



Selected sections for: Integrated agriculture-aquaculture production systems in southern Malawi

Name

Integrated agriculture-aquaculture production systems in southern Malawi

Summary

Southern Malawi is characterized by the Rift valley and the Shire Highlands, which are dominated by the Zomba and Mulanje plateaux, and the Kirk Range. These mountainous areas are a source of various rivers and streams, which support small-scale integrated agriculture-aquaculture systems (IAA).

The IAA systems were introduced to Malawi in 1986 by the WorldFish Center when a range of IAA technologies were developed and disseminated to farmers. The most common IAA system consists of fishponds, vegetables, fish, rice and irrigated maize. This system is practised by over 2,000 farmers in southern Malawi. The number of farmers practising this system has grown by 25% per year over the past 5 years because of the impact that this system has on household food security, income and environmental sustainability. Farmers practising IAA achieve yields of over 1,500 kg ha⁻¹ yr⁻¹ extrapolated from 450 m² ponds compared with 900 kg ha⁻¹ yr⁻¹ for non-integrated farms and twice as much annual household income (US\$ 270) than non-IAA farms.

Background

The southern region of Malawi is characterized by the Shire Highlands, the Shire River, which is located in the southernmost tip of the African Rift Valley and Lake Malawi. The climate is tropical but highly influenced by the highlands with an average altitude of 900 m. The average maximum and minimum temperatures range from 22-26°C and <10-16°C in the highlands to 30-32°C and 18-20°C in the rift valley, respectively. Rainfall is also highly influenced by the topography with the highlands receiving high rainfall (1,200-2,400 mm) while the rift valley receives only 800-1,200 mm of rain per year.

Small-scale agriculture, mainly consisting of mixed farms centred on maize cultivation, dominates but the region also produces coffee, sugar, tea and tobacco on large-scale estates. The mixed farms are small (<0.5 ha per household) and characterized by a high integration of various crop types and varieties, diverse livestock species and diverse growing systems and patterns. The adoption of such a diversity of production system raises land productivity and at the same time reduces risks of failure due to unfavourable weather conditions. It therefore suits the rural households which are in deep poverty.

The southern portion of Lake Malawi and the Shire River support a fishery that produces over 40,000 t yr⁻¹ of fish. However, fish production has been declining due to overfishing and the use of illegal fishing gears. Declining fish production and an increasing population have reduced the per caput fish consumption by over 50%, from 14 kg in the 1980s to less than 6 kg caput⁻¹ yr⁻¹ in 2004. The Government of Malawi and its development partners, the WorldFish Center in particular, have, since 1990, conducted IAA systems research to increase fish production from aquaculture to improve fish supply in rural areas and to increase farm income and overall farm productivity.

The basic principle of integrated agriculture-aquaculture is to grow fish in a water body that is closely integrated into the resource flows of all the diverse activities on a farm. The basic aim is to convert agricultural wastes and manure into high quality fish protein, to use the nutrients generated in the pond as fertilizers for growing plants on the farm, to reduce the need for off-farm inputs and to maximize the use of on-farm resources through recycling (Brummett, 1994). Ponds on the farm are not viewed as a stand-alone enterprise in this system but as a pivotal component in the whole farm ecosystem. This is the practice which many farmers in the southern region have adopted in their farming system which combines fish farming and other agricultural enterprises to increase the production of fish and other marketable products with minimal extra inputs.

The most common IAA systems are fish-vegetables, fish-rice and fish-livestock. IAA makes use of agricultural wastes and byproducts from the farming of livestock or the growing of crops. In this way farmers do not pay for inputs as they

use their own crop and livestock wastes, and the ponds contribute water for irrigation and fertile pond mud to fertilize adjacent gardens for growing crops and vegetables.

The adoption of IAA technologies has grown at an average annual rate of 20% in southern Malawi. IAA has significantly improved the farming systems as it is a more efficient and environmentally-sound farming practice than either conventional, traditional or estate-scale commercial food production systems. IAA farms currently produce up to six times the income generated before integration. By retaining water on the land, ponds have enabled farms to continue food production and balance their losses on seasonal croplands. Average fish productivity on these farms is over 1,500 kg ha⁻¹ yr⁻¹ compared to 900 kg ha⁻¹ yr⁻¹ for non-integrated farms.

Cultured Species

- Barbus paludinosus*
- Clarias gariepinus*
- Cyprinus carpio*
- Oreochromis karongae*
- Oreochromis shiranus*
- Tilapia rendalli*

Description

Fish Production Systems

Ponds are normally used for the production of fish in the IAA systems alongside crops such as banana, maize, rice and vegetables (cabbage, rape and tomato), and livestock such as cattle, goats, pigs and scavenging chickens or ducks. In southern Malawi the pond sizes range from less than 100 to 2,000 m² with an average pond size of 250 m² and an average pond depth of 0.7-1.5 m. The recommended minimum pond size is 450 m² and most farmers are expanding their ponds to attain this minimum pond size. Fish are cultured throughout the year and the ponds are harvested every 6-12 months. The common practice among farmers is a polyculture of indigenous tilapia species (*Oreochromis shiranus* and *Tilapia rendalli*). Masuda et al (2004) reported that 70% of the fish farmers in southern Malawi use these two species on their farms. Other species raised by the farmers include *Barbus paludinosus*, *Clarias gariepinus* and *Oreochromis karongae*. Fish production ranges from 900 to 4,000 kg ha⁻¹ yr⁻¹ with an average production of 1,200 kg ha⁻¹ yr⁻¹ (Hecht and Maluwa, 2004).

Pond Inputs

The use of locally available resources is encouraged among farmers. Most use on-farm resources as pond inputs in the IAA systems. Usually farmers use animal manure and submerged compost pits in ponds to enhance the primary productivity of the ponds. The use of inorganic fertilisers in ponds is practiced by few farmers due to limited financial resources to purchase them.

The most commonly used animal manures are cattle, chicken, goat and pig manures. The manure is applied at an initial application rate of 100 g m⁻², in most cases on a monthly basis, with subsequent applications depending on water colour. Green manure (grass and weeds) and compost are also used by farmers. Farmers are also adopting the use of nitrogen-rich leaves from agroforestry trees such as *Glyricidia* as a pond fertilizer.

Maize bran is used by over 90% of the farmers as fish feed, other feeds including grass, left-over homestead food, termite ants and vegetable leaves.

Stocking Density and Harvesting

Mixed-sex fingerlings (average body weight of 5 g and total length of 60 mm) are stocked at about 2-3 fish m⁻² in the polyculture production systems. Prolific breeding occurs leading to severe stunted growth of stocked fish. Some farmers introduce the African catfish (*Clarias gariepinus*) to control the tilapia population. The production when farmers use a combination of tilapia and catfish is generally higher than tilapia alone. After a culture period varying from 6 to 12 months, farmers usually use partial harvesting techniques such as hook and line, nets and traps to harvest fish. When total harvesting is done it is achieved through netting or breaking the pond dyke, all fish are harvested, except fingerlings retained for restocking.

Fingerlings

Prior to 1990, farmers used to rely heavily on government hatcheries for the provision of tilapia fingerlings but recently there has been an increasing number of progressive fish farmers who rely on their own seed for pond stocking and have surplus for sale to other farmers. For catfish, the government is the sole producer of the seed through induced spawning. However, farmers and researchers are in the process of developing technologies for the production of catfish fingerlings using natural spawning methods, with impressive progress.

Linkages within IAA Systems

There are myriad linkages within the IAA system and some are outlined below:

- Some farmers have livestock such as cattle, goats, pigs and scavenging chickens or ducks. These animals provide manure which is used to fertilize the ponds to boost pond productivity. Some of the manure is used for the production of field crops like maize and vegetables.
- Agricultural byproducts and wastes produced from field crops, such as maize bran and rice bran, provide a good supplementary feed, which most farmers use to feed fish.
- Leaves of vegetables and some agroforestry trees are used to feed herbivorous fish or as green manure for compost pits.
- Ponds are usually drained every 2 years with the pond mud removed and used as a basal dressing fertilizer to produce maize and/or to provide nutrient-rich soil to cultivate vegetables.
- Ponds provide water with a wide range of uses, including domestic use and the irrigation of crops.

Research Development

The development and dissemination of IAA technologies in southern Malawi is promoted through Farmer Scientist Research Partnerships using a model known as Participatory Aquaculture Research and Extension (PARE). In this approach, outreach teams known as Research Extension Teams (RETs) are formed. These comprise extensionists, farmers and researchers who are responsible for fostering the development and dissemination of IAA technologies through on-farm experimentation and extension. The impact of the partnership has been manifested in the increase in farm experimentation of different aquaculture technologies in which farmers take a lead in designing, planning, execution and monitoring of the experiments (Brummett and Noble, 1995b).

Participatory Aquaculture Research and Extension

PARE is an evolutionary approach. In Malawi it has been found that the mobilisation of farmers in a community is an important initial step for wider adoption and sustainability of activities. This involves organization of village meetings, explanation of the idea and the task to the farmers and discussion of the issue. Local leaders are always involved. Groups of farmers have also been found to be useful to understand how rural communities classify their local resource system. Thus, groups provide a better setting than individual encounters as they allow wider discussion and consensus on the indigenous categorization of their local resources. To facilitate farmer mobilisation, there has been an increase in participation of NGOs, community-based organizations (CBOs) and village chiefs. The PARE approach empowers farmers to the extent that they have control over both the process of technology development and the technologies developed.

Impact of the PARE Approach: The Case of Mr. Chitonya

Fish production has generally improved among farmers in the course of implementing IAA. Mr. Chitonya started fish farming in the early 1970s, rearing exotic common carp (*Cyprinus carpio*) and tilapias, and benefiting from a top-down approach by researchers and extension staff from the Department of Fisheries (DoF). "I never reared fish for money or food until 1998. I just liked looking at the fish every morning without even knowing the species I was keeping", he says.

During the late 1980s, Malawi banned the use of common carp in fish farming due to biodiversity concerns. Between 1990 and 1997, Mr. Chitonya raised tilapias to a marketable weight of 60 g, with yields averaging 1,500 kg ha⁻¹ yr⁻¹ after 6 months of production. In 1998, Mr. Chitonya became one of the pioneers to collaborate with RETs in technology development and transfer. He then started taking IAA production seriously for both food and income. Average fish weights at harvest and yields have increased to 130 g and 4,000 kg ha⁻¹ yr⁻¹, respectively, as a result of the adoption of better pond management. He now cherishes a large, beautiful house which he says is a manifestation of the profits he is

making from IAA production.

IAA Production through the PARE Approach

The RET approach has been found to be a valuable tool to empower farmers to innovate and solve production bottlenecks on their own. For example, collaborating farmers in Mwanza district have, on their own, included new cyprinid species into the tilapia-based polyculture systems. These species include two cyprinids, *Barbus* sp. and *Labeo* sp. Farmers have identified these species as having high local demand.

According to the farmers, *Barbus* commands a higher market price than *O. shiranus*. The small size of the fish also makes it easier to share among household members. Another initiative is farmer-to-farmer fingerling exchange as a means of reducing inbreeding and maintaining high growth rate traits in the cultured tilapias.

There has been an increase in farmer experimentation with new feeds to replace maize bran (the feed recommended by the DoF in Malawi and used by more than 90% of farmers). For example, in Mulanje district in southern Malawi, farmers use cassava peels (farmer-generated technology) as an alternative to maize bran. Maize bran was recommended as a fish feed input in Malawi without recognizing the differences in cropping patterns within the country. Cassava and not maize is the major food crop in Mulanje so farmers do not have adequate supplies of maize bran for fish feeding. On-farm research to validate and further improve the use of cassava peels indicated no significant differences in terms of yield per ha between maize bran (3,000 kg ha⁻¹ yr⁻¹) and cassava peel (3,120 kg ha⁻¹ yr⁻¹). Similar activities have been adopted in Mchinji district in central Malawi where farmers belonging to a CBO Village Initiative for Food Security and Development (Vifod) came up with a demonstration on predation control using the fence system. These farmers also disseminated the technology through an open day attended by 40 farmers from 10 villages. One of the farmers achieved 2,888 kg ha⁻¹ of fish after 6 months of production. The farmers attributed this high yield to the high survival rate of the fish due to the fence constructed around the pond to control predation.

IAA has also increased crop production. Results from various evaluations (Brummett and Noble, 1995a) have generally indicated that the level of integration of different enterprises is in general increasing among farmers. Most participating farmers have increased the production of other crops adjacent to fish ponds using pond water either directly or utilising the effect of seepage to provide moisture for growing other crops. Such crops include beans, maize, rice and vegetables. In Zomba, for example, some farmers obtain maize yields as high as 6,000 kg ha⁻¹ from such areas, higher than average yields of 1,666 kg ha⁻¹. This contribution is significant for the rural poor in Malawi where maize supplies last for about 7 months.

Production Sustainability with IAA

Diversity, recycling, economic efficiency and capacity (productivity) of the farm are the main sustainability indicators used to evaluate farming system performance in the PARE process. Diversity refers to the number of enterprises that the integrated farm can sustain. Recycling refers to the use and/or reuse of on-farm organic resources. Economic efficiency (cost/benefit analysis) refers to the farmers' ability to generate cash income to support on-farm and off-farm activities. Capacity refers to the potential increase in farm productivity or individual enterprise productivity. Farmers collaborating with RETs have also shown improvements in the above sustainability indicators.

Analysis by Dey et al. (2004) for 12 farmers in Zomba indicated that the capacity of natural resource types increased by the end of the 4-year data collection period. During the first growing season, the biomass produced was 0.42 t ha⁻¹. Three years later this sustainability indicator amounted to 1.23 t ha⁻¹. Species diversity exhibited the same pattern as it increased from 18 to 22. The recycling of biological resources also increased from 8.25 to 15.50 flows. The economic efficiency increased from 1.62 to 3.42.

Dissemination of IAA Technologies

Farmer Exchange Visit

To facilitate and encourage farmer-to-farmer technology transfer, inter- and intra- farmer-to-farmer visits are organised by the WorldFish Center in collaboration with other stakeholders (NGOs, the DoF in Malawi and Zambia). These visits provide farmers with an opportunity to learn from each other by observing realistic and working technologies to boost crop, fish and livestock production. Studies by Baker 2003 indicate that small-scale aquaculture technologies are being passed along more by farmer-to-farmer dissemination (71% of respondents) than by extension-to-farmer transmission (29% of respondents).

The main technologies passed from farmer-to-farmer are fingerling production, fish selection, IAA, pond construction

and pond management. Data regarding the quality of messages transmitted by the farmer-to-farmer pathway is still inconclusive. In Malawi the capacity of farmer-to-farmer dissemination of technologies has been strengthened by the use of trained contact farmers. Two contact farmers in Mchinji district have mobilised farmers in 10 villages. In addition to facilitating technology development, the two contact farmers are responsible for outreach programmes in the area. Another contact farmer in Thyolo district in southern Malawi has formed his own farmers' group consisting of 50 farmers in which he is responsible for training, the supply of fingerlings and technology development.

Open Days and Agriculture Shows

At the end of each trial, farmers from different areas are invited to open days that are either held on-farm or on-station. At the open days RETs present the whole process of identifying a problem on-farm and the setting of trials. This is backed by farmers' presentation of the process. Discussions are heard after each open day regarding the technology. These open days bring both technicians and farmers together to share practical experiences and decide on other modifications to technologies, should the technologies being tried require such action.

Stakeholders' Workshops

Stakeholders' workshops are organised to review progress in scaling up and institutionalising PARE in government and NGO sectors. Specific objectives of these workshops include:

- Review of institutional and technical challenges facing the implementation of the participatory approach by government and NGO stakeholders.
- Evaluation of the impact of participatory methodologies in the development and dissemination of IAA technologies.
- Review of the Draft Policy Guidelines for PARE.
- Development of a common vision among stakeholders on the role of the participatory approach in accelerating the development of aquaculture.

Future Trends

NGOs are becoming a major driving force in facilitating the adoption of IAA and provision of extension support to new farmers. The market is also starting to emerge as one of the main drivers of aquaculture adoption and intensification of production by successful farmers. *O. karongae* with late maturity and high market value in urban markets is increasingly being adopted by farmers targeting these markets and will possibly become a species of choice for the market-oriented IAA farmers in the near future.

Ecosystems

Ecosystem

[Field crops and vegetables](#)

[Lowlands](#)

[Reservoirs](#)

[Rural areas](#)

Organisations

Organisation

WorldFish Center, Malawi
PO Box 229, Zomba Zomba, Malawi

www.worldfishcenter.org

National Aquaculture Centre (NAC)
Box 44, Domasi Domasi, Malawi

nac@sdpn.org.mw

JICA-NAC project

Box 1365, Zomba Zomba, Malawi

World Vision International
Box 650, Zomba Zomba, Malawi

www.worldvision.org

Growout Systems in this Ecosystem

Growout System

Enclosed systems : Ponds

Issues

- Agriculture and animal husbandry
- Aquaculture systems: technology and its management
- Culture technology
- Extension
- Extension: training
- Feed wastes and byproducts
- Feeds
- Fertilizers
- Food security
- Growout management
- Harvesting strategies
- Institutions and governance
- Integrated agriculture aquaculture systems (IAAS)
- Integrated systems
- Livelihood issues in sustainable social development
- Monoculture/polyculture
- Natural food sources
- Participatory approach to R&D
- Production systems, best management practice, social aspects, economic/financial aspects
- Research
- Research and development
- Scientific versus local or indigenous knowledge
- Seed
- Single/multiple harvesting
- Single/multiple stocking
- Social issues in sustainability
- Species availability and seed supply
- Stocking strategies
- Success in research and development
- Suitability for use in integrated systems
- Sustainable development
- Sustainable economic development
- Water sources and irrigation

Countries

Africa[Malawi](#)**Authors****Main Author**

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