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A Farmer-participatory approach to aquaculture technology development & dissemination

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Abstract

A realistic alternative to traditional technology development and transfer has been utilized by the WorldFish Center to integrate pond fish culture into farming systems in Malawi and Cameroon. Participatory rural appraisal tools are used to assess farm resources and constraints and introduce the basic concepts of aquaculture. Topics for farmer-participatory research projects aimed at integrating aquaculture into the existing farming system are then agreed and conducted on-farm, monitored by researchers through direct observation by a research-extension team comprised of senior research staff and extension technicians. In areas where such participatory research has been field-tested, typical technology-adoption rates by farmers are in the range of 86% with 76% adopting at least two and 24% adopting four or more technologies. Within six months of the completion of farmer-participatory research, 46 percent of new adopters had learned about it from other farmers. A third of these farmers had adopted two or more technologies from their neighbours. Within two years, almost 80 percent of the farmers practicing IAA in and near targeted villages had never participated first-hand in any research/extension exercises. In those areas of Malawi where these transformations have been studied in detail, an original group of 34 farmers undertaking four years of participatory IAA research, has now expanded to more than 225 practicing farmers.

Key words: Fish farming, fish pond, technology transfer

Introduction

Increasing population pressure in sub-Saharan Africa has led to over-utilization of land and a subsequent decline in actual and potential agricultural productivity, and an increase in poverty among smallholding farmers. Putting more land under cultivation will only exacerbate the decline of environmental quality, which is already occurring (Brummett 1994). Increasing intensity of production systems and improving their economic viability is therefore essential.

Aquaculture has been promoted as one means of improving the performance of small-scale farming systems. However, as a secondary activity after staple crop production (maize in Malawi and cassava + plantains in the case of Cameroon), a fishpond is similar to chickens, goats, vegetable production and a number of crops grown primarily for cash (e.g., tobacco, cotton, coffee, tea, cacao) depending upon the climate. Small-scale African farming systems produce dozens of such crops, nearly 130 having been identified by Dupriez and De Leener (1988). The majority of these products, including fish, are either consumed by the family or traded to neighbors and/or relatives (Brummett 2000). Surpluses and crops grown exclusively for cash are sold.

Rather than making tradeoffs and taking risks by allocating all farm resources to the one or two most profitable crops, small-scale farmers tend to diversify by growing a number of crops simultaneously (often in mixed plots) and thereby lowering overall risk. The diversity of crops reflects the main objective of these farms: to provide daily food through all seasons. In addition to being internally diverse, these farming systems are also highly variable from place to place, depending upon a wide variety of social, economic and environmental circumstances.

Despite a number of projects, this group of farmers has, in general, failed to benefit from “green revolution” agricultural innovations disseminated by extension agents working under a Training and Visit outreach model. Since aquaculture technology works on the experiment station and generates profits for larger-scale investors, it is logical to assume that the problem with getting the technology to smallholders is more to do with the T&V approach to dissemination than with the actual techniques of aquaculture. If this is true, a reasonable first step in helping these farms move forward would then be the development of improved methods for problem analysis and technology adaptation aimed specifically at smallholders. A realistic alternative to traditional technology development and transfer has been utilized by WorldFish Center (formerly

ICLARM) to integrate pond fish culture into low-input farming systems in Malawi and Cameroon.

This paper is a compilation of experiences of WorldFish and its partners in Malawi and Cameroon. The objective is to show how a reworking of the farmer-extension-research continuum can overcome constraints to the development, adoption and dissemination of improved aquaculture technology to small-scale farmers in sub-Saharan African.

Farmer-Scientist Research Partnerships (FSRP)

Farmers and researchers often have trouble communicating with each other. Poorly educated small-scale farmers, operating from within the perspective of a rural ecosystem which incorporates a large number of unquantifiable social and environmental factors often have difficulty explaining their situation clearly to researchers who too often use reductionism to focus on the details of maximizing the output from their special crop. Designing and/or adapting appropriate technologies and giving farmers the mental tools they need to adopt a more progressive approach to farming requires mechanisms for the interactive exchange of information and ideas between farmers and researchers. The idea is to have researchers working on real problems of immediate relevance to local farming systems and extension agents who can effectively communicate solutions to farmers.

The classical model links research and farmers through the intermediary of extension. Extension is supposed to accurately interpret constraints and opportunities on target farming systems and relay this information to the experiment station where researchers develop new technology. This technology is then written into research reports that the extension agent should synthesize and interpret for farmers.

This system seldom works, largely due to two factors:

1.Extension agents are poorly trained and generally incapable of either accurately characterizing farming systems or interpreting research reports.

2. Research is rewarded for publications and therefore focuses its attention on peer-reviewed, cutting-edge science rather than practical problem solving.

Training and equipping extension agents up to the point where they are capable of making a real difference to agriculture is expensive and time-consuming. Likewise, sending the better-paid researchers who understand the technology out into the field to help farmers is probably not cost-effective.

WorldFish has developed a pragmatic approach to aquaculture research and development that avoids these problems and in the process creates joint learning exercises whereby research is driven by real problems, extension delivers clear messages and farmers get the technology they need. The Research-Extension Team (RET) model uses a research scientist (at 25% of full time) to guide joint learning exercises (participatory research projects) undertaken by farmers and extension agents working together. Extension agents (either from government or non-government organizations, NGOs), rather than promoting technology, serve the process as the eyes and ears of research. During regular farm visits, they collect structured datasets that can be analysed to provide insights into the results of on-farm adaptive research. Farmers, extension agents and researchers get together at the end of the season to present, compare and discuss findings, in preparation for another cycle of research. Described by Brummett & Noble (1995a), WorldFish calls this process the Farmer Scientist Research Partnership (Figure 1).

Resource Flow Diagramming (RFD)

In designing research projects aimed at the development of more appropriate technologies for smallholders, the WorldFish Center starts with a group interview during which a number of technological options are presented to farmers and their feedback is solicited. Over the course of the discussions (or through additional PRA exercises), farmers who are truly interested in participating in collaborative research can be separated from those who wish only to be part of a development activity (Harrison 1995). Following these initial discussions, a walking tour of the farm can enable researchers to roughly characterize the farm in terms of aquaculture potential.

Once farmers who are both interested and have real capacity to undertake aquaculture are identified, resource flow diagramming (RFD) is used to characterize the farms in terms of their resource base (Figure 2). For greater detail, values can be attached to flows to give them a quantitative dimension (Lightfoot & Noble 1993). Depending upon the purpose to which it is to be put, details of soil type, slope and water resources can also be added. Resource flow diagramming of the village natural resource base is best done with groups of farmers rather than individual farmers as this allows for wider discussion and consensus on the indigenous categorization of their resources.

Once complete, the RFD shows the various farm enterprise systems and the movement of resources around the farm and into the surrounding economy. Such mapping provides the researcher with a detailed picture of the diversity and distribution of land, soil and water resources from the perspective of the farmer. In addition to capturing key information for the design of technological improvement, the RFD also serves to give farmers a systematic perspective on their farming system which they may have never had before and which might arguably be a prerequisite for efficient farmer experimentation (Lightfoot and Noble 1993).

Participatory Research

Having established a map showing the enterprises and resource flows on the farm, farmers are requested to imagine a scenario where a new or modified enterprise is incorporated into the farming system. In the case of

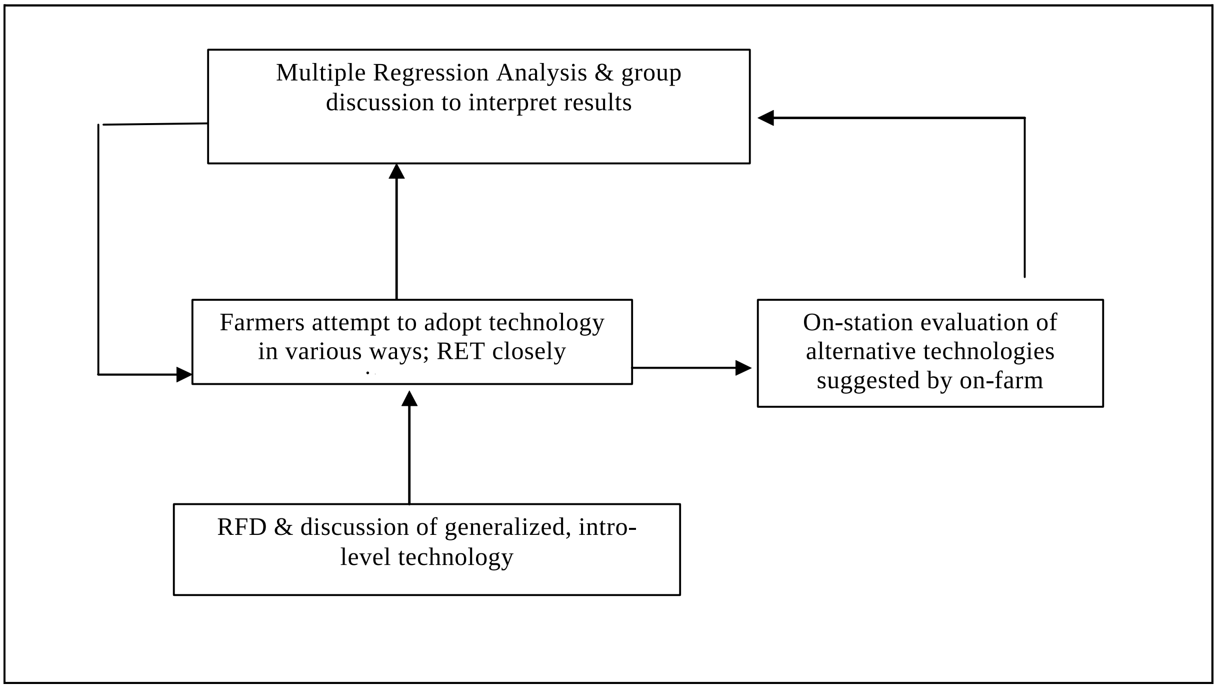

Figure 1. The Farmer-Scientist Research Partnership (FSRP) technology development and transfer methodology as implemented by Research-Extension Teams (RET).

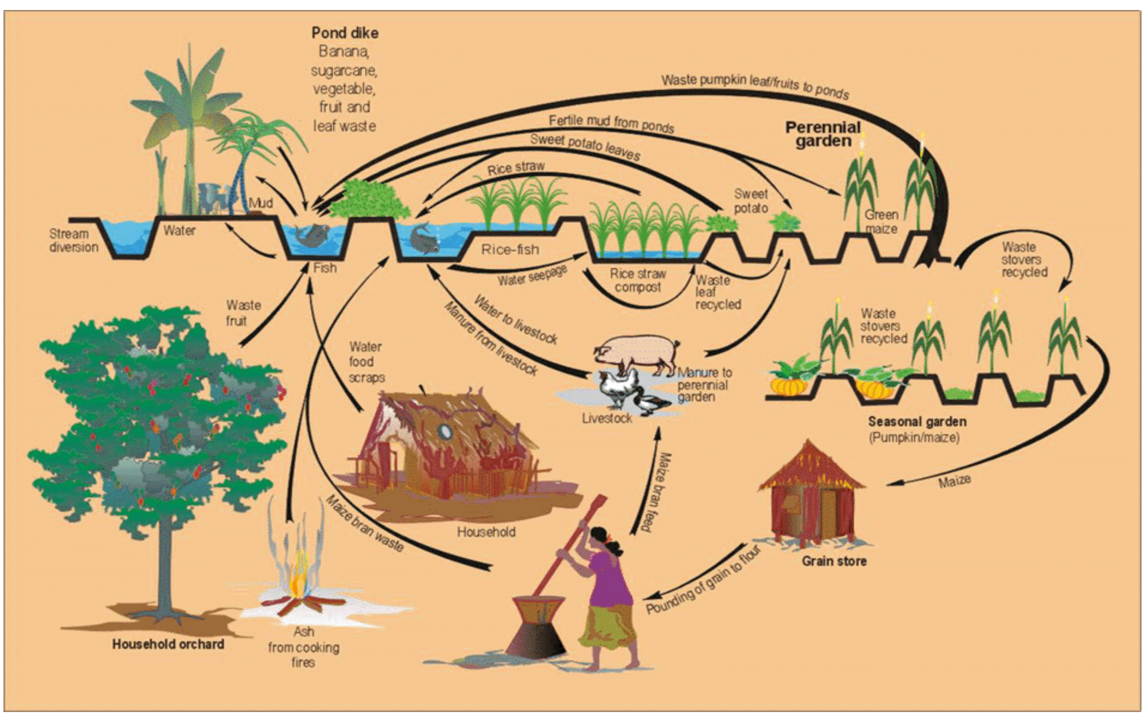

Figure 2. A typical resource flow diagram (RFD) for a small-scale farm in Southern Malawi.

WorldFish, researchers are trying to introduce the idea of aquaculture. Fishponds have a particularly high capacity for using and transforming agricultural wastes without creating pest or human health problems and so create an ideal option for farmers with little or no investment capital (Lightfoot *et al*. 1993). Once the new idea has been presented in general terms, the resource flow diagram is re-drawn to show the theoretical relationships between the new and existing enterprises. The re-drawing of the map gives researchers and farmers the opportunity to discuss salient features of the new technology as they relate to each particular farm.

The theoretical farming system model created during the re-drawing session is used by farmers and researchers as a guide for conducting applied experiments both on-farm and on the experiment station. On-farm studies are comprised of a number of farmers who agree on a common problem and introductory-level technology that they feel is suitable for them. Farmers and researchers develop an experimental protocol and undertake to follow it as closely as possible during the grow-out period. Each farm serves as one replicate in the experiment and because these farms are so variable, standard deviations are high. In the experience of WorldFish, at least 10-12 farms are needed to get statistically significant results.

Routine data collection and experimental monitoring is done by a Research-Extension Team (RET) comprised of a senior researcher and a number of technicians (extension agents). Rather than being the vehicle for transferring information from researchers to farmers and vice versa, the technicians follow a routine of regular data collection and compilation as their main activity during bi-weekly visits. The senior research scientist guides the process by determining what data should be collected.

In addition to guiding on-farm work, observations made on-farm in regard to inputs and management practices used by farmers can guide research conducted on the experiment station. This gives the researcher an opportunity to experience, at a personal level, the problems faced by farmers. It also gives insights to potential new technologies and, maybe more importantly, provides the shared experience necessary to the creation of a more positive mutual understanding between scientist-researcher and farmer-researcher. Such a relationship is one of the keys to a more realistic and fruitful research and development methodology.

When the growing season is over, all ponds both on-farm and on-station are harvested and the results analysed and compared. The outcomes are presented to the farmers for discussion. Sometimes, this requires the use of ingenious methods to clearly demonstrate to the farmers what has happened and care must be taken to avoid confusion (Hopkins, 1988). Group discussion among participating farmers is often useful (Lightfoot and Noble 1993).

Longer-term ecological, capacity and economic development of farms and farmers is monitored using the RESTORE monitoring and evaluation tool for describing farming systems transformation (Lightfoot et al. 1993). The main focus is to elucidate the patterns and parameters which are most important in determining the economic and environmental sustainability of a farm and the impact of the adoption of a new enterprise by a farm household through integration, in this case aquaculture (Figure 3).

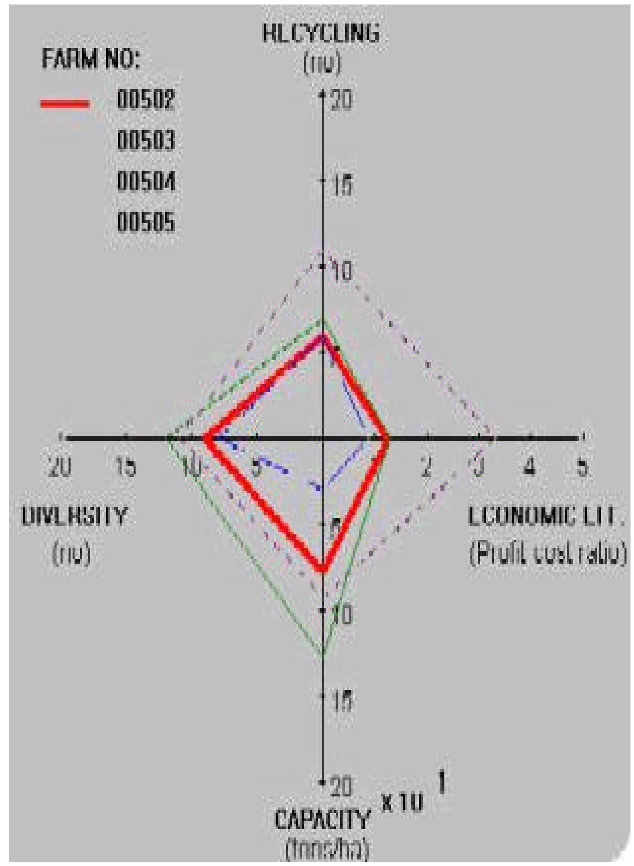

Figure 3. A Restore kite diagram of the Maundala Salimu integrated fish farm showing its development over time after introduction of the FSRP approach.

Based on the results of both the farmer's and researcher's studies, farmers are requested to re-draw their resource flow diagrams again to show how the system will be managed in the following year. Depending upon the objectives of the research program, this cycle can be repeated and may, over time, help to develop in farmers a new ability to systematically analyse problems and empirically search for solutions.

In summary, the FSRP utilizes the resource base and constraints faced by farmers to establish control conditions and works from there to modify the production system. Productivities of systems developed in this way are, of course, much lower than those designed by researchers seeking to improve fish growth rates in isolation from all other farming activities. There are also problems with communication, trust and misunderstanding motivations that must be overcome (Harrison 1995, Noble 1995).

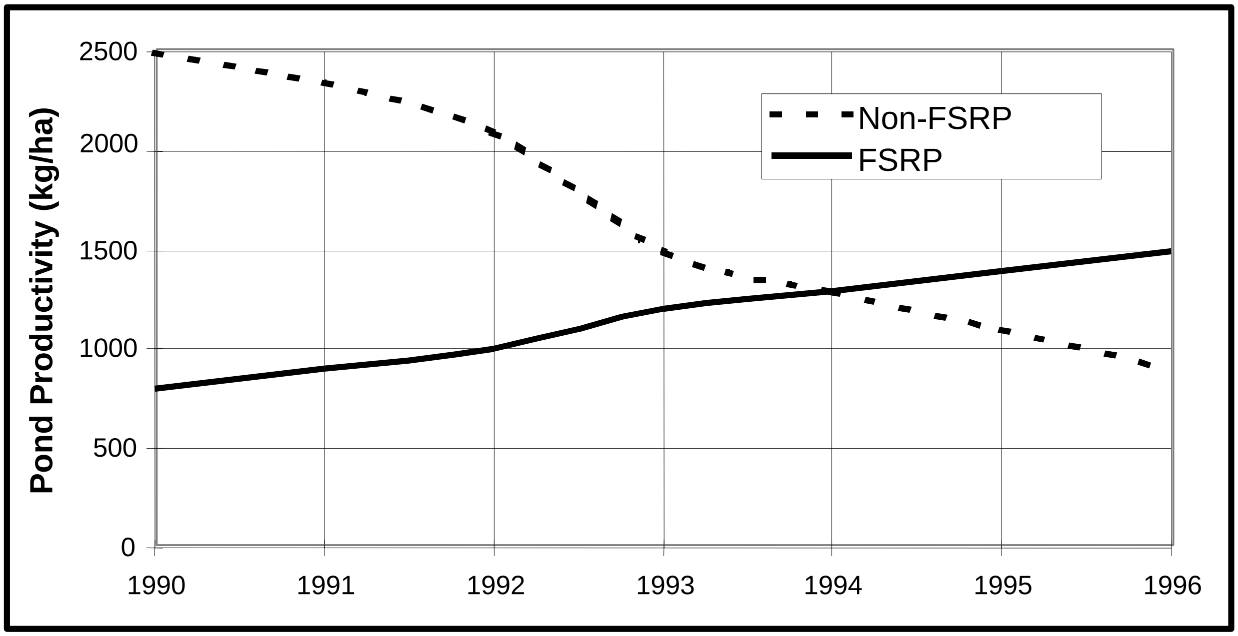

Figure 4. Pond productivity over time in FSRP Vs non-FSRP fishponds in Southern Malawi. Entry-level technology under the FSRP is, initially, much simpler and less productive than production-focused technologies but evolves on-farm as farmers who understand the technology are able to more efficiently manipulate it to suit their individual situation.

However, the results are much closer to those which farmers can actually expect to achieve and doing the research with the farmer's situation firmly in mind gives researchers a much clearer idea as to what might be possible within the context of the complete farming system than does the approach of focusing on the fish alone. Building new farming systems from the ground up in this way also gives the farmers a sense of propriety over new technology which facilitates its evolution into more sophisticated and productive forms (Chikafumbwa 1994). The relationship established with the farming community as a result of this sort of exercise can also facilitate the collection of longer-term monitoring data on technology adoption and impact.

Sustainable Impact

The FSRP process leads to high rates of technology adoption. Of Malawian farmers who have been exposed to integrated aquaculture technology through the FSRP, 86% have adopted at least one of the demonstrated technologies 76% adopted at least two and 24% adopted four (Brummett and Noble, 1995b). In addition, the adoption is sustained over time. All of the farmers with which WorldFish Center has worked who have access to permanent water supplies are continuing to grow fish and improve their production. Among those farmers with only rainfed fishponds, 36% dropped out for one reason or another (40% of those dropping did so because of family deaths or illness rather than for any agricultural reason), but those remaining also have continuously improved their ponds and production. For example, average pond size has increased from 64 m^2 to 88 m^2 and new gardens are being planted around the ponds (Brummett & Chikafumbwa 1995).

Once in the rural community, the technologies spread and evolve without further extension support. A survey found that, within six months of the May 1990 open day, 46% of adopters in the target area had learned about it from other farmers. A third of these farmers had adopted two or more technologies from their neighbours. By the end of 1992, almost 80% of the farmers practicing integrated rice-fish farming in Zomba District had never witnessed first hand an extension demonstration (Chikafumbwa, 1994). In Zomba East, where WorldFish Center worked with 34 farmers from 1991-1995 (ICLARM-GTZ, 1991), there are now 225 practicing fish farmers (Scholz *et al.*, 1997). Recent data (Baker, 2003) from Malawi indicate that the FSRP strategy increases farmer-to-farmer transfer of technologies. Seventy-one percent of farmers interviewed indicated that they obtained fish farming information from fellow farmers who had participated in FSRP activities compared with 29% of farmers who obtained their fish farming information from extension workers.

Improvements in Productivity

Figure 4 illustrates the trends among farmers working with researchers and those with only access to extension messages. Average fish productivity of integrated Malawian smallholdings is 1350 kg/ha/yr in rainfed areas and 1650 kg/ha/yr in springfed areas compared to an average of about 900 kg/ha/yr for the 48 most productive fish farms in Southern Malawi (Chimatiro and Scholz 1995). The difference stems from the range of inputs available as pond inputs and the location of the ponds relative to other farm enterprises. To properly feed the typical farm pond, a farmer needs about 522 kg of dry matter (Brummett 2002). On well-integrated farms, ponds are generally located in vegetable gardens (or, as often happens, vegetable gardens develop around the fishpond to take advantage of emergency irrigation water) and wastes from the garden are used to feed fish. Typically, these wastes amount to some 3700 kg of dry matter per year and the material is generated in close proximity to the pond, minimizing the work involved in transportation. Non-integrated farms, on the other hand, are using exclusively maize bran as recommended by extension as the best fish food. Maize bran production averages around 192 kg of dry matter, only 37% of the amount needed. The maize bran is produced in the house, often far from the pond. Maize bran is also a possible emergency food for humans whereas vegetable garden wastes are typically just burned if they are not used in a pond.

The case of Maundala Salimu in Malawi illustrates the positive impacts of the FSRP approach on the farmer (through empowerment and improved income and profitability) and the environment (ecological sustainability). An output of the RESTORE monitoring and evaluation software, Figure 3 illustrates trends in the development of Maundala Salimu's integrated fish farm over a five-year period in which he was working with researchers using the FSRP approach. Over this period, capacity (total farm production in tons per hectare) decreased, recycling increased (number of recycling pathways representing internal recycling of nutrients), diversity (number of species used on the farm) was maintained and economic efficiency (profit/cost ratio) substantially increased. In other words, through the FSRP approach, Maundala Salimu was able to recognize that the fish-vegetable system was the most productive and profitable enterprise on his farm and hence substantially reduced the capacity of the farm while increasing the economic efficiency without affecting the ecological sustainability (recycling and diversity).

Economic Growth

Economically, integrated farms produce almost six times the cash generated by the typical Malawian smallholder (Chimatiro and Scholz 1995). The integrated pond-vegetable garden is the economic engine on these farms, generating almost three times the annual net income from the staple maize crop and the homestead combined. The vegetable-fish component contributes, on average, 72% of annual cash income (Brummett and Noble 1995b). On a per unit area basis, the vegetable garden/pond resource system generates almost \$14.00 per 100m^2 per year compared with \$1.00 and \$2.00 for the maize crop and homestead respectively. If this level of economic return is sufficient to overcome recurrent cash flow problems and give farmers enough cash to reinvest in their farms (something which is not yet proven) then integrated farming might contribute significantly to real economic growth of rural communities.

Farmer Empowerment

The FSRP approach has been found to be a valuable tool for empowering farmers to innovate and solve production bottlenecks on their own. For example, farmers in Malawi have, without extension input, included indigenous cyprinid species which have high local demand into their tilapia-based polyculture systems and are now collaborating with researchers and extension agents to develop better management systems. In places where cassava or plantain is the major staple food, farmers are using cassava peels and leaves as pond inputs instead of the extension recommended maize bran. On-station research to validate farmer-generated technology showed that, even under ideal conditions, there were no significant differences in fish yields from maize bran fed ponds (3000 kg/ha/yr) and yields from cassava peels-fed ponds (3120 kg/ha/yr). The farmers who generated this technology also initiated an open day that was attended by more than 200 farmers to demonstrate this technology. These examples demonstrate that the FSRP approach empowers farmers to the extent that they have control over the technology development process and the technologies developed through this process.

Challenges and Potential for Scaling up FSRP

The major institutional challenge to the implementation of the FSRP approach has been the inadequate human and institutional capacity of the Malawi and Cameroonian Departments of Fisheries. It has; therefore, become important to establish and strengthen partnerships with NGOs and community based organizations (CBOs). For example, WorldFish-Malawi has involved World Vision International (an international NGO) in farmer mobilization and in on-farm production of fingerlings in Chingale area of Zomba District. In this area World Vision has about 123 farmers engaged in IAA. Informal links were initiated with a Community Based Organization (Village Initiatives for Food Security and Rural Development -VIFORD) as a partner in the implementation of the FSRP. The involvement of NGO's and CBO's has also been introduced in the Eastern Province of Zambia. It should be noted that these initiatives are new in Malawi and Zambia and WorldFish is closely monitoring and documenting the activities implemented by these organizations.

Another major obstacle to the implementation of FSRP has been conflicts in the strategies used by different stakeholders. Further more, the shift from a top-down research and extension to a participatory approach technology development entails drastic changes in institutional focus, new roles for extension agents, researchers and farmers, and an appropriate set of policies and conditions. This constraint has been removed through the development of policy guidelines, both in Malawi and Cameroon, on participatory aquaculture research and extension. These guidelines provide common strategies for implementing FSRP and working with fish farmers and hence will reduce conflicts between different stakeholders.

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