Economics of small-holder fish farming in Africa. A case study from Malawi

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Abstract

The global aquaculture industry has seen dramatic growth over the last two decades, and is forecast to become **increasingly** important into the **next** century. The aquaculture output, of the African continent, however, remains low at about 4% of the total. There is a perception of failure where donor assisted projects aimed in stimulating the development of aquaculture operations, particularly in the small-holder sector of Sub Sahara **Africa.**

The reasons for this are complex and poorly defined. They include societal, economic and technological issues and extend beyond the aquaculture sector atone. To gain insight into regional and continental performance, there is a need to understand the behavior **of** individual **enterprises.** This paper examines **economics** of one sub-sector of African aquaculture, focusing on small-holder fish farming in Northern Malawi.

The economic viability of station tested models is demonstrated. Case **studies assessing** existing small-holder fishpond operations and other farm activities are presented in the form of farm budget analyses. The role and limitations of economic analysis and technological models are discussed in the context of constraints faced in small-holder farming systems. Implication for future development assistance are considered.

1. Introduction

Aquaculture as a range of aquatic resource based production activities has achieved rapid growth over the last 2 decades, production increasing more than 300% since the early 1970s to an estimated output of about 16 million tonnes in 1995 (excluding about 6 million tonnes of aquatic plants). Over the same period, growth in global capture fisheries has leveled out at about 85 million tonnes pa (FAO 1995), and in many cases, fisheries are already heavily overexploited. Forecasts suggest that the growth in aquaculture output will continue, rising to over 25 million tonnes by the year 2000, and potentially 50 million tonnes by the middle of the next century (Csavas 1995: New 1991). Set in the context of population growth, this increase would be required simply to maintain current per capita consumption.

While globally the growth in aquaculture might be considered a success story1[1], this is not evenly distributed: more than 85% of the current production occurs in Asian countries, while the African continent produced about 4%. There is a perception of 'failure' in the latter, often compared to the 'success' in the former. While the statistics might be seen to support this view, the value and validity of such comparisons might be questioned (Harrison 1994; 1993). The long history of aquaculture in Asia must be compared with almost no historical experience in most of Africa. The regions are simply different environmentally, politically, socially and culturally.

Within the African continent, aquaculture development represents a diverse range of activities, in a wide range of physical, economic and social environments. Excluding aquatic plant production, output in 1993 was ~ 70,000 tonnes. Northern African production represents about 58% of this total, most from Egypt (35,000 tonnes). Of the Sub-Saharan output of ~ 29,000 tonnes, more than half was produced by Nigeria and about 10% by South Africa. Thus the remaining 26 countries registered by FAO (1995) produced around 9000 tonnes or 14% of the African total2[2]. It is in this region in particular that the perception of 'failure' is manifest, where donor assisted projects have aimed, primarily, to assist the development of small-holder aquaculture. The reason for this are complex and poorly defined, include societal, economic and technological issues, and extend beyond the aquaculture sector atone (Harrison. 1994; Harrison et al 1994; UNDP/ NORAD/ FAO**.** 1987).

To gain insights into sectoral performance at the continental or regional level, there is a need to understand what is happening at the level of individual farmers and enterprises, which may represent a broad diversity of activities. This paper examines the economics of one subsector of African aquaculture represented by small-holder farmer enterprises in Northern Malawi whose 1993 country production was estimated at about 256 tonnes (FAO 1995), of which about half came from two estate owned farms (Stewart 1993).

Over this decade, there has been a number of major development efforts designed to stimulate the development of *a* small-holder aquaculture sector in Malawi, directly through extension and provision of stock, and indirectly through research programs aimed at appropriate technology and extension methodology development (Harrison; 1993: ICLARM /GTZ 1991). The rationale for these activities is centered firstly on a clearly identified need and demand for fish, associated with increasing population and decreasing yields from lake fisheries, and secondly on the identified technical potential,

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1[1] Recognising the legitimate concerns relating to the negative environmental, social and economic impacts of certain sectors, in particular shrimp farming.

2[2] Almost half of this figure is represented by Zambia's estimated 4,600 tonnes. An average yield of 177 tonnes was produced by the remaining 25 countries, ranging from 0 to 700 tonnes. If the Zambia figure was nearer the average, then total production from these countries would represent only 7% of the continental total.

based on Asian models of integrated aquaculture in resource poor farming systems (Lightfoot, 1990).

Both on station and on farm trials confirmed that total tilapia species could be successfully cultured using available agricultural by-products as the sole inputs to the system and where applied, economic analysis has suggested potential profitability (ICLARM/GTZ, 1991; Beverage and Stewart, 1986; Stewart, 1993; Brooks and Maluwa, 1993), However, despite the apparent potential, achievements at the development level are less encouraging: three major interventions over the last decade have achieved relatively minor increases in total fish farm yields (Harrison et al, 1994).

This paper is developed from a study of the economics aquaculture in Malawi (Stewart, 1993) as part of activities of the EC Funded Central and Northern regions Fish Farming Project (CNRFFP) based in Mzuzu. The analysis of small-holder fish farming operations is based on a case study farm budget approach. The aim was to provide greater resolution on the individual fish fanning systems than previous sectoral studies in the region (Johnson. 1992. Wijkstrom. 1991). These gave an overview of small-holder aquaculture, but lacked detail on individual systems in terms of relative roles of fish culture and perceptions of farmers. The specific objectives of this paper are to:

• develop a simple economic model of the aquaculture technology which forms the basis for regional aquaculture development programs,
• examine the economic viability of existing fish ponds in small-holder farming systems, based on a number of farm budget case studies,
• compare the performance of station tested models and actual practice of small-holder fanning operations, consider the constraints to model adoption, and implications for future development interventions.

The views expressed in this paper are those of the author, and do not necessarily reflect those of the Malawi Government Department of Fisheries.

2. Methods

The economic assessment of the aquaculture technology model for small-holder farming is based on data from a range of on-station trials developed as a component of the CNRFFP technology research activities (Brooks and Maluwa. 1993). Case studies were developed for six fish farming operations, identified from information available from the CNRFFP database and discussions with the aquaculture extension staff.
The selection criteria included:

• all farmers with operational ponds.
• two farmers selected in each of three extension areas (Mzuzu, Nchenachena and Limphasa).

• one "successful" and one "unsuccessful" farmer in each area, based on perceptions of the extension workers- which was generally related to gross fish harvest data.

Data sources and collection

Data on the farming systems (livestock, crops and respective areas, inputs and yields, costs and revenues, and labor requirements) were obtained through semi-structured and informal interviews with the farmers over two-farm visit.

Certain data such as the costs of purchased inputs, and in some cases the revenues from cash crops, are believed to be reasonably accurate. The reliability of other data, however, was questionable, and for many activities (particularly relating to goods for home consumption) farmers could not provide quantified information. Thus, a range of sources of information was used to complement and cross check that obtained directly from farmers, including the project data base, DOF and DOA staff, and literature on agriculture and livestock from the MZADD3[3] and other agriculture development organizations. Given that small-holder farming activities involve use of on-farm and off-farm resources, and produce can be sold, bartered or consumed on-farm, many resource flows do not involve cash transfers, the analysis considers costs and benefits in both cash and in-kind values. Information sources and methods of quantification and valuation are summarized in Table 1. In addition, farmers' perceptions on the role and value of their fish farming operation, and the potential for improvement, were recorded.

Table 1 Quantification of farm activities

Crop area estimates	Farmers- verbal description Visual and paced area (farm walk) Local extension workers-verbal accounts, field records.
Yield estimates	Farmers: sales and home consumption information (period consumption per day/week, seasonal availability, annual comparisons - is it a good/bad/ average year). Cross check with other farmers' information and agriculture extension worker, researchers, statistics.
Value (sales and in-kind)	Farmers (sales values where proportion crop sold) Other farmers, local markets (traders purchase price). ADMARK (government buyer of agricultural products, lower price than local traders)
Labor requirements	Farmers, agriculture statistics, reports (presented for case study 1 only).

3[3] DOF/DOA: Government of Malawi Departments of Fisheries and Agriculture respectively.
MZADD: Mzuzu Agricultural Development Division

3 .Results

3.1. Model aquaculture technologies

The results of station based trials and the performance of similar systems elsewhere suggests that under certain circumstances aquaculture systems can return significant benefits to land and labor invested in the operation. Table 2 presents *a* generalized case, with yields at the mid-range. Results suggested that even where inputs are purchased (or allocated an opportunity cost), and conservative market prices are applied, significant returns to land and labor are obtained (considerably greater than returns from maize estimated for Case study 1). Based on gross margins, the cost (or notional cost) of labor invested in pond construction is paid back in the first or second year of operation. A reduction in yields to 1 I/ ha/ yr, however, makes the full cost model a very marginal activity at the market price applied; at the higher market prices range recorded in the field (K6 - 10 /kg), this last option could still give acceptable returns. In practice, most input would not be coasted. Although the notion of opportunity costs may still represent a worthwhile means of assessing benefits form, this choice of resource allocation where real alternatives may exist**.**

Working on the assumption that aquaculture can be integrated into the existing farming system, and increase the efficiency of use of available on-farm resources, variations on the model have formed the basis for the range of development interventions in the regions. Although sensitive to levels of yield/ market price where inputs are purchased, the conclusion from this model representation is that small scale low input/ low output aquaculture appears to be not only a viable but a potentially highly profitable activity for the small-holder sector.

Table 2. Station tested 400 m2 model fish pond operation financial analysis (in Malawi Kwacha, K)

ITEM	DESCRIPTION	K	Sensitivity (K)	
CAPITAL[1]	50 days labour @ K5/day	250		
INCOME	60 kg/yr[2] @ K 5 / kg (sensitivity, yield 40kg)	300		200
INPUTS/COSTS Stock Maize bran Manure (poultry) Labour	 2 fry m2 / harvest = 1600 @ K 0.02 each from local mill, 200 kg @ K 0.1/Kg) 900 kg, no cost (sensitivity, @ cost K0.1/Kg) equivalent of to family labour days / year	 32 20 0 0	 90	 90
	TOTAL COSTS	52	142	142
	GROSS MARGIN Depreciation over 10 years NET MARGIN	248 25 223	158 25 133	58 25 33
	PAYBACK on capital investment (years)	-1	-2	-8

	Net Margin, return to labor (K per day) Net Margin, return to land (K per 100 m2)	22 56	13 33	3.3 8.2
	Comparative returns to Maize (from Case) study Net Margin, return to labor (K per day) Net Margin, return to land (K per 100 m2)	 7,6 9,9		

Note 1 Only capital input is labour for pond development. Farmers may use their own labour and dig ponds in the dry season when opportunities for other income gene rating activities may not be available. However, Johnson (1992) found that a significant proportion of fish ponds have involved investment of cash or exchange of goods, and thus the costs is included here.

Note 2 Yields average 1.5 t/ ha/ yr (range: 1 - 2 tonnes / ha) based on 2 harvests from monoculture *Oreochromis Karongae / Oshiranus,* applying totally available livestock and crop by-products. Sensitivity tests yield down to 1 t/ ha/ yr for fully coasted model. Market values MK 5/kg based on sales through local markets, and includes traders' margins. Actual pond side sales price reported ranged from 3 - to MK /kg (based on total income / total weight, as fish is sold by the piece).

Note 3 Inputs may obtained from on or off farm sources. Stock from own ponds, ongoing activities, other rearms, or government hatchery. Maize bran from own crop, other farmers, milts manure from own livestock, or from family/ neighbours, generally not available for purchase, and often in short supply. A notional opportunity cost of K.0.1/ kg applied to illustrate sensitivity to this item. Additional inputs of organic material are often applied (vegetable and household waste, with plant material), but were not included in station traits. Labour for feeding harvesting. Stocking and maintenance is minimal. Fish may be harvested by hook and line (partial) cast net (if available) or draining the pond by breaking the bank.

3.2. Small-holder fish farmer case studies

Results of farm budget analyses are presented in summary in Table 3 and Figures 1-5. No quantitative data was available for case study 6 and there appeared to have been a total failure in this farmer's adoption of the model aquaculture technology, discussed below. The first point this assessment reveals is the wide variability in the budgets of these farming operations, the wide range of performance of the fish pond system, and in most cases the fact that fish represents a relatively minor element of the fanning operations. All farmers had varying levels of off-farm income. The objective here is to consider the key points arising from individual studies. Constraints to model adoption are discussed later.

Case 1: Mr. Nkhata, Mzuzu.

This farmer was one of the most successful in terms of the technical performance of the fish pond system, and the most successful judged on economic criteria, with fish representing the second most important contribution to the total gross farm margin and cash income. Contributions from fish production to labour (K40/day) and land (K67/ 100m2) were considerably greater than those from maize (K7.6/day; K10/ 100m2). The output of this operation, however, was still only just over half the yield of the model technology presented above. Mr. Nkhata indicated that he was very happy with his ponds, and had bought a pig to provide some manure. However, this operation he had depended on a neighbour for most of the manure applied, but it was indicated that this was no longer an acceptable arrangement for the neighbour. The farmer expressed the intention to continue to produce fish and indicated that he would like to build more ponds. However, this analysis suggested that he would be better to maintain / improve the management of the existing ponds, for which there were already insufficient resources.

Case 2: Mr. Shaba, Mzuzu.

This farmer was considered unsuccessful by the project staff- with fish yields of less than 25% of the model system. This was attributed to long production periods and low input. Mr. Shaba took up fish farming primarily for cash income, and complained that benefits were less than expected because an otter had eaten a lot of his fish- He relies on others (family, neighbours) for inputs of manure. However, the economic analysis suggests that although yields are low, fish still makes a significant contribution to the gross farm margins, similar to cassava and beans: no input costs, and little labour was invoked. The main source of cash income from fanning is bananas, with a smaller contribution from fish: these activities subsidise the cash cost of maize produced for home use.

Case 3: Mr. Mbale, Nchenachena.

This case was also considered unsuccessful by project staff. Yields were very low (only 7% of model system output), and ponds poorly managed. Again, the farmer complained that the ponds were not earning as much as they could due to predation. However, as in the above case, the analysis suggests that fish still made a positive contribution, in particular to cash income. Coffee, on the other hand, made significant cash loss. As cash, income was the reported incentive for adoption of both fish and coffee. While fish income may be

Table 3. Summary in case study findings
(all values include cash and in-kind exchanges, unless cash specified)

CASE STUDY	1	2	3	4	5	6
TOTAL INCOME (K)	3884	3753	2153	2664	5312	na
FARM INCOME (K)	2684	3003	1193	1264	4812	na
OFF FARM INC.(K)	1200	780	960	1400	500	na
FISH						0
INCOME (k)	497	145	53	377	118	-?
COSTS	75	0	0	350	104	
GROSS MARGIN	404	145	53	27	14	
Gross cash Margin	+336	+103	+48	-80	-22	

Fish yields total	50 Kg	16 Kg	8 Kg	47 Kg	40 Kg	0
(kg/ha)	(800/ha)	(340/ha)	(100/ha)	(261/ha)	(900/ha)	0
Market price (K/Kg)	10	9	6.6	8	3.8	0
FISH AS % OF						
TOTAL INCOME	12%	4%	2%	14%	2%	0
FARM INCOME	18%	5%	4%	30%	2%	0
TOTAL MARGIN	12%	5%	3%	1%	0%	0
FARM MARGIN	19%	6%	7%	3%	0%	0
Cash farm margin	26%	9%	*	-54%**	-1%**	-
CONTRIBUTION TO GROSS FARM MARGIN OF :						
Fish	19%	6%	7%	3%	0%	0
Maize	60%	35%	39%	31%	6%	na
Beans	3%	5%	16%	27%	3%	
Cassava	9%	7%	38%	19%	19%	
Vegetable	1%	1%	14%	4%	10%	
Banana	2%	46%	-	3%	21%	
Rice	-	-	-	13%	-	
Coffee	-	-	-14%	-	-	
Sweet Potato	6%	-	-	-	-	
Layers	-	-	-	-	25%	
Other Livestock	-	-	-	-	16%	

* This farmer made a cash loss on fanning operations due to failure of the coffee crop, and a net cash outflow on the maize crop. The small positive cash margin from fish was over 3 times the total farm cash loss.

** In both cases a net cash loss was incurred for fish production expressed in relation to the total cash margin of the farming system.

FIGURE 1 : Farm Budget Case 1 (Nkhata)
Costs and Benefits

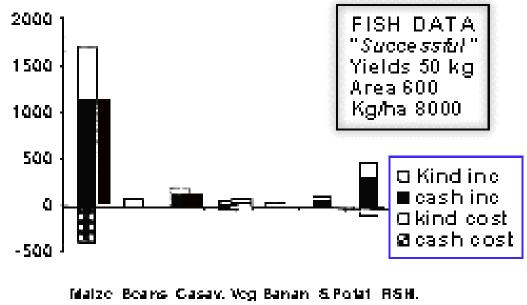


FIGURE 2 : Farm Budget Case 2 (Shaba)
Costs and Benefits

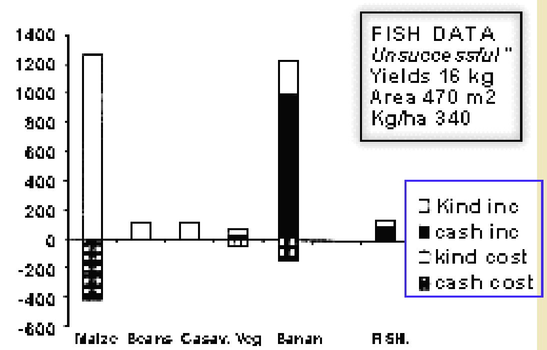


FIGURE 3 : Farm Budget Case 3 (Mbale)
Costs and Benefits

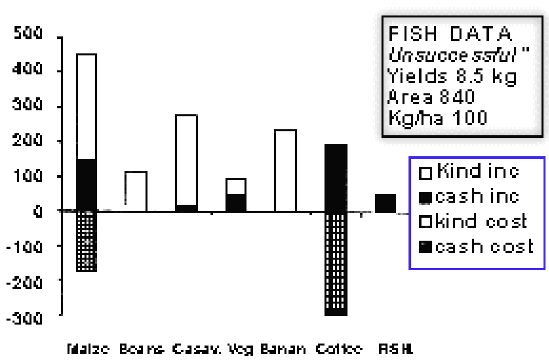


FIGURE 4 : Farm Budget Case 4 (Msiska)
Costs and Benefits

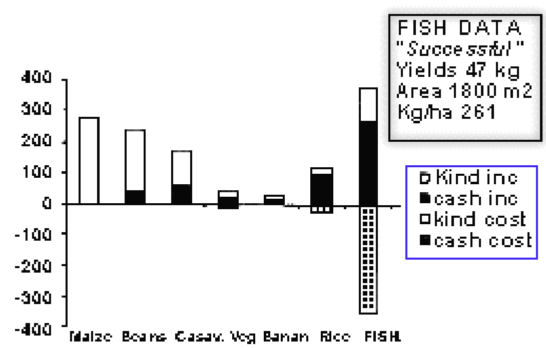
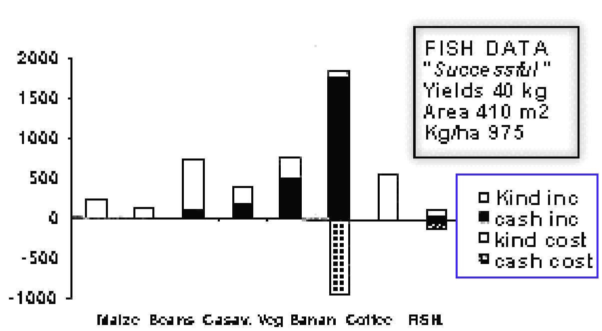


FIGURE 5 : Farm Budget Case 5 (Katete)
Costs and Benefits



small due to resource constraints and poor management, it appears that the risks were and remain considerably less than for coffee.

Case 4: Mr. M S Msiska, Nchenachena

This farmer had 9 fish ponds, and was the only case where fish production was directly integrated with crops, with two ponds for rice fish culture developed the previous year. Considered as a successful fish farmer by the project, Mr. Msiska claimed to be happy with the fish fanning operation, although yields per unit pond area were actually very low (at less than 20% of model yields). The farm budget analysis also gave a different perspective on viability than the farmer's expressed views. According to the information received, he actually spent more on the purchase of maize bran for fish feed than he obtained from cash sales, fish production therefore being subsidised by other income generating activities (note: this was the only case where off-farm cash income was greater than total farm income, in cash and kind). Including the estimated value of fish used for home consumption, the budget analysis suggests that fish represented a very small positive contribution to the total farm gross margins.

Case 5: Mrs. Jane Katete, Limphasa.

This farmer was considered successful by the project staff, as the yields from her ponds were high relative to most other systems (60% of model yields). However, as in the above case, the apparent expenditure of cash for pond inputs renders what appears to be a successful operation, based on yields, into a very marginal venture. As Mrs. Katete is one of the few farmers who has sufficient livestock to offer the capacity to obtain good yields with no cash expenditure, this operation appeared to have the greatest potential for economic success. The poor economic performance was due to the low price charged for pond side sales (K3/kg. compared to a range of K6-to/kg charged by other farm, and K8/kg charged at the local lake side market, 5 km distant). This farmer was relatively wealthy, and in comparison to other income generating activities, fish was unimportant. She stated that looking after the fish was her pleasure and that local people could not afford to pay more. The local extension worker suggested that she sold fish at a low cost to gain favour locally, as others were critical of her wealth. Thus, social factors appeared to be more important than conventional economic criteria in the farmer's decisions.

Case 6: Mr. D Chiteche, Limphasa.

This case study represented a small business fish farmer, where significant cash costs had been incurred in a relatively large pond development (almost 0.8 ha). No budget analysis was made as no information was available for his numerous other business, and no cash income had been received from the fish pond operation. He had started fish farming because it seemed to be a good idea when he heard about the project, and thought that fish would be more profitable than rice (the previous crop on the fish farm site), because no inputs were required). This farmer was making no real efforts to manage his ponds, and appeared to have no concept of production cycles, level of management or volume of inputs required to achieve the full potential from what appeared to be a well constructed pond site. He suggested that the project should provide a "better fish".

4. Discussion

It is clear from the case studies above that the aquaculture technology model developed from on-station trials, and promoted in the locality, was not replicated in most of the farming systems assessed, which demonstrated a wide range of levels of production, management, satisfaction and economic performance. Furthermore, while the application of economic criteria to the model system represents a relatively simple process, the analysis of fish ponds as a component of rural farming systems was found to be highly complex. This raises two issues for discussion, concerning the appropriateness of model technology systems as a basis for small-holder aquaculture development, and the applicability of economic criteria to the evaluation of these systems.

The role of economic analysis and technical models.

It was apparent during this study that economic criteria do not easily capture all aspects of the farming systems:

- the process of quantification and valuation of resource flows may contain significant margins of error.
- valuations and conclusions from technical and economic analysis may not necessarily reflect the views of the farmers.
- the farm budget approach here is limited by the linear nature of the analysis (e.g. higher returns from fish than maize does not reveal whether further fish pond development is desirable: available resources may already be insufficient to obtain the full potential from the existing system).

However, if viewed as indicative of the range of conditions which prevail, rather than a definitive description of specific cases, this approach, applied in conjunction with other views of the system, can provide a useful contribution to the understanding of factors influencing the adoption of these technologies. The case studies above suggest that poor technical performance in comparison, the model operation can still represent positive contributions in economic terms from minimal resource inputs. Good technical performance, on the other hand, does not necessarily indicate good economic returns.

Thus, those farmers identified as unsuccessful in terms of technology transfer may be derivingproportionally greater benefits that more "successful" operators, an observation also made in Zambia (Harrison, 1993). However, poor economic performance may still be successful from the farmers' perspective due to a range of social factors. To achieve sustained developments, satisfying farmers' objectives should represent the primary goal. This does not imply that technical and economic investigations are unimportant. All farmers are working within the economic system, and the process of change, in activities and attitudes, is ongoing. All systems can potentially benefit from the provision of sound, and appropriate technical advice.

Failure of technology transfer?

Reason for the apparent failure to achieve the performance identified in on-station trials include factors relating to lack of resources, predation, lack of knowledge, poor management, social priorities, and attitudes to fish (livestock) and development assistance. These issues are summarised in Box 1, based on this work and other studies (Harrison et al., 1994; Brooks and Maluwa, 1993; Harrison, 1993; Stewart, 1993).

While the aquaculture technology might be considered simple by those designing and implementing such development initiatives, it is apparent that standard technology models and their economic descriptions are not easily transferred to rural fanning systems. To some extent, the model technology is inappropriate, in that many farmers will not be able to follow recommendations based on these systems, due to the lack of appropriate resources. By default, there appears to be a process of technological adaptation resulting in a range of activities and technical performance, although the problems raised above suggested that this process could be much more successful in meeting the needs of individual operators. Thus, even with existing resource constraints, there may be potential for marginal gains in production through better pond management, particularly for farmers operating very low-input/ low-output systems. Constraints to such gains may be related as much to the attitudes of farmers (to livestock, and to development assistance), as to lack of proper technical knowledge.

The relationship between farmers and major development projects does not appear to have favoured innovative and adaptive developments, constrained in pan by the history of rural development culture, including the limitations of model technology transfer. This has lead more recent interventions, which seek greater participation of farmers in problem identification and solving, aimed at fostering self-reliance and adaptive technology development (Lightfoot, 1990; ICLARM/GTZ, 1991; van der Mheen-Sluijer, 1995). However, to date these approaches remain the exception, and are still largely research based activities. The challenge for the future is to seek the means to integrate the benefits of simple technological messages, which can be related to farmers through the existing extension systems, but to structure the approach such that these messages are suitably flexible to meet individual farmers needs.

Box 1: Constraints to the development of model aquaculture technologies
Availability and application of inputs

Lack of on-farm resources is the single greatest constraint to the adoption model technologies. Full potential of the pond is rarely reached. Brooks and Maluwa (1993) noted that on average farmers apply only 10% of' recommended inputs. Lack of knowledge of the requirements (total amounts) and potential resources, which can be used (in addition to manure and maize bran) was one factor. The main constraint, however, is lack of available resources. For a pond area of 400m2, the models input of poultry manure would require *a* unit of 18 birds, which requires a considerably greater level of cash investment in operation, and consequently risk, than the fish pond operations. In only one case in this study (case 5) did the farm have these resources. Many farmer rely on neighbours of family for inputs, but this may not be a sustainable arrangement.

Losses (predation and theft)

Losses due to predation by frogs (in the case of fry), birds, otters, mink, and humans are a major threat to the viability and sustainability of fish farming in Malawi. However, it is extremely difficult to estimate the scale or extent of the problem. The on-farm monitoring of a number of Mzuzu farmers indicated losses of up to 80% from initial stocking (Brooks and Maluwa, 1913). Investment in protective structures can not be justified by the system, and combinations of measure to limit losses are required. Possible options include initial siting of ponds (close to homesteads), protection measures (e.g. branches as sources of cover in ponds) and management (timing of stocking and harvesting to avoid holding larger fish in the dry season when risks of bird and animal related loss may be greatest). In some cases, however, it appears that farmers attribute poor performance to predation, when the real reason in poor management.

Lack of understanding of livestock management and the production system.

Farmers understanding of fish in ponds and their attitudes to livestock limit adoption of model technology practice. Some consider that fish should grow like the fish in the rivers, or like other, free range, livestock, without inputs. Again like other livestock, fish are often considered as an asset, rather than a crop. Thus, many farmers do not harvest for long periods, potentially increasing risk of loss due to predation and theft, in addition to lost production potential.

Dependency culture: looking to the government to provide something better.

A number of farmers appeared to have started fish farming in the expectation of loans or subsidies from the project, and were dissatisfied with the assistance received. Another view expressed by many farmers was that they were waiting for a better fish, which the project would provide, resulting in ponds remaining idle. This was based on a misinterpretation of the on-going research on the project station, has been reported elsewhere (Harrison, 1993). To some extent, extension staff may unintentionally lead farmers to believe the problem is their stock. while marginal gains may be achieved by alternative species, and in some cases in-breeding over a number of years may RESULT in poor strains, in most cases new stock with not improve performance of such low input, poorly managed systems.

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