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From researcher to farmer: partnerships in integrated aquaculture – agriculture systems in Malawi and Cameroon

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The potential for integrating aquaculture with agriculture has been widely recognized as a means of improving the use of inputs, diversifying output and economic opportunity, and enabling smallholder producers to maintain and strengthen livelihoods. This paper describes the outcomes of this approach and explains the extent to which it has been taken up and has led to sustained and self-generated capacity. Based in particular on experience in Malawi, Ghana and Cameroon, it also considers implications more widely in the region. The overall picture is that this is a partial and still emerging success story, linked as much with the social and economic drivers surrounding smallholder farmers as with the development support approach adopted.

Keywords: fish farming; rural development; sub-Saharan Africa

Introduction

The potential for integrating aquaculture with agriculture (IAA) has been widely recognized as a means of improving the use of inputs, diversifying output and economic opportunity, and enabling smallholder producers to maintain and strengthen livelihoods. Traditionally applied in Asia, the concepts and practical application have been a major area of development interest elsewhere, particularly in Africa. Here, the aim has been to develop IAA-based technology and extension approaches to stabilize and improve the economic and food production performance of small-scale African farming systems in the context of sustainable watershed management. Incremental increases in sustainable production at farm level could lead to widespread adoption into sustainable landscapes (Figure 1).

This review describes the outcomes of this approach and explains the extent to which it has been taken up and has led to sustained and self-generated capacity. Based in particular on experience

in Malawi and Cameroon, it also considers implications more widely in the region. The overall picture is that this is a partial and still emerging success story, linked as much with the social and economic drivers surrounding smallholder farmers as with the development support approach adopted. Over time, a more targeted approach built around better identification of high-potential context, together with a gradually rising technical and skill base, and better market access, is strengthening the process of adoption. However, the spillover effects are also important, and the evolution of more specialized and commercial aquaculture in the region, the basis of much of the current growth in the sector, has been due in no small part to the skills and technologies made available through the IAA initiative.

The WorldFish Center (formerly The International Center for Living Aquatic Resources Management, ICLARM) has been the primary agent in developing IAA approaches in Africa since 1983. A range of donors have been engaged, most notably BMZ/GTZ (Malawi 1987–1992 and Ghana 1991–1994),

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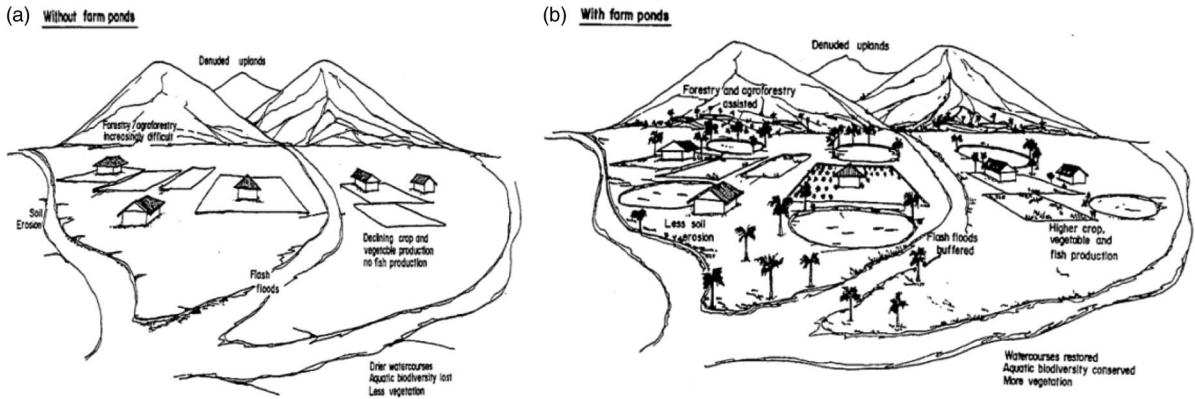


Figure 1 | The original concept of aquaculture integrated into small-scale farming systems as a component of sustainable watershed management

Source: Pullin and Prein (1995).

DANIDA (Malawi 1995–1999), USAID (Malawi 1999–present) and DFID (Cameroon 2000–2005).

What partnerships helped?

From the outset, WorldFish research has been influenced by the principles and practices of participatory action research, described by an approach to on-farm collaboration dubbed the Farmer–Scientist Research Partnership (FSRP). This iterative process engaged farmers, field researchers and extensionists in a series of joint learning exercises aimed at incrementally integrating aquaculture into the farming system (Figure 2). The FSRP was also adopted by the Malawian (1996) and Cameroonian (2003) Fisheries Departments as the principal method for conducting on-farm research and extension. From 2005, the

French research for development agency, CIRAD, initiated the Renforcement des Partenariats dans la Recherche Agronomique au Cameroun (REPARAC) project, the aquaculture part of which also adopted an FSRP-based approach. The outcomes reported below reflect the experiences of this wide range of partners.

Partnering with farmers to evolve technology in situ empowered users with a more thorough understanding, thus enabling them to further adapt and share IAA with their neighbours. Within six months of a May 1990 open day, 46 per cent of adopters in the target area had learned about IAA from other farmers, a third of whom had adopted two or more technologies from their neighbours. By the end of 1992, almost 80 per cent of farmers practising integrated rice–fish farming in Zomba District had never witnessed an extension demonstration. In

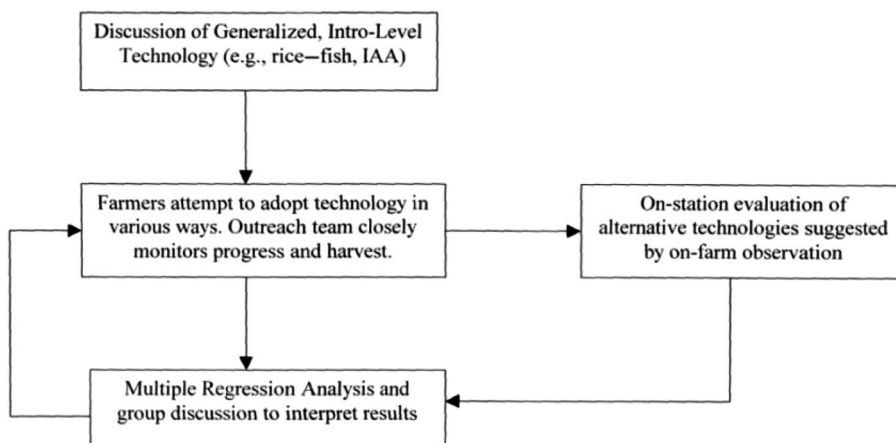


Figure 2 | The FSRP approach for systematic integration of aquaculture into existing farming systems

Zomba East, where the WorldFish Center worked with 34 farmers from 1991 to 1995, there were some 225 practising fish farmers by the end of 1998.

Non-governmental organizations (NGOs) seeking to address the complex constraints faced by rural smallholders rapidly understood the potential of IAA. OXFAM, World Vision, ActionAid, CARE, Salvation Army, Africare, Christian Health Association, Creative Centre for Community Mobilisation, Community Partnership for Sustainable Resource Management and Malawi Social Action Fund incorporated IAA into their portfolios for Malawi, facilitated by donor funding targeting food-insecure rural populations. These partnerships have been critical in scaling up IAA.

In Cameroon, a 2003 survey identified six local NGOs – COSADER, CANADEL, CHASAADD-M, PPDR de Sa'a, AGRO-PME and the Voix du Paysan CDDR – interested in IAA as part of a basket of low-external input farming technologies. However, competing donor priorities and other limitations constrained NGO support to small, short-term interventions that failed to significantly increase the rate of adoption of IAA.

Role of social capital development

Although no specific emphasis was placed on building social capital, initial work in both the WorldFish and CIRAD activities was organized around farmers' groups in the hope that mutual dependence based on collective action could help overcome the considerable constraints faced by rural African smallholding farmers, most specifically the lack of capital and access to markets. However, there were important limiting factors, particularly social levelling, in getting rural communities to cooperate in such ways, even when strong outside intervention temporarily imposed transparency on local decision-making structures.

Although a number of NGOs sought to catalyse collective action by helping groups to organize, register with the government, establish bank accounts and/or revolving credit schemes for inputs, and undertake group marketing arrangements, impacts were questionable. Although women worked more successfully in groups than men, significant increases in social capital associated with IAA development were not noticeable. At a regional meeting in Cameroon in 2005, farmers listed 'conflict with neighbours' as one of the top three constraints to expansion, after

fingerling supply and market access. Most of the more successful outcomes were associated with individuals or family groups taking up the technical opportunities in a more privatized context.

The mix of agricultural innovations

Early work focused on generating innovations to increase the efficiency and productivity of resource-poor farms, based only on the on-farm resource base. In collaboration with the University of Malawi, on-farm resources were inventoried and tested as fishpond inputs, indigenous species for aquaculture were screened and a range of management options were piloted, focusing on integrating existing crop production practices with fishponds. At the research station, these resulted in significant improvements in fish productivity from some 700kg/ha to a maximum of about 2,500kg/ha.

The difference in performance is due to the recycling of previously unused materials and/or fish stocking and management technologies that optimize outputs. In Malawi, maize bran is the primary input, where the average farm production of around 192kg of dry matter is only 37 per cent of typical needs. However, they generate some 3,700kg of dry matter per year that can be used if well integrated. In Cameroon, farms are larger and better endowed, and compost is the primary input. However, labour for cutting and transporting organic matter is limiting. In Mozambique, farmholdings are larger; although pond sizes are relatively small, low agricultural productivity limits the amount of by-products available for fish production.

Based on these results, a series of extension bulletins, on-farm trials/demonstrations and farmer field days were developed. Researchers engaged government and NGO extension personnel to improve both their technical capacity and their field methodologies. The other significant production input, fish seed, was made available through a range of sources, with particular emphasis on improving quality by avoiding traditional and poorly controlled in-pond breeding, which commonly leads to adverse selection pressures.

Outcomes

Number of farmers adopting

From an original 32 farmers involved in FSRP pilot trials, by 2004 there were over 7,000 small-scale IAA adopters in Malawi (Figure 3).

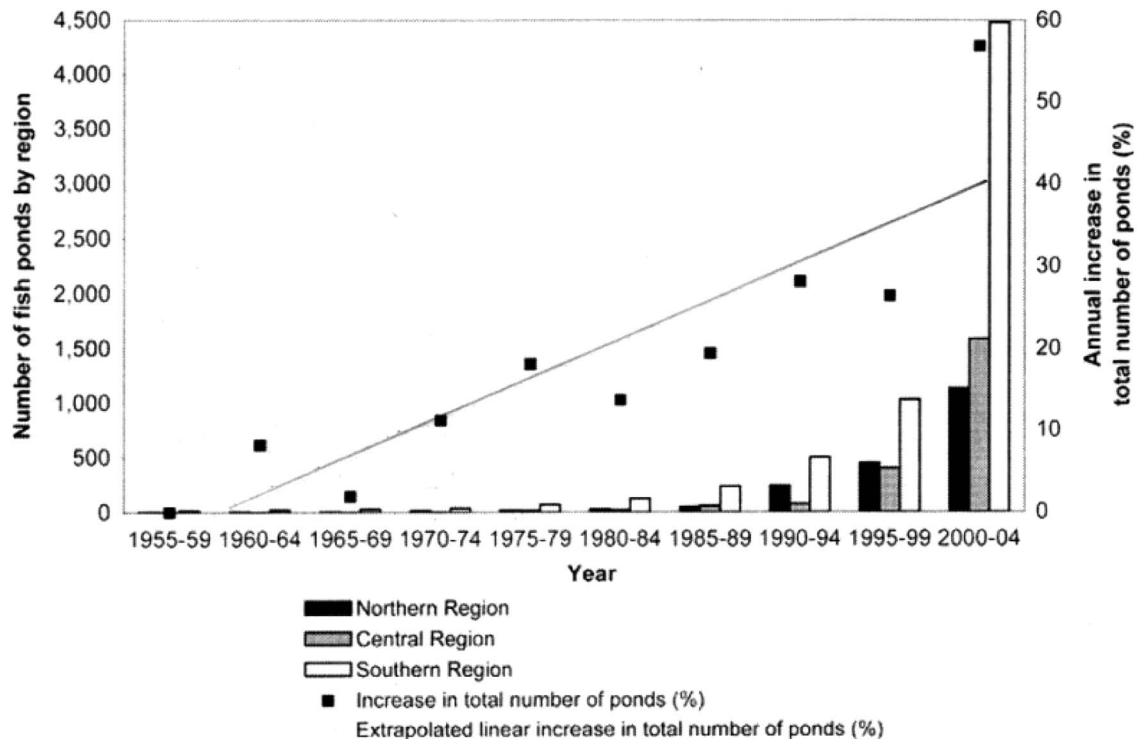


Figure 3 | Trend in number of small-scale aquaculture operations in Malawi
Source: Russell *et al.* (2008)

In Cameroon, the number of small-scale farmers practising IAA increased from 15 to 137 over the course of the 2000–2005 project, and partner NGOs were, in 2003, providing limited support to another 260 farmers. However, although formal data are lacking, indications are that these numbers have not significantly increased since. More farms are now producing commercial quantities of fish, virtually all in periurban areas, with new adopters seeking to replicate the success of those project participants who succeeded in commercializing their farms through IAA. In mid-2008, a Food and Agriculture Organization of the United Nations survey identified 16 small- and medium-scale commercial fish farms with a total pond surface of 18.4ha (11,500m² average per farm) operating in the southern part of the country.

Number of hectares covered by new technologies or practices

The 7,000 small IAA farms in Malawi have a combined total of 186ha in pond surface area, an average 275m² per farm. The best and most productive IAA units average over 2ha in total land area, compared to an average of less than 0.4ha for all small farms. In contrast, Cameroon has only

300–400 IAA farms, with about 125ha under ponds, but the average water surface is close to 1,400m² out of average landholdings of about 5ha. Mozambique has currently just over 3500 small backyard earthen ponds ranging from 100 to 400m² with a total area of 105ha. Collectively these produce about 100 tonnes per year mainly for family consumption. The 6,400 IAA farms in Zambia have a combined total of 155ha of pond area, an average 242m² per farm.

Predicted trends for both farmers and hectares into the future

Given the importance of context – market access and the support environment for smaller-scale farmers – a trend towards specialization, intensification and higher productivity and profitability can be foreseen as natural capital is developed and as rural–urban transfers shift aspirations towards cash economies. The outcome for IAA can be outlined as in Table 1.

A considerable spillover effect could also be expected, in that the fertilization, feeding, management, and marketing knowledge and skills developed during the IAA approach are equally relevant for more intensive systems and can be easily transferable.

Table 1 | Anticipated outcomes for IAA approaches in sub-Saharan Africa

Support/external assistance	Market access	Outcome
No	Low	Little adoption or evolution towards profitability
No	High	Adoption mainly by wealthier investors; more rapid evolution towards intensification, higher yields and profitability
Yes	Low	Higher adoption; little evolution towards profitability
Yes	High	High adoption among a range of investors; range of intensification and yields, high rates of evolution towards profitability

Effects on food production or productivity (either yields or total production)

Near the end of 1996, a GTZ review of their nearly 10 years of aquaculture interventions in Malawi found that adoption of IAA in small farms through the farmer–researcher process (FSRP) had led to substantial increases in fish production compared with those who had adopted IAA through field days or receipt of extension materials (Figure 4).

By 1996, the average productivity of the 32 IAA units in Malawi engaged in FSRP reached 1,350kg/ha in rain-fed areas and 1,650kg/ha in spring-fed areas

compared to an average 900kg/ha/year for the 48 best non-FSRP farms. However, productivity has since changed only modestly to an average of 1,200 and 2,000kg/ha, respectively (Russell *et al.*, 2008), being constrained by small farm sizes and limited access to more lucrative urban markets (Andrew *et al.*, 2003). Elsewhere, productivity was found to be constrained by low levels of agricultural productivity (Mozambique), inadequate supply of high-quality agricultural by-products (Zambia) and in Kenya, where market access is moderately high, expensive agricultural by-products.

In Cameroon, five years of FSRP engagement engendered increases from 498kg/ha (range: 113–905kg/ha) to 2,060kg/ha (range: 1,062–4,710kg/ha). However, there were significant differences in pond size, inputs, production, allocation for sale, market value and productivity between rural, low-market-access farms and peri-urban farms (Table 2). In a follow-up study in 2008, most of the 100 original FSRP participants continued to produce fish but rural farmers had more or less returned to pre-project production levels, generating an average value of CFA 30,400 (£32.00). By contrast, peri-urban farmers had improved their production systems, with average outputs of 4,400kg/ha valued at CFA 400,000 (£421). Interestingly however, even the more commercialized peri-urban systems recorded significant allocations of production to gifts (social exchange) and household consumption.

Effects on environmental services

At the farm level, positive impacts include a 40 per cent improvement in farming system resilience

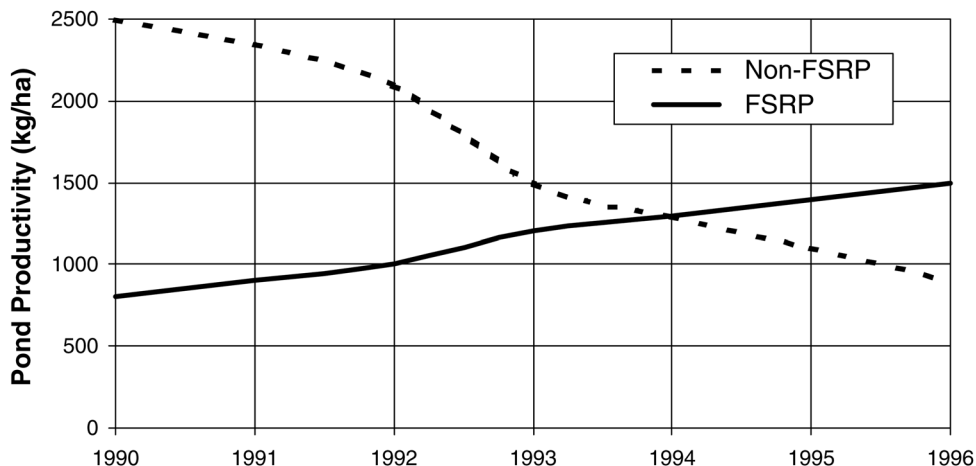


Figure 4 | Evolution of fish pond productivity on FSRP and non-FSRP farms in Malawi

Table 2 | Differences in scale, intensity and market parameters between rural and peri-urban fishpond harvests in southern Cameroon following 7 production cycles (£1.00 = CFA 950)

Variable	Periurban (N = 40)	Rural (N = 44)	P
Weight per pond harvest (kg/ha)	2,060 ± 940	1,200 ± 475	0.0194
Total pond area per farm (m ²)	6,260 ± 4790	1,083 ± 495	0.0711
Average production pond size (m ²)	957 ± 984	476 ± 193	0.1343
Fingerling stocking density per m ²	1.56 ± 0.876	0.603 ± 0.655	0.0070
Use of purchased feed	75 ± 0.463%	23 ± 0.417%	0.0259
Number of buyers in market	25.4 ± 8.96	8.31 ± 7.32	0.0004
Average quantity per sale (kg)	4.12 ± 3.47	2.4 ± 0.76	0.1660
Total quantity marketed per harvest (kg)	89.9 ± 48.7	28.2 ± 23.5	0.0127
Total quantity given as gifts (kg)	55.7 ± 41.2	11.4 ± 9.3	0.0458
Total quantity consumed by household (kg)	50.3 ± 89.6	8.3 ± 6.8	0.3020
Mean fish selling price (CFA/kg)	1,908 ± 570	1,290 ± 386	0.00533

(i.e. defined by the ability to maintain positive cash-flows through drought years), a 50 per cent reduction in nitrogen loss and improved nitrogen-use efficiency. Uptake among rural smallholders in Malawi and Cameroon has, however, been insufficient to generate evidence that landscapes have been substantially stabilized or improved. In Malawi, despite very positive changes on some farms, the 7,000 small-scale aquaculture investments are too small (186ha) to

signify in terms of reducing soil erosion, fertility declines or loss of tree cover.

Social outcomes

Depending on the degree of out-sales from the different IAA enterprises, the primary beneficiaries are farming households and consumers. Although farm sizes and market access varied widely, most farms produced substantial amounts for domestic consumption and social exchange. Impacts of IAA varied with economic context. In generally wealthier conditions in Cameroon, small farm households are not starving, but lack the cash income to move out of poverty. Aquaculture enterprises that meet this need expand and grow. If not, IAA diversifies farming systems, marginally increases the resilience of household food security, but does not justify substantial investment in time and energy to move beyond subsistence level productivity. In Malawi the adoption of IAA increased the total farm productivity by 10 per cent, per hectare farm income by 134 per cent and total income by 61 per cent. Per capita consumption of fresh fish increased by about 208 per cent and that of dried fish by 21 per cent.

Although the cycling of on-farm nutrients and the retention of water within ponds may have represented potential opportunity costs with respect to alternative activities, or in more extreme cases deprived others of livelihoods, there were no apparent negative impacts of this. More broadly, a greater supply of fish could depress the prices for other sources, thereby reducing incomes for capture fishing communities. However, partly because of the limited output in national terms and the generally high demand for fish in most countries concerned, there was little evidence of this, either.

Options for spread, greater resilience and increased productivity

With a broad shift from localized household food security and ecological sustainability towards rapid economic growth and poverty alleviation, sector development focus has moved towards entrepreneurial individuals in zones considered to be of high potential (as defined by suitable land and water, and proximity of markets for both inputs [such as seed, feed, fertilizer and technical advice] and outputs). To define the scope for this, in 2005 WorldFish

initiated a three-year study of the biophysical and socio-economic potential for the further expansion of aquaculture in Malawi and Cameroon.

This suggested that although the approach could be scaled up further, there were important constraints. Without support in the form of technical assistance, communications, marketing and logistics, only those farmers with better market access generated sufficient earnings to keep them interested in aquaculture, and for aquaculture to provide a route out of poverty.

An underlying premise was that if thresholds of productivity and profitability could be achieved, small-scale farmers will evolve in the direction of increasing revenues and larger scale (Brummett and Williams, 2000). However, in rural areas in both countries, together with various socio-cultural constraints, constrained access for inputs, high production cost and poor markets for produce kept production and profits below a level above which capitalized farms could reinvest assets and grow.

The broad conclusion was that depending upon context, and provided water and soils were suitable for pond construction, promoters of IAA in Africa could expect that (i) entrepreneurial farmers with good market access and appropriate technical advice can create successful aquaculture enterprises and (ii) subsistence farmers in rural areas can – with logistical, technical and coordination support – adopt IAA to improve household food security and farming system resilience.

Based on the partnership approach adopted (and including international salaries of key researchers), the internal rate of return (IRR) from research and dissemination of IAA technologies in Malawi was estimated to be at least 12.2 per cent (Dey *et al.*, 2006). This was very conservative and did not include many of the positive non-market benefits of IAA technology such as impact on ecosystem health and local institutions. Regression analyses showed that better extension, higher amounts of training opportunities in IAA, better access to water, higher number of farm enterprises and bigger farm size positively affected the adoption of IAA technologies in Malawi.

Depending upon the context, IAA interacted with the bioresource base to produce different outcomes. In Malawi, resource poverty and poor market access limited productivity, but perceived benefits of an integrated fishpond in terms of household food security were such that many farmers were willing to invest their labour. With technical assistance and coordination services provided by the many active NGOs,

risks could be minimized, enabling even very poor farmers to successfully adopt increasingly integrated production.

In Cameroon, superior natural resources shifted farmers away from household food security towards cash income. With a range of alternative cash crops, but little or no technical or logistical support from NGOs, aquaculture was only favoured where technology was readily available and market access was not a major constraint, that is, close to town.

The main similarities between the patterns of adoption in Malawi and Cameroon were that measurable positive economic impacts of aquaculture were limited to wealthier farmers, and collective action for others, although sometimes workable with external influence from NGOs, failed to sustainably improve access to productive inputs or to markets for product. As with other sectors of the rural economy, the data indicate that the rural poor can be given opportunities to improve their livelihoods, albeit at significantly higher costs than those farmers with greater adaptive capacity (e.g. human, natural and economic capital).

To target economic expansion and job creation, means need to be found for supporting the growth of rural businesses of a sufficient scale to produce adequate profits to achieve sustainability in the absence of subsidies. The best small-scale fishpond systems in Central Cameroon generate profits of about CFA 530,000 (£560) per year, compared to an average of about CFA 2.6 million (£2,700, on sales of 1.7 tonnes of fish) reported by what could be described as commercial SMEs (small- to medium-scale enterprises) in the same area.

A more strategic issue, although not measured in these examples, has been that this longer-term initiative, together with other capacity-building programmes and the gradual improvement of rural infrastructure, has started to bring about conditions where access to inputs, including technical skills, and access to markets, is gradually improving. The availability of better-quality seed and better feeds at competitive prices is starting to change opportunities for many small farmers, and where market prices are positive, the aquaculture industry is starting to grow. The overall balance between subsistence production, for which IAA may be a viable technical alternative, and more commercialized small-scale production may be changing, but changes may also be expected in markets for agricultural by-products, as these also become commercialized. Evidence from Asia suggests that this follows on from a shift towards

more specialized aquaculture production, also bringing local employment opportunities in collecting and supplying fertilizing materials.

By carefully targeting external assistance, the benefits of further expansion, especially those accruing to lower-income investors and consumers, can be maximized. Options for creative, positive and pro-poor interventions would include:

- low-cost credit to allow lower-income investors to afford the inputs for a meaningfully profitable system;
- appropriate technical assistance at SME production scales;
- reduction of arbitrary tariffs and simplification of permitting;
- assistance with market access and information.

Among these, providing direct technical assistance to SME investors who want to build commercially viable farms may be the cheapest and quickest way to help rural farming communities out of poverty, and with good technical assistance, many other constraints to profitability might be resolvable (Pouomogne and Pemsil, 2008).

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