of Fingerling Production

With the assistance of the UNDP/FAO-MAG/88/005 project *Promotion de l'Aquaculture et Privatisation de la Production d'Alevins*, the Malagasy government elaborated a new, more sustainable, approach. The key role in this approach is granted to the private sector. The government, in collaboration with the project, developed a strategy and a procedure for the implementation of a network of private fingerling producers. Awaiting the production of fingerlings by the private sector, the government continued its yearly sales campaign, but in four years' time, 72 private fingerling producers had been established and were distributing over one million fingerlings (Fig. 1). Whenever a private producer became fully operational, all government sales offices were canceled in that region. It is expected that government sales will soon close down entirely, as 75% of the market is already being serviced by the private sector.

A New Extension Service

The strategy of relying on private fingerling producers requires a new type of extension agent. This person, in addition to possessing good technical skills, needs a strong grounding in the socioeconomic constraints to rural development. Understanding of local communities, water rights, land ownership, management, credit and bank formalities, marketing, etc., are extremely important in guaranteeing long-term success. Quality of extension was stressed over quantity. Out of the 60 available extension officers, 11 were selected, received, and continue to receive. the necessary training. The goal was to create a team of well experienced "regional extension officers" who could operate semi-autonomously in field. In addition to being

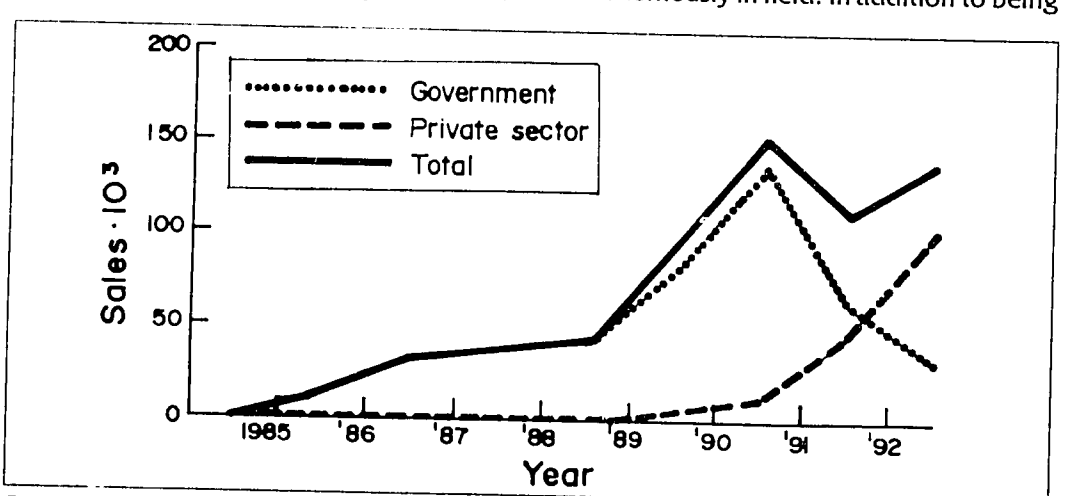

Fig. 1. Government and private sector total sales of common carp fingerlings at the "Hauts Plateaux" of Madagascar, 1985-1993.

well-trained, it was possible, with limited financial resources, to better equip and motivate this smaller number of officers. The smaller number of officers also permits more personalized attention from administrative staff. Being "promoted" from the lowest ranks, the increased status of the extension agents means that information and suggestions from the field are given higher priority than previously. The closer relationship between field and administrative staff is reinforced during monthly meetings wherein problems and progress are discussed.

Privatization of (Rice-) Fish Culture Extension

With these changes in the extension service, all direct extension activities of (rice-) fish technology to farmers by the government had come to an end. Since the main objective of the government and project remains the sustainable development of (rice-) fish farming, a new approach was formulated in which the private sector plays a major role in the extension. This is based on the assumption that private fingerling producers will carry out extension services to other (rice-) fish farmers for their own benefit.

Fingerling sales depend on the number of fish farmers willing to buy and the number of fingerlings actually bought per farmer. The number of fingerlings needed per farmer will depend upon how well the farmers manage their production operations. Application of proper technique will lead to increased production and revenue. Having had good results, fish farmers are likely to expand their operations. Improving the technology available to farmers is thus clearly in the interest of the fingerling supplier.

Depending on the capacities of the fingerling producer, two types of extension were identified, a passive one and an active one. Passive extension is characterized by the producer who, being a convinced fish farmer him/herself, knows the basics of fish farming and marketing. This person is able to explain the technology, but may be constrained by lack of didactic skills. The type of extension which this type of fingerling producer could undertake is restricted to the distribution of technical posters and leaflets, and individual explanation and demonstration of his or her own fishponds to passing farmers.

Active extension is undertaken by fingerling producers with greater organizational, didactic and extension skills. These people invite farmers to participate in organized demonstrations and teaching sessions and may actually travel to other farms to assist in problem-solving and monitoring. The degree to which this approach to extension succeeds depends upon the degree to which attitudes, roles and relationships between farmers can evolve to accommodate the new social status of the fingerling producer/extension agent. This will take time and support.

In 1992, the government/project made a beginning with the training of fingerling producers in marketing, didactics and extension methods. Several extension materials have been developed. A manual addressing the key issues is being prepared especially for private producers.

Since the strategy to privatize extension has only recently been developed and is yet to be fully implemented, only preliminary results can be reported. Although a growing number are attempting active extension, the majority of fingerling producers are currently engaged in passive extension. This promising beginning for privatized extension and the successful implementation of privatized fingerling production show the potential benefits and positive impact of an enlarged role of the private sector in the development of rural fish farming.

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