No. 1

Japan International Cooperation Agency

Republic of Malawi
Ministry of Mines, Natural Resources and Environment
Department of Fisheries

Master Plan Study on Aquaculture Development in Malawi

Main Report

National Aquaculture Strategic Plan (NASP) 2006-2015

July 2005

SSC System Science Consultants Inc.

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Japan International Cooperation Agency

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National Aquaculture Strategic Plan (NASP) 2006-2015

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Master Plan Study Outputs

The outputs of "the Master Plan Study on Aquaculture Development in Malawi" consists of the following,

1. Summary (Japanese version)
2. Main Report -National Aquaculture Strategic Plan (NASP) 2006-2015-
3. ADiM Working papers
4. Aquaculture database (CD1 and 2)
5. NASP profile
6. Photograph collection

Preface

In response to a request from the Government of Malawi, the Government of Japan decided to conduct the Master Plan Study on Aquaculture Development in Malawi and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. YAMAMOTO Sachio of System Science Consultants Inc. and consists of System Science Consultants Inc. between January 2003 and June 2005.

The team held discussions with the officials concerned of the Government of Malawi and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Malawi for their close cooperation extended to the study.

July 2005

KITAHARA Etsuo
Vice President
Japan International Cooperation Agency

July 2005

Ms. Sadako OGATA
The President of
Japan International Cooperation Agency
Tokyo, JAPAN

Letter of Transmittal

Dear Madam,

We are pleased to submit to you the report for "The Master Plan Study on Aquaculture Development in Malawi". This report presents the result of all work performed in both Malawi and Japan over 32 month period from January 2003 to August 2005.

In Malawi, over 60 percent of the peoples are living under the poverty lines and most of them are rural farmers. The aquaculture sector has large potential to contribute to the life of these peoples through diversifying farm production and generating incomes. Regarding to food security, production from fish farming a still small but significant importance in supply of animal protein to the people complementing capture fisheries that can not satisfy the fish demands near future. This Plan provided aquaculture development strategies and action plan as a road map of the sector. Implementation of the Action Plan will contribute to reduce the poverty and hunger through the improvement of the food security and livelihood of rural community.

We wish to express our deep appreciation and sincere gratitude to the officials concerned of your Agency, the Ministry of Foreign Affairs, and the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan for the courtesies and cooperation kindly extended to our team. We additionally inform you that we had sincere cooperation from our counterparts of the Department of Fisheries, the Ministry of Mines, Natural Resources and Environment of the Government of Malawi. The opportunity to work with farmers and dedicated efforts of all concerned, particularly Bunda College of University of Malawi, World Vision Malawi, who were our important partner, are also gratefully acknowledged. We also express our hearty gratitude to the officials concerned from JICA Malawi Office, the Embassy of Japan in Zambia for the close cooperation and various form of assistance extended to our team during field investigations and studies in Malawi.

Very truly yours,

YAMAMOTO Sachio
Project Manager
Master Plan Study on Aquaculture Development in Malawi
System Science Consultants Inc.

Map of Malawi

Photographs 1 - Fishes of Malawi -

Cultured Fish Species 1

Two indigenous tilapiine species, *O. shiranus* (left) and *T.rendalli* (right) are the predominant aquaculture species in Malawi. The species are well adapted for pond conditions. Because of inadequate nutrition, their growth is slow and productivity remains low.

Oreochromis shiranus

Tilapia rendalli

Cultured Fish Species 2

O. karongae (left) and *Clarias* (African catfish: right) are common on the market but presently they are peripheral aquaculture species. These species grow bigger than *O. shiranus* and *T. rendalli*. Farmers are keen to culture both species but fingerlings are in short supply.

Oreochromis karongae

Clarias gariepinus

Exotic Fish Species

To protect the biodiversity of Lake Malawi, the farming of exotic fish species is prohibited. Common carp (left) was introduced in the 1970s and still remains in the country, mainly for research purpose. Nile tilapia (right) are is farmed in neighbouring countries.

Cyprinus carpio

Oreochromis niloticus

Lake Fish

The Lake Malawi fish fauna is unique and provides the bulk of animal protein consumed in Malawi. The government has initiated a programme to develop the farming technologies for indigenous species, but success has eluded the attempts so far.

***Barbus* species**

Mbuna cichlids of the Lake

Photographs 2 - The aquaculture scene -

Rural aquaculture

It is estimated that there are about 4,000 small-scale fish farmers in Malawi. A typical farmer has one or two small pond and harvests about 13 kg of fish per annum. Ponds are normally constructed by family members and sometimes with help of hired labour.

The majority of farmers use maize bran as feed and green compost for pond manuring. Partial harvesting is the norm and many farmers do not harvest their ponds on an annual basis. Only 3 % of fish farmers owned a seine net.

Nevertheless, the current outputs from fish farming form an important part of household livelihoods and provide an additional option for spreading risk and increasing the overall value of the farming system.

Fish pond

Pond-farm irrigation

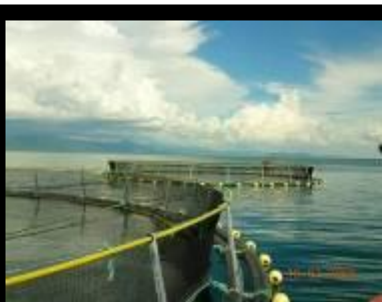
Pond Construction

Fish farmer and fish

Commercial aquaculture

Two carefully planned middle/large-scale fish farms have started in 2004, viz. Chambo cage culture in Lake Malawi (MALDECO Fish Farm) and semi-intensive pond culture in the Lower Shire valley (G.K. Aquafarm). MALDECO Fish Farm used *O. karongae* and G.K. Aquafarm use common carp and *O. mossambicus*.

Though still in the nascent phase, these farms are making excellent progress and at full-scale production will produce over 3,000 mt per annum.



Cage culture -MALDECO-

Large scale pond -Kasinthula-

Concrete fish tanks -MALDECO-

Harvesting of fish -Kasinthula-

Photographs 3 - Capture Fisheries and Marketing -

Capture Fisheries

Since 1976, the total fish supply has fluctuated between 40,000 and 76,000 mt with no definite trend. Lake Malawi is the most important contributor (57%) to the annual fish supply. Fish supply from capture fisheries was estimated at 56,000 mt in 2000. Total fish yield has remained fairly static since then and despite fish imports (1,630 mt in 2000) and a limited contribution from aquaculture sub-sector, per capita supply fell from 12.8 kg during the early 1970s to 5.8 kg in 2000.

Artisanal fisherman

Midwater trawling in the lake

Fish being dried by the Lake

Trawl vessel

Fish marketing

Processing of fish by small-sale fishers is rudimentary. Distribution and marketing of fish is complex but appears to be efficient. The bulk of the fish landed by small-scale fishermen is smoked or sun dried while the remainder is sold in fresh style. Tilapias are the most valuable fish species in Malawi and its price is sharply increasing with more than 30% growing rate. Fresh tilapia currently fetches up to MK 200 / kg (USD 2/kg) in the city market. While, small dried fishes, such as Matemba are most popular in the villages and its prices are about one-ten of tilapia

Processed fish sold at the market

Dried fish shop in a village

Smoked tilapia sold at market

Fresh tilapia at city market

Photographs 4 - Pilot Projects -

Innovative farmers approach

During the pilot project, capacity building of two different farmer groups was examined. Innovative farmers are successful farmers with innovative ideas and an entrepreneurial spirit. 25 farmers were identified for the pilot project. They were provided with intensive training, including study tours to Egypt and Zambia. After training, farmers started their own small projects on their farms. Some of these farmers are now teaching other farmers in fish farming and farm integration. The group has been formalised into the "Innovative Fish Farmers Network Trust" and this is the first officially registered fish producers' association in Malawi.

Farmer to farmer extension

Farmer's project – poultry

Study tour Worldfish Center, Egypt

Training at Bunda College

Farmers' club approach

Innovative farmers are relatively better-off, while farmer club members are resource poor. Farmer Clubs have the following advantages, i) collective resources, ii) rapid dissemination of information among members, iii) encourage one another within the club. The project identified two model farmer clubs "Mawila" and "Limbikani" in the Zomba and attempts were made to replicate them in adjacent communities. Farmers were encouraged to communicate their knowledge of composting, pond construction and management, fish feeding and manuring and irrigation techniques to other communities.

Collective club fish pond

Horticulture at club land

Club members

Water bridge built by club

Photographs 5 - The Master Plan Study Process -

Participatory planning

The NASP was drafted through a consultative process with a wide range of stakeholders and key strategic partners, including private fish farmers, academic institutions, NGOs and the Department of Fisheries. Several workshops were held at both community and national level. These workshops contributed towards the development of an understanding of the planning process, the exchange of information among different stakeholders, capacity building of farmers such that they could express their opinion to government, creating unity of the stakeholders to promote aquaculture development, etc.

Year	Month	Events
2003	January	Project started Situation analysis of aquaculture in Malawi
	March	1st National aquaculture workshop (Kick-off workshop)
	June-July	National socio-economic survey
	August	DoF high level planning meeting
	October	1st Counter part training in Japan
	December	2nd National aquaculture workshop
2004	January	Pilot project started Innovative Fish Farmers Network Trust (IFFNT) established
	June	Innovative farmer study tours: Egypt & Zambia
	July	Regional aquaculture workshop (Zambia, Tanzania, Mozambique)
	October	2nd Counterpart training
2005	February	3rd National aquaculture workshop Pilot project completed
	May	Draft final report submitted
	June	4th National aquaculture workshop with international participation
	July	3rd Counterpart training in Japan
	August	Final report submitted

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Currency

Malawi Kwacha = MK

Currency Equivalent

USD 1.00 = MK 113.00 (April, 2005)

MK 1.00 = USD 0.00885 (April, 2005)

Remarks: Currency equivalents during the last 10 years are shown in Attached Table A1
Source: OANDA (2005)

Fiscal Year of Malawi

July 1 - June 30

Abbreviations and Acronyms

ADB	African Development Bank
ADiM	Master Plan Study on Aquaculture Development in Malawi
ARTDMIS	Project on Aquaculture Research and Technical Development of Malawian Indigenous Species (JICA)
CAS	Catch Assessment Survey
CNRFFP	Central and Northern Region Fish Farming Project
CPUE	Catch Per Effort Unit
DA	District Assembly
DANIDA	Danish International Development Agency
DEC	District Executive Committee
DFID	Department for International Development, U.K.
DoF	Department of Fisheries
EIA	Environmental Impact Assessment
EPA	Extension Planning Area
EU	European Union
FAO	United Nation Food and Agriculture Organization
FCR	Food Conversion Ratio
FRU	Fisheries Research Unit
GDP	Gross Domestic Product
GNI	Gross National Income
GTZ	Gesellschaft für Technische Zusammenarbeit
HIPC	Highly Indebted Poor Countries
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
ICEDA	Icelandic International Development Agency
ICLARM	International Centre for Living Aquatic Resource Management (WorldFish Center)
IFAD	International Fund for Agricultural Development
IFFNT	Innovative Fish Farmer Network Trust
JICA	Japan International Cooperation Agency
MAGFAD	Malawi-German Fisheries and Aquaculture Development Project
MASAF	Malawi Social Action Fund
MAIFS	Ministry of Agriculture, Irrigation, and Food Security
MMNRE	Ministry of Mines, Natural Resources and Environment
MSY	Maximum Sustainable Yield
mt	metric tonnes
MTF	Malawi Traditional Fisheries
MPRSP	Malawi Poverty Reduction Strategy Paper
NAC	National Aquaculture Centre
NARMAP	National Aquatic Resource Management Programme
NASP	National Aquaculture Strategic Plan
NGO	Non-governmental Organization
NORAD	Norwegian Agency for Development Cooperation
NSO	National Statistics Office
ODA	Official Development Aid / Assistance
ODA (UK)	Overseas Development Agency, U.K.
SIDA	Swedish International Development Agency
S/W	Scope of Work
TOR	Terms of Reference
UNDP	United Nations Development Programme

General outline of the NASP

National development goal	Poverty alleviation and food security

⇩

Background for aquaculture development

Why is aquaculture important?	Aquaculture can be one of the economic activities for rural farmers which diversify source of income and contributes to the enhancement of the livelihood.	Increase in aquaculture production results in a sufficient supply of animal protein for Malawian citizens and contributes their health.	Development of commercial aquaculture provides job opportunities and active economy in rural area.	-	-
Constraints to aquaculture development	"Poor resources" · Aquaculture alone cannot improve farmer's livelihood. · The relation between aquaculture and rural farmer's livelihood is not well understood.	"Lack of policy and technologies that promote commercial aquaculture" · There is not technology that maximises productivity and profit. · The policy and the banking system which support commercial investors are weak.		"Poor service" · DoF lacks human and financial resources. · There lacks reliable information.	
Development opportunities **Lessons learned from the pilot project**	· Some NGO has know-how on integrated livelihood approach. · Due to decentralisation, it becomes easier to support cross-sectoral activities.	· Through past research on aquaculture development, there has been information/ data being accumulated. · With an initiative of the private sector, experimental trial on commercial aquaculture has been initiated.		· Through decentralisation, producer-oriented services can be further achieved. · There are producers all around Malawi with high technologies and leadership. · The producers' organisations are being organised at both central and district levels. · NGO are actively involved in aquaculture sector.	

Strategies

Customers (target group)	Small-holder farmers	Commercial fish farmers	District Assembly, NGO & Producers' organisation	Department of Fisheries (DoF)
Strategic themes	Integration of Aquaculture into Rural Livelihoods	Enhanced Economic Opportunities for Commercial Fish Farmers	Competent Local Government, NGOs and Producer's Organizations	Smart and Practical DoF

Strategy	The strategy proposes the introduction of multi-sectoral livelihood approaches. It includes utilisation of limited resources (e.g. land, water, and labour) through organising farmers into a group, training at farmers' school, research on poverty and aquaculture, etc.	The strategy aims to promote aquaculture technologies development which maximise its profit, and improve the investment environment. These include promotion of: research and technology development for commercial aquaculture; better accessibility for funds; business training; one-stop-shop for aquaculture permit; introduction of tax exemption; marketing; and environment conservation scheme. Such activities are to be carried out in collaboration with the private sector and other stakeholders.	The strategy promotes aquaculture enlightenment among district officers with appropriate information. Strengthening the relationship between NGO and DoF, and the capacity building of NGO staff on aquaculture planning and implementation are some of activities to be carried out.	The strategy promotes the establishment of the aquaculture advisory body, privatisation of underutilised government facilities, establishment of a statistical and economic analysis system.

Effects of the NASP on the national development goal

	Economic growth for poverty alleviation	Human capacity development	Relief for vulnerable groups	Good governance
Short-term	· Increase in cash income for rural farmers and improved livelihoods · Improved investment environment for commercial aquaculture	Improved nutrition status among fish farmers	Aquaculture to be a part of social safety net for women-headed families, families with orphans, and ultra-poor families	Through planning and implementing aquaculture activities, the capacity of officers at district level will further be strengthened.
Medium/ Long-term	Activated rural economy through fish sales, improved job opportunities, & development of related industries	Aquaculture to be a supplement to capture fisheries, so that enough animal protein is provided to all citizens in Malawi		

PART 1 BACKGROUND

Table 1.1 Summary of Malawi's Fisheries and Aquaculture Sectors

Country	Total area	118,900 km^2
	Population	11 millions
Main water bodies	Lake Malawi *	29,000 km^2, average depth 292 m, maximum depth 785 m, shoreline 1,500 km
	Lake Malombe	420 km^2
	Lake Chirwa	700 km^2
	Lake Chiuta **	199 km^2
	Lower Shire River	402 km
Fisheries Industry	Share of fisheries sector in GDP	n.a.
	Number of fishermen	48,000 persons
	Number of people in related business	230,000 persons
Fish production (Capture fisheries) Year 2000	Total	55,900 mt
	Lake Malawi	31,644 mt (56.6%)
	Lake Malombe	4,490 mt (8.0%)
	Lake Chirwa	-
	Lake Chiuta	-
	Lower Shire River	1,602 mt (2.9%)
Fisheries trade	Export (2000) Import (2000)	nil 1,630 mt (2,808 mt in 1999)
Fish consumption	Per capita fish supply (2000)	5.8kg
	Animal protein intake (2001) ***	3.7g
	Share of fish in animal protein (2001) ***	1.1g (29.7 %)
Prices (2000)	Tilapia (*O. karongae*)	Wholesale: USD1.8 (MK199.0) Retail: USD2.2 (MK244.9)
Aquaculture	Introduction of aquaculture	1906 (Rainbow trout) 1950s (Tilapia)
	Number of fish farmer (2002) ****	4,050 persons
	Number of fish pond (2002) ****	9,500 ponds
	Production (2002) ****	800 mt
	Productivity (2003) *****	700kg/ha/yr.
Aquaculture institutions	Number of government fisheries staff engaged in aquaculture sector	60 person (officer + technical staff)
	Number of government fish farm	13 demonstration fish farms
	Tertiary educational institution	Bunda College (BSc & MSc in aquaculture & fisheries science)
	Major NGO involved in the sector (2005)	World Vision Malawi, CARE, Oxfam, Action Aid, CARD, Concern Universal, etc.
	Major donor in the sector (2005)	JICA (Japan), ADB

Source: *Ribbink (2001); **Nyasulu (2002); ***FAO food balance sheet; ****NAC; *****ADiM National socio-economic survey (2003)

CHAPTER I STRATEGIC CONTEXT

1. Project Genesis

In 2002, the Government of Japan agreed to conduct and support the Master Plan Study on Aquaculture Development in Malawi (ADiM). The aim of the project was to develop a national strategic sector plan as a "Road Map" for future aquaculture development in Malawi. Recently, Malawian government has adopted the revised National Fisheries and Aquaculture Policy (NFAP, 2002). This aquaculture sector plan is expected as a document that promotes the implementation of the NFAP. Following the preparatory study mission (Scope of Work mission, from 9 to 17 September 2002) the Japan International Cooperation Agency (JICA), responsible for the implementation of technical cooperation programmes for the Government of Japan, selected and contracted with System Science Consultants Inc. to implement the Master Plan Study. System Science Consultants Inc. sub-contracted Enviro-Fish Africa (Pty) Ltd. to participate in the development of the Strategic Plan. The project was launched in January 2003 and a Project Coordination Committee was established within the Department of Fisheries (DoF) of the Ministry of Mines, Natural Resources and Environment. The duration of the project was 32 months.

The Project was undertaken in four stages (the planning process is described in Annex 1). Stage 1 included an analysis of present and historical data and information and undertaking a national socio-economic survey of fish farmers in the country. This provided the background to develop the NASP on the basis of past experiences, lessons and challenges. Interim strategies for aquaculture development were built during the second stage. The third stage consisted of testing the interim strategies through the pilot projects. The fourth and final stage was the development of the NASP through a consultative process with a wide range of stakeholders and key strategic partners, including private fish farmers, academic institutions, NGOs and the DoF.

This document is the Final Report, which presents the NASP and examines the “best” approaches and actions to be taken by the DoF to ensure the sustainable development and growth of small-holder and commercial aquaculture in Malawi during the next 10 years.

The Final Report consists of four parts: Part I provides the background on the importance of the aquaculture sector in Malawi and describes its salient features and considers the opportunities and challenges that face the sector. Part II presents the strategies for the future development of the sector. Parts III and IV present the proposed actions and arrangements for the implementation of the strategies.

2. Malawi’s National Development Goals

Aquaculture in MPRSP

Malawi is a small, land locked country with a total area of approximately 118,900 km^2 and is one of the world’s poorest countries. The lakes of Malawi comprise a total surface area of 23,900 km^2. Poverty is widespread and deep, and this is reflected by poor social and economic indicators. In 2003, the per capita GNI (Gross National Income) was USD 160 per year, which is approximately half of the regional average, and 65% of Malawians live below the poverty line (NSO, 2002). Although infant and under-five mortality rates have declined since 1980, it is still higher than the averages for other Sub-Saharan African countries. Similarly, the HIV/AIDS epidemic is serious and 14.2% of the 15-49 age group is infected with HIV. Life expectancy has declined from 44 years in 1980 to 37.5 in 2003 and food insecurity remains widespread (World Bank, 2005). 70% of the population are subsistence farmers. However, their food sufficiency is approximately 70%. Malawi experiences chronic seasonal food shortages and is a net importer of food. In 2004, Malawi was ranked 165th out of 177 countries with a Human Development Index value of 0.388 (UNDP, 2004).

Poverty reduction and economic development are the overall national goals of Malawi. In 2001 the Government adopted the Malawi Poverty Reduction Strategy Paper (MPRSP). The MPRSP provides the broad guidelines to achieve the national strategic goals of economic and social development. The strategy is built around four pillars: (i) sustainable pro-poor growth, (ii) human capital development, (iii) improving the quality of life of the most vulnerable, and (iv) good governance. HIV/AIDS, gender as well as science and technology are cross-cutting issues of all strategies outlined in the MPRSP. The opportunities of aquaculture sector are spell out in this MPRSP as a part of strategies that aim at increasing sustainable utilisation of fisheries resources.

Table 1.2 Malawi basic data

	Figure (year)	Others
Population		
Population (millions)	11.0 (2003)**	
Population growth (annual, %)	2.0 (2003)**	May decline to 1.7% by 2010 because of HIV/AIDS
Rural Population (% of total population)	84.9 (2001)	
Population density (people / km^2)	105 (1998)*	
Economy and Finance		
GDP growth rate (constant, %)	0.7 (2001-03)	MPRSP target 3.0%
GNI per capita, Atlas method (current USD)	160 (2003)**	
Real interest rate (%)	23.9 (2001)	
Agriculture, value added (% of GDP)	38.4 (2003)**	
Industry, value added (% of GDP)	14.9 (2003)**	
Services, value added (% of GDP)	46.7 (2003)**	
Imports of goods and services (% of GDP)	40.6 (2003)**	
Export of goods and services (% of GDP)	27.5 (2003)**	
Total debt service (% of export good & services)	7.7 (2003)**	
Net ODA (USD, 2001-03 average)	426.3	Bilateral share (gross ODA): 55%
Aid per capita (current USD)	45.4 (2003)**	
Net ODA per GNI (%, 2001-03 average)	24.7	
Health and Education		
Life expectancy at birth (years)	37.5 (2003)**	Decreased from 44 in1992
Under 5 mortality (/'000)	178 (2003)**	220 (1992)
Fertility rate (births per woman)	6.0 (2003)**	
Malnutrition children (low height at age, %)	49.0 (2000)	No improvement from 48.7 (1992)
HIV infection (% of population aged 15-49)	14.2 (2003)**	Sub-Saharan Africa: 8.6%
Illiteracy rate, adult total (% of age 15 & above)	46 (2000)	40 (1992)

Source: World Bank, 2003; *National Statistics Office report, 2004; **World Development Indicators database, 2005

Aquaculture in National Fisheries Policy

Reflecting MPRSP, the National Fisheries and Aquaculture Policy has adopted vision and mission statement for the DoF as well as its new objectives for aquaculture sub-sector as follows;

<u>Vision</u>: To be a dynamic, high performance, consultative and client focused that promotes, builds

and ensures sustainable development, utilization and management of the fisheries resources of Malawi.

Mission: To provide framework condition and excellent services for maximization of socio-economic benefit through sustainable utilization and management of capture fisheries and increased aquaculture production.

Objectives of Aquaculture: The overall policy goal of fish farming is to improve fish supply in Malawi. To achieve this goal, the policy guides specific objectives as follows;

- To solve problems related to fish farming and management of small water bodies through biological research,
- To develop adoptive/appropriate recommendations for fish farming, and
- To encourage farmers to adopt fish farming as a source of subsistence and income.

3. Why is Aquaculture Important?

Despite the progress made in economic reforms under the MPRSP, the levels of poverty have largely remained unchanged. Agriculture has been stagnant, and poor farmers continue to generate insufficient income and their nutritional status has continued to decline since the 1970s. The current conditions lack the decisive means for economic growth in traditional production systems. Consequently, the need for diversification of economic activities at household, and indeed the national level, has become pivotal for economic growth. Small-holder fish farming can play an important complementary role to improve income generation and food security and the commercial aquaculture sector can contribute towards economic growth and the creation of wealth.

Aquaculture- an alternative production opportunity for the poor

In Malawi, 65 % of the population live below the poverty line and 85% of the poor live in rural areas and depend on agriculture for their livelihood (NSO, 2002). **Improving farm income levels of the rural population is a precondition for poverty reduction in Malawi.**

Malawi has focussed on four main pro-poor development strategies (Ellis *et al*., 2002); (i) Increased maize production through modernisation (e.g. hybrid maize, fertiliser, irrigation), (ii) Improved food security by diversifying food crops, especially drought resistant crops such as cassava, sweet potatoes, beans and ground nuts, (iii) Increased reliance on cash crops for income generation to improve food security and (iv) Increased emphasis on non-farm activities to diversify options and sources of income. Adoption of these strategies varies regionally and within the socio-economic context of the farmers. For example, hybrid maize production cannot solve the food supply problem of small-holders with less than 0.5ha of land; at best it can provide food for an additional 2-3 months in comparison to traditional varieties (World Bank, 1995). Food security gaps persist at the household level and must be addressed through alternative measures. There have been notable increases in the production of cassava, sweet potatoes and other alternative food crops. However, these are low-value products and cannot act as an engine to drive the rural economy. **Farmers need alternative opportunities for income generation.**

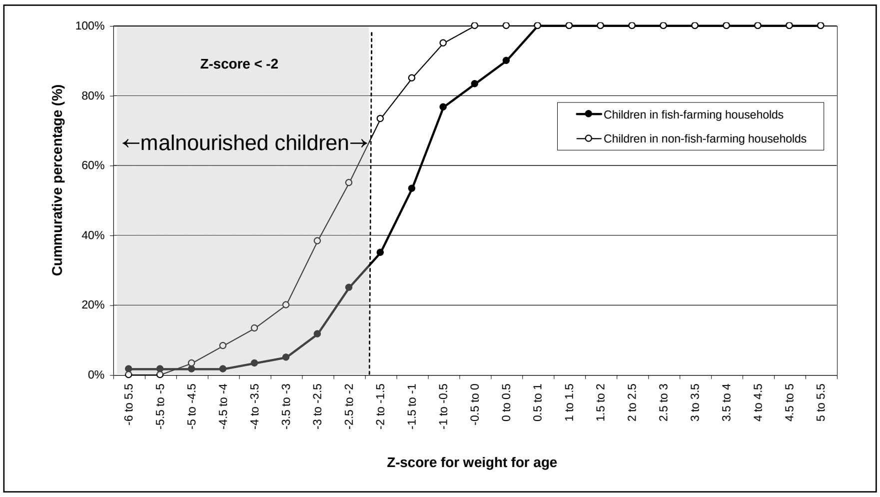
There are several reasons why aquaculture can contribute towards income generation and food security at household level.

Fish has several major advantages over other cash crops. Fish is a high value product (USD1.5 to USD2/kg), there is a ready market for fish in rural, peri-urban and urban areas, there is an increasing demand for fish, production can be scheduled to provide fish all year round (refer to Attached Table A2). The majority of small-holder farmers are net purchasers of food. Moreover, the price of cash crops fluctuates widely because of the highly seasonal nature of supply and demand. This has a serious impact on disposable income and food security during the year. Because fish production can be scheduled, aquaculture provides an opportunity for improved household food security and income generation.

Aquaculture promotes better utilisation of available land. Many fish ponds are constructed around, or in close proximity to seasonal wetlands ("Dambos") on under-utilised land. For many land-limited farmers, intensification of land use could be the most important strategy to increase production. A total of 35,000 ha of underutilised Dambo land has been identified in Malawi for small-scale irrigation (World Bank, 2004). The integration of aquaculture and irrigation can lead to significantly higher levels of production.

Aquaculture is a good entry-point for diversification of income generating activities. In the context of the rural poor, aquaculture is capital intensive. Nevertheless, depending on the investment capacity of the farmer some quantity of fish can be produced, once a pond has been constructed, and this may be less risky than other activities. Small-holder aquaculture in Malawi is almost entirely integrated into the agricultural system, and is more closely related to farming (seed/ fingerling production, fertilisation, disease and pest/ predator control, etc. in a managed environment) than to fishing. The synergies between farming and aquaculture provides opportunity for entrepreneurial farmers to adopt fish farming as an additional income generating activity.

Aquaculture stabilizes the livelihood of poor and improves their nutritional status. Many of fish farmers benefit from the direct contribution of fish through having food for home consumption in addition to cash income from the sales of fish. In the Pilot Project baseline survey, average annual cash income for fish farming was MK 1,706 (9.7% of total annual cash income) for those who are engaged in aquaculture (Attached Table A3). Figure 1.1 shows the comparison of nutritional status between two groups of children in rural area. One is from the households having fishponds and another from ordinary households. In this study, it clearly indicates that children of fish farming household have better nutritional status compare to others. Incidence of stunting (children more than two standard deviations below the median height for age of referenced population) among children under five year old is 30% in fish farming households and 70% in non-fish farming households.



Data: Data were obtained from 60 randomly chosen children (under 5 years old) from farmers' household in Zomba District
Source: JICA Study Team (2003-2005)

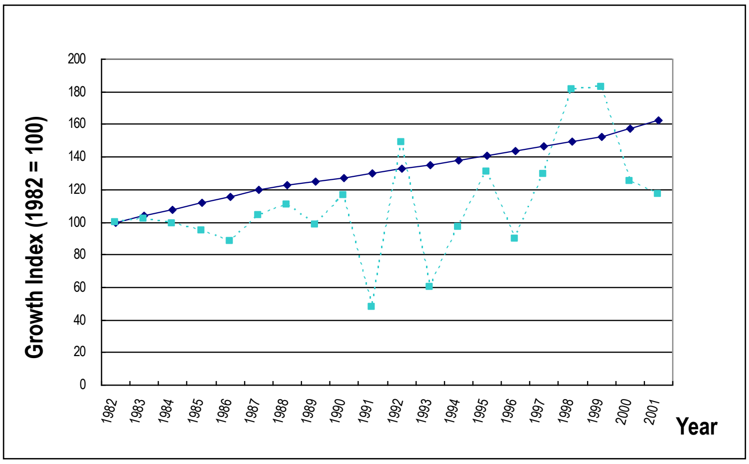
Figure 1.1 Comparison on nutrition status between children in fish farming households and children from non-fish farming households

If fish farmer is poor, fishponds may play more variety of roles in their livelihood. These are, apart from the roles as cash incomes and food source as already mentioned above, as kind of bank in other words "living-stock", or the fish distributed fro the harvest to neighbours and relatives may strengthen their social relationships, and these are all very important to resist the external shocks for the poor.

Box 1 The Main Features of Agriculture in Malawi

Agriculture is the most important economic sector in Malawi and accounts for over 36% of GDP, and a large proportion of the population is directly or indirectly dependent on agriculture for their livelihoods. Thus, agriculture-led development is a pivotal part of the national poverty reduction strategy and the growth of agri-businesses in Malawi. However, growth in agricultural output over the past 30 years has been disappointing. Agricultural production indicators demonstrate that per capita production has fallen from 290.9kg/year to 141.5kg/year between 1971 and 2002 (FAO, 2005).

Small-holder farmers dominate the agricultural sector, occupy 76% of land area and account for 68% of the agriculture workforce. The small-holder farming system can typically be described as "low input - low output". The principal farming implement is a hoe and there is limited use of fertiliser. There is a very high dependency on maize with a limited measure of intercropping or crop rotation. Rainfall is relatively high but is concentrated over a four-month period (Attached Figure A1). Yields vary according to rainfall and there have been several severe droughts and floods in the last decade, which have severely impacted agriculture production. Over 70% of farmers cannot produce enough food for home consumption and are net purchasers of food (World Bank, 2004). Severe food shortages often occur in January and February, just before the harvest season (refer to Attached Figure A2). Livestock ownership is generally low with a small minority of farmers owning large or medium stock units. 23.8% farmers own some kinds of livestock and chickens are most popular, yet not all households own them (44.7%). Overall livestock rearing generates annual cash income of USD8.46 in 1998 which is lower than the cash income generated by fish farming (Attached Table A3 and A4). Moreover, the increase in national maize production (dotted line) in most years during the period 1982 to 2001 was lower than population growth (solid line in the figure below). Poverty in Malawi may therefore have worsened over the past two decades largely on account of poor agricultural yields.



Source: MAIFS statistics (2003)

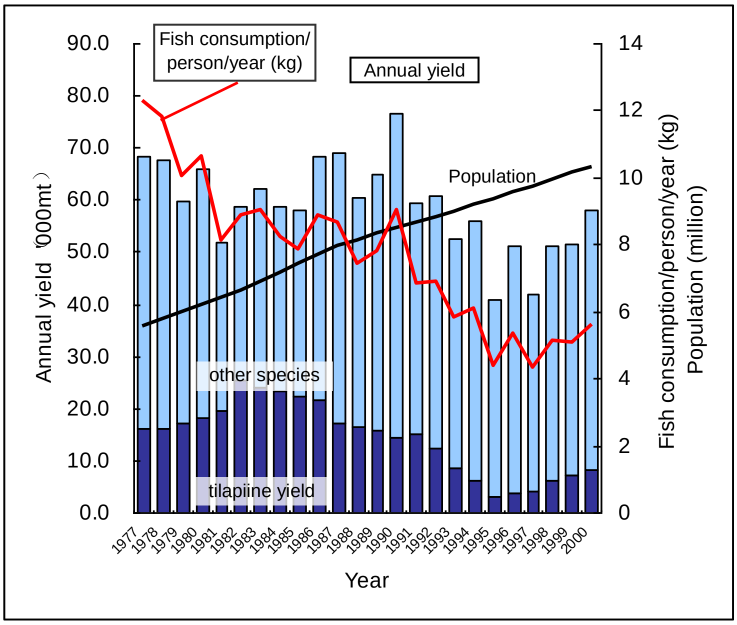
Population growth and maize production 1982-2001

Capture fishery cannot meet future demand

Adequate nutrition strengthens the ability of an individual to become more productive. In Malawi, the nutritional status of the population has been deteriorating since the 1970s. Food intake has declined by 10% from 2,417 calories in 1971 to 2,168 calories in 2001 and animal protein intake has fallen by 40%, from 6.6g per day in 1971 to 3.7g in 2001 (FAO, 2005) (Attached Table A5). As a consequence, approximately 25% of children under the age of 5 years presently suffer from chronic malnutrition. Improving the nutritional status of its people is a fundamental challenge facing the Government of Malawi.

The decline in animal protein intake is directly related to fish supply, which cannot match the population growth rate. Traditionally, fish has been the main source of animal protein, accounting for approximately 60% of total supply. Per capita supply has declined from 12.8 kg during the early 1970s to 5.8 kg at present (ADiM Working Paper No. 1). In poorer family, the dependence on fish for the animal protein is higher than that of wealthier family. At the same time, the poorer family share higher percentage of their income for fish than the wealthier family (Attached Table A6). This fact suggests the important role that fish plays especially in poor family households. **Unless adequately managed the current fisheries are unsustainable and fish intake will decline further.**

Under the present population growth rate of 2% per annum, the fisheries, even if managed on a sustainable basis, will not be able to supply future demand. The decline of CPUE is observed at various fishing grounds (Attached Figure A3). The decline is especially prominent in tilapiine stocks (Attached Table A7). The total potential yield from the capture fisheries in Malawi is estimated at 78,000 mt (Attached Table A8). This leaves a deficit of 17,000 mt, to maintain the per capita fish supply of 5.8 kg of 2000 in 2025. The demand gap would have to be met by importation or by other means (ADiM Working Paper No. 1). However, access to imported fish may struggle in future as diminishing world fish supplies may elevate market prices above Malawi's purchasing power. **This deficit clearly illustrates the need to strongly support and aggressively promote the development of the aquaculture sector in Malawi in an appropriate manner.**

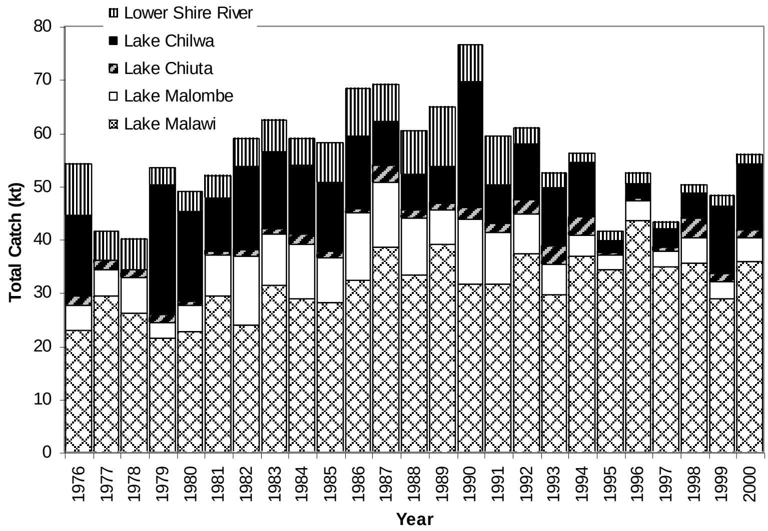


Source: Compiled by JICA Study Team (2003-2005)

Figure 1.2 Total annual fish yield in Malawi 1977-2000 and per capita fish consumption

Box 2 The Main Features of Malawi's Capture Fisheries Sector

The water bodies of Malawi, which cover 20% of the surface area, are vital resources. The main water bodies are lakes Malawi, Malombe, Chilwa and Chiuta, the upper Shire river and the lower Shire Floodplain. The overall national fish supply from these water bodies is illustrated in the figure below. Since 1976, the total fish supply has fluctuated between 40,000 mt and 76,000 mt with no definite trend. Lake Malawi is the most important contributor (57%) to the annual fish supply. Fish supply from these waters was estimated at 56,000 metric tonnes in 2000 (Attached Table A9). Total fish yield has remained fairly static since then and despite fish imports (1,630 mt in 2000) and a limited contribution from aquaculture, per capita supply fell from 12.8kg during the early 1970s to 5.8kg in 2000.



Source: ADiM Working Paper No. 1

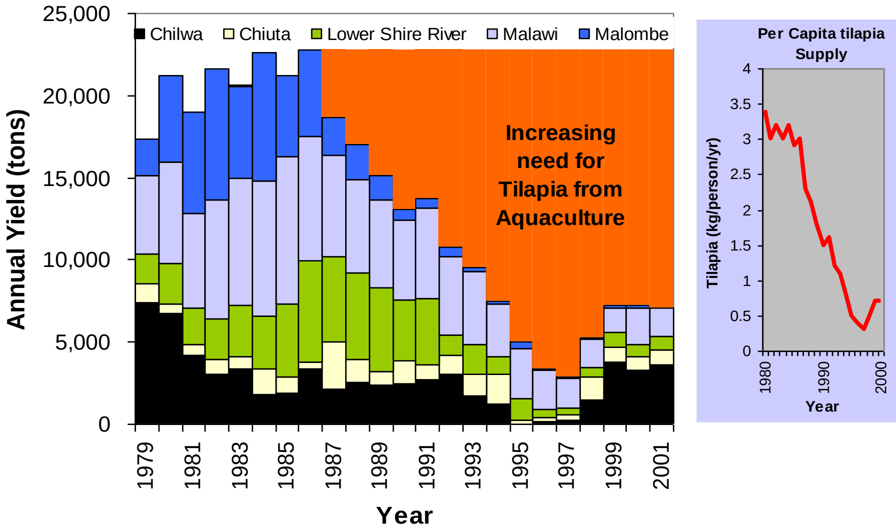
Fish yield by water body 1976 to 2000

The fisheries provide a source of direct (48,000 people) and indirect (230,000 people) employment. The sector is highly diverse ranging from large stern trawlers to hook and line fishing from the shore. Small-scale commercial fishers, who are either self employed or employed by boat owners, dominate the fisheries. Small-scale commercial fisheries contribute approximately 87% to the total fish landings and uses a highly diverse assemblage of gear including beach and open water seines, gill-nets, fish traps and hooks.

Future yields from the capture fisheries can only be increased if current fisheries are managed on a sustainable basis and by harvesting underexploited or unexploited deepwater pelagic and demersal stocks in Lake Malawi. The total future potential yield has been estimated at 78,000 mt, of which some 58,000 mt would be from Lake Malawi. The total potential yield from deepwater stocks in Lake Malawi has been estimated at 43,000 mt. Malawi is however only one of the riparian states and would have to share the resources with Mozambique. Malawi is currently planning a project (supported by the African Development Bank) to increase production from the pelagic zone of Lake Malawi by 11,000 mt. While technologies exist for the harvesting of deepwater fishes, the exploitation of these stocks in Malawi is however constrained by a number of physical, technical and economic factors and it is highly unlikely that these resources would be fully exploited in the medium term. At best, it should be considered as a long-term objective (ADiM Working Paper No. 1).

Commercial aquaculture – an opportunity for the creation of wealth and enhancing the rural cash economy

The species composition of Malawi's capture fisheries has changed with major declines in the catches of the more valuable tilapiine species. The per kg beach price of tilapiine fishes is up to 400% higher than for other species. The decline of the tilapiine fishery has therefore resulted in highly significant economic losses (ADiM Working Paper No. 1). Figure 1.3 illustrates the decline in the tilappiine catch from 23,000 mt in 1984 to 7,000 mt in 2001 and the extreme decline in the per capita supply. **This leaves a deficit of 16,000 mt, and illustrates a major market opportunity for tilapiine aquaculture.**

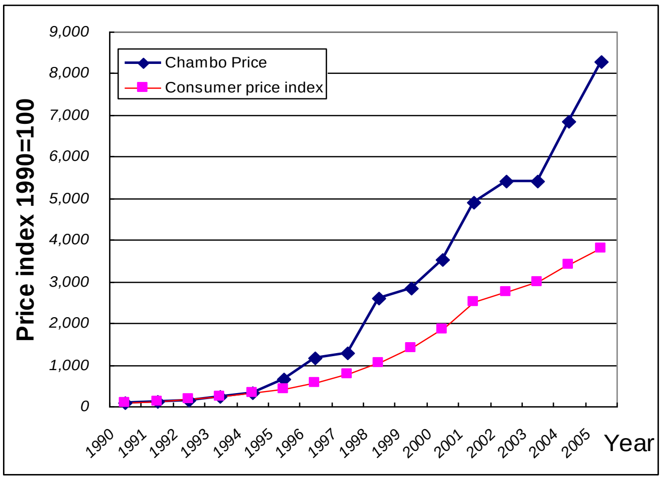


Source: Compiled by JICA ADiM Study Team (2003-2005)

Figure 1.3 Total tilapiine yield from major fisheries in Malawi 1979-2001 and per capita tilapia supply showing the increasing need for tilapia produced by aquaculture

The rapidly escalating price of fish is another factor that improve the climate for investment in medium to large-scale commercial fish farming in Malawi (Figure 1.4). Up to the end of 2002 the calculated return on investment was too low for investors to show any real interest in aquaculture. Since then the situation has changed dramatically and this is reflected by the current surge in interest by both small, medium and large-scale investors.

In environmentally suitable areas and districts, aquaculture has the potential to become an important contributor to the local cash economy. The establishment of a nucleus of successful fish farms will unquestionably unlock the entrepreneurial capacity of many farmers, which in turn would lead to greater earning and spending power, employment opportunities and the creation of wealth.



Source: Fish =MALDECO retail price;
Consumer price inflation =World Bank (2004) and EIU (2004)

Figure 1.4 Price trend of tilapia 1990-2005 (retail price)

CHAPTER II OVERVIEW OF AQUACULTURE IN MALAWI

1. History of Aquaculture

According to Meecham (1976), aquaculture in Malawi began in 1906, when rainbow trout (*Onchorhynchus mykiss*) was first introduced into the Mulunguzi Stream on the Zomba Plateau. Tilapia culture started in the mid 20th century with the building of several "coarse fish" ponds at Tipwiri, Nchenanchena, which where stocked with *Oreochromis shiranus* and *Tilapia rendalli* from Lake Malawi. By 1958, there were 52 ponds with a combined area of 5.9 ha and a total production of around 1,000kg.

Since the late 1960s, Malawi has made a concerted effort to develop small-holder and commercial aquaculture. During the period 1970 to 2002, Malawi has received substantial support through the FAO, ODA (UK), Malawi-German Fisheries and Aquaculture Development Project: MAGFAD (GTZ/ICLARM), the National Aquatic Resource Management Programme: NARMAP (GTZ), the Central and Northern Regions Fish Farming Project: CNRFFP (EU), the Border Zone Development Programme: BZDP (GTZ) and the Project on Aquaculture Research and Technical Development of Malawian Indigenous Species: ARTDMIS (JICA), amongst others (refer to Attached Table A10).

Overall, there has been a substantial investment in the establishment of aquaculture stations. Today, there are 13 aquaculture demonstration stations with more than 200 experimental ponds. These investments, in addition to the tertiary training provided by the University of Malawi at Bunda College (Kaunda, 2003) have established Malawi as one of the foremost exponents of inland aquaculture in central and southern Africa.

Commercial aquaculture in Malawi has a chequered history in Malawi. The first attempt to demonstrate the feasibility of commercial aquaculture was made in the early and mid 1970s at Kasinthula. Though some successes were achieved, an assessment of the potential for commercial scale aquaculture in 1990 (Balarin & Hecht, 1991) showed that the price of fish at that stage was too low to justify any substantial scale of investment. Though several attempts were made to establish commercial aquaculture operations during the 1990s, they all failed for various reasons. Contributing factors included under-capitalisation, high interest rates, inadequate management expertise, inappropriate site selection, an investor unfriendly environment and a lack of institutional support (ADiM Working Paper No. 2 and 6). Because of the declining yield from capture fisheries and increasing demand, the price of fish has increased significantly since 2001. As a direct consequence, two carefully planned large-scale fish farms were started in 2003 viz. Chambo cage culture in Lake Malawi and pond culture in the Lower Shire valley at Kasinthula. Though still in the nascent phase, these farms are making excellent progress and at full-scale production will collectively produce over 3,000 mt per annum. The trout farm on the Zomba plateau was privatised in 2002 and produces a small quantity of fish for the local hotel and restaurant trade.

Cognisance also has to be taken of the fact that Malawi is a signatory to the Convention on Biological Diversity, which was ratified in 1993. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention promotes to improve the conservation of biological diversity and sustainable use of biological resources (CBD, 2005). To reflect the Convention, the DoF has banned translocation and introduction of exotic species in Malawi, as articulated in the ‘Fisheries Conservation and Management Act 1997’ (refer to Annex 2 for further detail).

2. Rural Aquaculture

Aquaculture in Malawi now consists of two sub-sectors, namely a long established "low input - low output" rural aquaculture and a nascent commercial sector. Currently, rural aquaculture predominates the sector.

Edwards and Demaine (1997) define rural aquaculture as an activity that,

- is undertaken by small-scale farming households or communities;
- uses extensive or semi-intensive low cost production technology;
- may use off-farm agricultural inputs such as inorganic fertilizers to intensify production;
- avoids the use of formulated feeds;
- produces a commodity which must be of low-market value affordable to poor consumers.

Most small-holder rural Malawian fish farmers are adequately described by this definition. Some additional characteristics of African rural fish farmers however include,

- small-scale rural aquaculture complements the farmer's livelihood as a part of their subsistence coping strategy (fish as food, gifts, prestige and limited cash income).
- small-scale rural aquaculture is partially or totally integrated into the farming system and is not a stand-alone activity.
- small-scale rural aquaculture is a "low input - low return" system.

2.1 Distribution, Number of Fish Farms

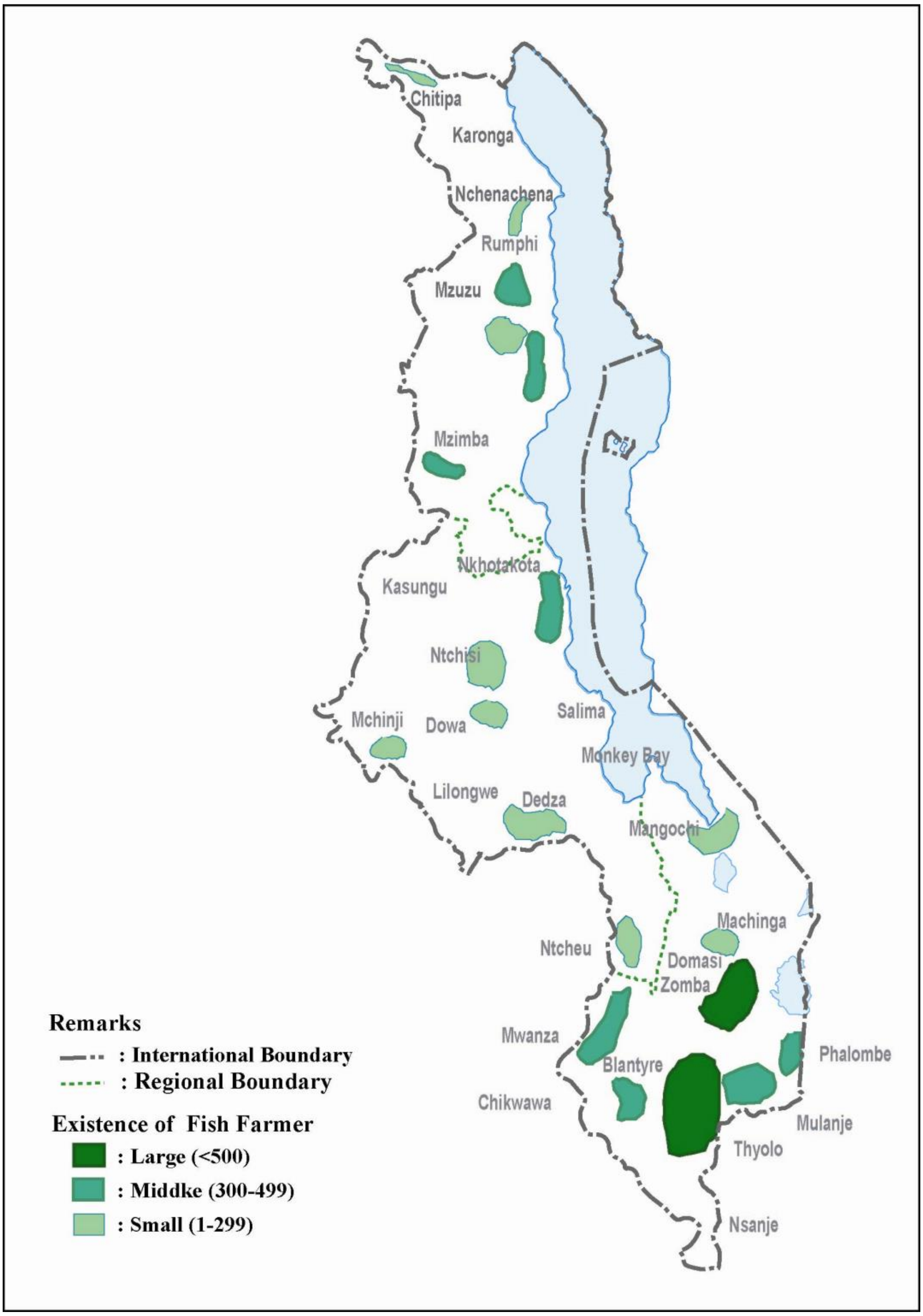
A typical small-holder fish farmer has one or two small ponds (about 200 m^2 or less) usually located in close proximity to a seasonal wet-land (Dambo). These fish farmers are widely distributed in rural area and practically, it is difficult for the government to capture the number of these farmers. Despite incongruent sources of information, it is clear that the number of ponds and fish farmers has increased significantly during the last 15 years. The National Aquaculture Centre (NAC) at Domasi estimated that there were approximately 2,000 small-holder fish farms in 1995 and that their number had increased to 4,050 farmers with 9,500 ponds in 2002 (Table 1.3 and Attached Table A11). Unfortunately, there is very little information on the proportion of active small-holder farmers or of ponds that are in production. Field observation suggests that many of existing ponds have been abandoned, yet exact figure is not known. Without this information, it is not possible to accurately estimate current levels of fish production in the country. Nevertheless, it is clear that there has been a significant increase in the number of fish farmers in Malawi over the last five years (ADiM Working Paper No. 2 and 3).

Table 1.3 Total number of small-holder farmers and ponds by region in 2001-2003

Region	No. of farmers			No. of ponds		
	2001	2002	2003	2001	2002	2003
South	1,500	1,500	1,972	3,278	3,500	n.a.
Central	990	1,200	922	2,056	2,900	n.a.
Northern	1,320	1,350	1,517	3,100	3,100	n.a.
Total	**3,810**	**4,050**	**4,411**	**8,434**	**9,500**	**n.a.**

Source: NAC, 2001 and 2002 and Chimangeni, 2002

Though there are distinct, regional biophysical, political and economic differences the two categories of farmers were distributed relatively evenly across the country. It was apparent that household level factors such as access to labour, availability of pond inputs and the level of agricultural diversification had a stronger influence than the geographic, political other variables on their distribution. The major fish farming areas in Malawi are illustrated in Figure 1.5.



Source: Updated by JICA ADiM Study Team (2003-2005) based on DoF information and Brooks. 1992

Figure 1.5 Distribution of fish farmers in Malawi

2.2 Production and Future Projections

Rural aquaculture production and productivity

Aquaculture production in Malawi in 2002 was estimated by the National Aquaculture Centre (NAC) at 800 metric tonnes, comprised of 93% tilapia (*O. shiranus, T. rendalli, O. mossambicus and O. karongae*), 5% catfish and 2% exotic species such as common carp and rainbow trout. This is in contrast to the estimates of the ADiM National socio-economic survey (ADiM Working Paper No. 3) and the ADiM situation analysis of aquaculture in Malawi (ADiM Working Paper No. 2), which estimated total current small-holder fish production to be between 40 and 200 mt per annum. In 2003, there were no medium or large-scale commercial aquaculture activities in Malawi. In relation to capture fisheries, the proportion produced by aquaculture (even if the NAC total country production estimate is correct) is insignificant and does not exceed 1.4%.

All small-holder agricultural enterprises in Malawi are resource limited (ICLARM & GTZ, 1991). Higher levels of production from small-holder fish ponds is limited by the affordability, availability and access to better quality inputs (feed, manure and fertiliser). Brummett (1994) estimated that only 27% of nitrogen requirements are met in integrated pond aquaculture systems in Southern Malawi. Some projects have reported maximum yields of 5,000 kg/ha/yr. However, given that most of the production figures quoted in the literature are based on small target groups a more realistic estimate of overall production in Malawian small-holder fish ponds is probably in the region of 700 – 1,200 kg/ha/yr (ADiM Working Paper No. 2 and 3).

Table 1.4 Malawi aquaculture production statistics 1995 – 2001

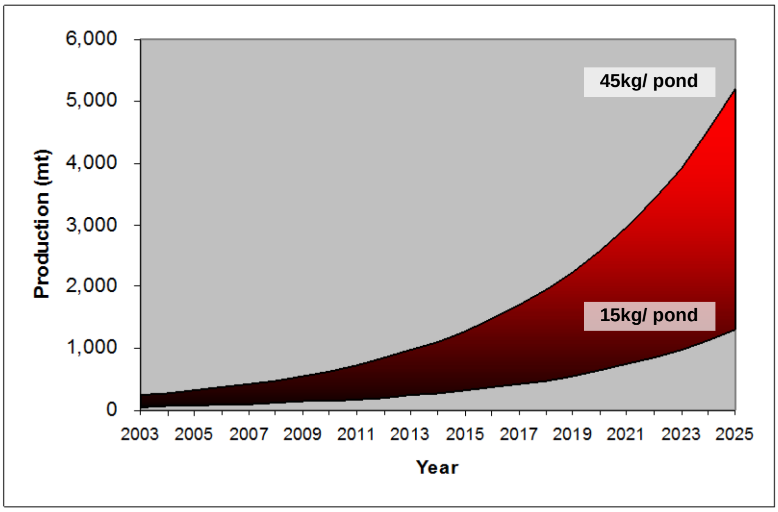
Unit: mt

Year	Production
1995	200
1996	210
1997	250
1998	340
1999	550
2000	640
2001	750
2002	800

Source: DoF, 2002

Projection

Future projections of the growth of the rural aquaculture sector were made on the basis of historical trends. During the period 1965 to 2002, the number of ponds has increased at an annual rate of 15% (ADiM Working Paper No. 3). The most dramatic increase occurred from 1999 to the present. If this rate of annual increase is projected, starting at an estimated current national pond count of 4,000, then up to 80,000 ponds may be constructed by 2025. This assumes that it will be possible to maintain a 15% growth rate per annum and that there is a adequate infrastructural and institutional support. However, on a national level there are sufficient new suitable pond sites to allow this increase to occur. Using two conservative levels of production (15kg/200m^2 pond and 45kg/200m^2 pond per year) the potential range of total production from small-holder fish farms is shown in Figure 1.6.



Source: ADiM Working Paper No. 3

Figure 1.6 The potential range of total production from small-holder fish farms under two of production scenarios of 15 and 45kg/200m^2 pond per annum (Attached Table A12)

Fingerling production

The number of fingerlings distributed during the 2000 / 2001 season in the South and Central Regions is shown in Table 3. No figures are available for the Northern Region as the CNRFFC was flooded during the rainy season and the Centre did not have any operational funds. *Clarias gariepinus* fingerlings are produced at NAC on demand, so only 16,905 fingerlings were sold in 2001.

The price of fingerlings (MK 5, 5 and 10 for *O. shiranus, T. rendalli* and *O. karongae,* respectively in September, 2004) is remarkably high. Theoretically, the high fingerling price makes small-holder fish farming uneconomical if the farmer has to purchase fingerlings. For example, if a farmer sells fish at an average weight of 40g then the fingerling cost can be as high as 90% of the selling price. Similarly, for a 150g fish the attributable fingerling cost would be 18%. In comparison to Asian countries, the cost of fingerlings is exorbitant.

However, it would appear that existing fish farmers produce their own fingerlings for on-growing and that new entrants buy their initial stock of juveniles from fingerling producers. Thus, the high cost of fingerlings may be a constraint for many new entrants to take up fish farming as a diversification strategy. Established fish farmers who produce their own fingerlings are not constrained by price.

Ideally, in the long term, fingerlings must be supplied by producers at a reasonable and appropriate price, such that fish farmers can concentrate on producing marketable size fish. Dual purpose ponds (fish and fingerling production) are uneconomical. Reduction of the cost of fingerlings by dedicated fingerling producers obviously requires a certain economy of scale. Development efforts should therefore focus on cost effective, mass-production and supply of high quality fingerlings. By high quality fingerlings we refer to young fish and not, as has often been the case in the past, the supply of small old fish as fingerlings. In the short term, this may only be possible through the NAC but once the technologies have been perfected they should be transferred to entrepreneurial farmers who wish to specialise in fingerling production or to dedicated farmer club hatcheries.

Table 1.5 Number of fingerlings distributed by the government in 2004

Unit: fish

Name of Station	Number of fingerlings produced
Nkhata Bay	1,960
Mzuzu	3,140
Chisitu	1,200
NAC	350,000

Source: DoF (2005)

2.3 Marketing of Cultured Fish

Most of cultured fish are sold at pond-side and are purchased by the people in same community. It is rare that fish farmer takes fish to the market and it counts only 5% of total harvest. Therefore, the market price of cultured fish is not available in the country. Table 1.6 shows the prices of natural fishes sold by MALDECO. MALDECO is the biggest fish supplier in the country and their prices will well represent real market prices. According to their records, tilapia is always most expensive fish at the market with MK245 (USD2.2)/kg in 2005. While Utaka and Ndunduma belong same family of tilapia, its small size and large amount supply make them reasonable in price and very popular to Malawians. Current small size of cultured tilapia might be given the same status as these Utaka and Ndunduma. Although price of cultured tilapia (*O. shiranus*), around 100g per piece, sold in the villages fluctuates largely by occasions, usually its price is around MK100-120/kg. Price of large cultured Tilapia (150g or above) is not known as fish with such size are rarely produced in the pond. Beach price of *O. shiranus* has 40% less price compared to Chambo with same size (ADiM Working Paper No. 1).

Table 1.6 Price of major fish species in 2005

Unit: USD (MK)

	Fresh		Frozen		Smoked		Sun Dried	
	W/sale	Retail	W/sale	Retail	W/sale	Retail	W/sale	Retail
Oreochromis Karongae (Chambo/Tilapia)	1.8 (199.0)	2.2 (244.9)	2.3 (255.4)	2.6 (293.9)	3.1 (352.0)	3.5 (400.0)	-	-
Clarius gariepinus (Mlamba/African catfish)	1.0 (108.2)	1.1 (126.5)	-	-	-	-	-	-
Copadichromis species (Utaka/Mbaba)	1.0 (111.1)	1.2 (132.0)	-	-	-	-	-	-
Diplotaxodon limnothrissa (Ndunduma)	0.8 (93.5)	1.0 (110.4)	1.1 (126.6)	1.5 (166.0)	-	-	1.6 (178.3)	1.8 (207.0)

Remarks *: Wholesale price at MALDECO (Mangochi) and retail price at city (e.g. Blantyre and Lilongwe)
Source: MALDECO official price (2005)

2.4 Fish Farmers

The ADiM National socio-economic survey (ADiM Working Paper No. 3) provided the nation-wide information with which to characterize this sector in Malawi. The survey covered 563 farmers in 13 districts in all regions in Malawi. The baseline information on farmer clubs within the Chingale area in the Zomba District was also obtained (122 households) through the ADiM Pilot Project baseline survey (ADiM Working Paper No. 4). These two surveys and other documents provided the background with which to portray the rural aquaculture sector.

Outline of the farmers

The ADiM National socio-economic survey found that the average size of ponds throughout the country was 180m^2 and that farmers had an average of 1.5 ponds with a total surface area of 280m^2. The national average production was 706 $\pm$ 131 (SE) kg/ ha / year, which is equivalent to 12.3 $\pm$ 3 (SE) kg / fish farmer / annum. This is slightly higher than the sub-Saharan regional average of 500 kg/ha/yr (Machena and Moel, 2000). Harvesting is not scheduled and fish are often left in the ponds for prolonged periods. For example, 18% of farmers interviewed during the socio-economic survey had not harvested their ponds for over a year. Table 1.7 shows the use of harvested fish. In comparison to fish farmers in Asian countries, Malawian fish farmers share less percentage for sales, which suggests them being less market-orientated. In the other words, Malawian fish farmers are not professional fish farmers.

Among farmers whom harvest fish, only 4 % produced more than 60kg/yr, 10 % produced between 20 and 59kg/yr, and 55 % less than 19kg/yr (refer to Attached Figure A4), suggesting that there are two broad categories of small-holder fish farmers in Malawi;

(i) those who harvest a small quantity of fish that contributes to household food security. Over 90% of the fish farmers in Malawi fall into this category, and

(ii) those who harvest larger quantities of fish and in addition to contributing to household food security also obtain a tangible income from the activity.

Ponds are normally constructed by family members and sometimes with the help of hired labour. The most common species farmed are *O. shiranus* and *T. rendalli* and these are generally farmed under mixed sex, monoculture conditions. Reproduction is not controlled and few farmers have dedicated fingerling production ponds. Many farmers are still dependent on the NAC and its satellite stations for fingerlings, though latterly more farmers produce their own fingerlings or purchase them from other fish farmers. The ADiM National socio-economic survey (ADiM Working Paper No. 3) indicated that farmers generally have adequate knowledge regarding pond inputs but very few practised what they knew. The majority of farmers use maize bran as feed and green compost for pond manuring. Partial harvesting is the norm and many farmers had not harvested their ponds for over a year. Only 3% of fish farmers owned a seine net.

Nevertheless, it became evident that the current outputs form an important part of household livelihoods and provide an additional option for spreading risk and increasing the overall value of the farming system.

Table 1.7 Utilization of harvested fish (pond) cultured in Malawi and that of some Asian countries

Unit: %

	Malawi	Bangladesh	China	Philippine	Thailand	Vietnam
Home consumption	47.3	55.0	5.0	1.0	5.0	9.0
Sold	40.0	18.0	95.0	97.0	95.0	90.0
Given away	12.0	26.0	0.0	0.0	0.0	1.0

Source: * ADiM National socio-economic survey (2003), others R. D. Guerrero III *et al.* (2002)

Aquaculture is integrally linked to crop farming

The ADiM National socio-economic survey results suggest that fish farming contributed between 1% and 17% to overall household income. This is not much different from various other studies conducted in Malawi and Africa, which suggest that farmed fish contribute between 6% and 30% to total farm production (Lazard, 2002; Woldfish Center, 2004). The Pilot Project has also shown that fish farming contributes more or less 10% of total annual cash income among farmers who practise aquaculture in the Chingale area, Zomba District (refer to Attached Tables A13).

Fish farming, therefore, is one of a variety of activities that are combined to maximize income and food security of small-holder farmers. This suggests that fish farming must be seen as part of the overall agricultural system and should not be considered as a stand-alone activity. In general, the more productive fish farmers also generally tend to be the more progressive farmers.

Better producers have greater access to resources and are more experienced

The more productive farmers tend to be older, have larger families (= more labour), larger land holdings, higher education levels, and more skilled employment experience. They also have access to and cultivate more land of all types, have better access to water, produce a more diverse range of agricultural produce, have more diverse livelihood strategies and are less food insecure. The constraints facing small-holder fish farmers are similar to those facing small-holder agriculture in general.

Category 2 fish farmers (see above) have larger and / or more ponds, feed their fish and manure their ponds more appropriately than the Category 1 farmers. Fish production per farm was found to be related both to the intensity of fish farming activities and available pond surface area.

Table 1.8 Characteristics of fish farmers in different categories

Category	Fish Yield (kg/ha/yr)	Household size	Age of household head	Land holdings (ha)	Skilled job experience (%)	Food secure (%)
Non fish farmer	-	7.3	39.7	2.58	21	47
Small producer*	538	8.3	43.2	3.14	25	57
Larger producer**	2,316	11.3	50.2	5.92	50	75

Remarks: *Small producer – fish production between 0 and 19kg per year
**Larger producer – fish production >60 kg per year
Source: ADiM Working Paper No. 3

Another observation is that fish farmer household tend to be male-headed households. Female-headed households often have less resources, human as well as financial resources, to initiate fish farming (Attached Table A14).

Fish farmers need support to improve production

The majority of fish farmers recognize that fish farming provides an opportunity for farm diversification and improved income. However, most were dissatisfied with their performance. The main reasons for the dissatisfaction in all groups currently engaged in fish farming was the slow growth rate of fish (35%), small pond size (25%) and the lack of technical support (8%), though all farmers were satisfied with the market and the price of fish. The survey result showed that 8% of farmers had abandoned fish farming in recent years. The main reason for abandoning the activity was lack of water. All of these reasons indicate a poor understanding of the critical requirements for successful fish farming. This clearly suggests the need for capacity building, education, improved extension and the need for access to small loans for the more progressive farmers and a greater supporting framework (extension) for those farmers at the lower end of the spectrum.

Table 1.9 Summary of socio-economic indicators of Malawian fish farmers

Descriptor/Indicator	Value	Comment
Mean household size	8.2 people	More productive farmers tend to have more people to assist with labour on the farm
Mean age of fish farmers	42 years	Better fish farmers are normally older and have greater ability to manage their fish ponds Mean age of farmers producing in excess of 60kg/yr is 50.2 years
Greater degree of food security	64.4%	Most fish farmers are better-off than small-holders without fish ponds
Mean size of land	3.32 ha	Fish farmers have significantly larger land holdings than the average small-holder farmer in Malawi
Mean number of ponds per household	1.6 ponds	Farmers generally see the number of ponds as a constraint to increased production
Mean pond size	178 m^2 (Total Pond Area 284m^2)	Larger pond size may improve production and this may therefore be a constraint to development
Mean fish production per farm	12.26 kg per annum	In most instances benefits only accrue through improved home fish consumption
Mean fish production/ pond	7.69 kg per annum	Indicates low level of management and lack of resources
Main supply of fingerlings (% of respondents)	DoF : 55.0% Other farmers: 32.8%	DoF and farmers provide most fingerlings
Use of manure (% of respondents)	85.6%	Although a high % of farmers use manure, the quantities applied are too low to satisfy the nitrogen requirements
Harvest methods (% of respondents)	Partial harvest: 94.3%	The high % of partial harvest shows the importance of the pond as a food store for home consumption
Use of fish (% of respondents)	Sold at pond or market: 47.0% Home consumption: 31.6% Distribution: 15.0%	Current quantities of fish produced are easily sold directly from the pond with little need for transport to the market
Mean contribution of fish to household income	17.0%	Although this is low, the contribution of fish farming to increased integration is of great importance to households
Average number of income generating activities per household	6.78	Small-holder farmers rely on a wide variety of income sources. More productive farmers are more diverse
Sources of income (% of respondents)	Food crops : 83.0%; Fruit & vegetables : 74.0%; Off-farm activities : 49.0%; Livestock : 26.0%; Fish : 19.0%*	A reliance on agricultural income can be expected, but the importance of off-farm sources is significant as it increases diversification
Priority expenditure items (% of income)	Food & basic necessities: 61%; Agricultural inputs : 19%; Education: 9%; Other: 11%	Small-holder farmers are not often able to produce enough food themselves and have to buy in food during certain times of the year.
Mean number of livestock per household	Large Livestock Unit: 1.58** Poultry : 10.66	The low levels of livestock are a constraint to pond nitrogen inputs
Households engaged in Ganyu (temporary employment)	26.5%	Ganyu can be used as an emergency strategy for survival, or as a means of increasing diversity of income sources

Remarks: *Respondents could provide multiple answers; therefore, the total percentage can be over 100%
**One large livestock unit = 1 head of cattle, or 2 head of sheep or goats

Source: ADiM Working Paper No. 3

3. Commercial Aquaculture

The FAO, Committee for Inland Fisheries of Africa (CIFA, 2000) defines commercial aquaculture as the rearing of aquatic organisms with the goal of maximizing profit where profits are revenues minus costs. Commercial aquaculture can include small to large-scale operations, and range from extensive to intensive systems. Commercial fish farms actively participate in the market by purchasing inputs (including capital and labour) and engage in off-farm sales of the fish produced. Normally aquaculture is the principal economic activity of farmers in this category.

Malawi started to develop aquaculture technologies through research and development. Major efforts were made in the late 1980s, which emphasised the development and transfer of technologies appropriate for small-scale aquaculture and in particular focused on the poorest of the poor. On the other hand, while the government was assisting and developing small-scale fish farmers, the private sector initiated fish farming on several sugarcane and tea estates. Their main objective was to produce fish for their labour force and not to sell product. The estate farms had the necessary resources and existing infrastructure (e.g., roads, machinery, irrigation systems, and adequate water supply) to begin fish farming and their ponds were stocked with fingerlings purchased from government stations. The DoF categorized the estate farms as commercial aquaculture. However, none of the estate fish farms really operated on business principles and little if any effort was made to employ technically skilled management, or to invest in appropriate technologies. At its peak, the "commercial" sector produced a maximum of around 100 mt per annum and from the mid 1990s to around 2001/02 the sector virtually collapsed.

The reasons for the failure of these farms are many and include the lack of proper financial planning, lack of commercial fish farming expertise, absence of commercial aquaculture expertise at government stations, inadequate fingerling production capacity (quality and quantity), and most importantly the fact that fish farming was not the core business of the estate. The failure of the estate fish farms and the absence of focus on commercial fish farming by government stations also sent a signal to prospective investors that fish farming was not commercially viable and this led to increased investor hesitancy. These factors certainly affected the development of the sector in Malawi, though many potential investors realised the futility of commercial aquaculture at the time because of the low price of fish (Balarin & Hecht 1991, Brooks 1992, Balarin 1997). The price of fish over the last 5 years has increased by over 350% and "chambo" now sells for up to USD 2 / kg.

This dramatic change is the main reason for the re-emergence of the commercial aquaculture sector in Malawi. Two meticulously planned commercial aquaculture operations were established in 2003/2004. One is a large-scale cage culture operation that is geared to produce between 2,000 and 3,000 mt of *Oreochromis karongae* in circular floating cages in Lake Malawi. The operation consists of a cage unit and a pond based fingerling production unit. The other is a medium scale pond culture operation in the Lower Shire valley at Kasinthula and consists of 10 ponds with a total surface area of 8 ha. The main species farmed include *Oreochromis mossambicus* and *Cyprinus carpio*. The only other "small to medium" scale commercial fish farm in Malawi is the recently (2001/2) privatised trout farm on the Zomba plateau. In addition, and as a direct consequence of the ADiM Pilot Project, several small-holder farmers have also taken the first steps towards the commercialisation of their fish farming activities. The success of these ventures will provide the impetus for the development of the sector in Malawi. Table 1.10 profiles the past and present commercial aquaculture ventures in Malawi.

Table 1.10 List of past and present commercial aquaculture ventures in Malawi

PAST	
1. SUCOMA farm (Sugar Corporation of Malawi)	
Location	Nchalo in Chikwawa district, Southern Region
Pond area	Total 17.2 ha consisting of 28 ponds ranging in size from 0.1 to 1.0 ha.
Fish production	49 mt at peak production.
Current status	SUCOMA fish farm was the largest commercial farm; the species farmed were *O .mossambicus*, *T .rendalli*, *Clarias gariepinus*, and *Cyprinus carpio* with an average production ranging from 3.1 to 3.6 mt/ha/year. The farm supplied fish to plantation workers on the sugar estate. Currently, the farm is operating at minimum capacity and production is inconsequential.
2. Dwangwa Sugar Estate Fish Farm	
Location	Nkhotakota District, Central Region
Pond area	3.2 ha
Fish production	94 mt in 1990.
Current status	This estate had a crocodile farm and produce fish mainly to feed the crocodiles. Crocodiles skins were exported. The farm has now ceased production and has closed down.
3. Liwonde fish farm (Nu-Line Foods Fish Farm)	
Location	Liwonde, Southern Region
Pond area	more than 10 hectares
Fish production	No records
Current status	The farm was planned to produce fish for sale to schools and other institutions of higher learning. The farm has closed down.
4. Benthos fish farm	
Location	Mangochi District, Southern Region
Pond area	No accurate data
Fish production	Currently no production.
Current status	The farm is owned by Club Makokola. The farm originally planned to supply *O. karongae* to the Club Makokola and other restaurants, but has now stopped production. Some fingerlings were supplied to MALDECO. Theft was one of the major problems.
PRESENT	
5. MALDECO fish farm	
Location	Mangochi District, Southern Region
Year established	2003
Pond area & cages	2 ha earthern ponds and concrete tanks for fingerling production, and 4 x 16m diameter cages
Fish production	Not yet harvested (target production = 3,000 mt)
Current status	This is Malawi's first major commercial fish farm. Currently, the farm produces *O. karongae* fingerlings for stocking into production cages.
6. G.K. Aquafarm	
Location	Kasinthula, Chikwawa District, Southern Region
Year established	2004
Pond area	10 ha (leased from DoF) and hatchery facility.
Fish production	Geared to produce 12 mt /ha /year.
Current status	The ponds have been renovated and produces *Cyprinus carpio* and *O. mossambicus*. Farm made feeds are used for fish production.

Source: Compiled by JICA ADiM Study Team (2003-2005)

4. Aquaculture Institutions

4.1 Department of Fisheries

The Department of Fisheries (DoF) within the Ministry of Mines, Natural Resources and Environment, has the primary responsibility for fisheries administration and providing professional services to ensure sustainable fisheries utilisation and enhanced aquaculture production at national and district level (refer to Attached Figures A5 and A6 for the structure of the Ministry and the DoF). It currently has about 500 staff with 80 professional officers (Qualifications of such DoF staff are shown in Attached Table A15). The DoF is composed of six divisions, viz. (i) Management and Administration, (ii) Planning, Monitoring and Evaluation, (iii) Research, (iv) Extension and Development, (v) Aquaculture, and (vi) Training. The aquaculture division with its headquarters at Domasi is known as the National Aquaculture Centre (NAC). Domasi was established in 1959 as an experimental fish farm. The main objective of the NAC is *to increase and sustain fish production from small-holder and large fish farming operations in order to improve fish supply in Malawi*. The DoF has 37 stations in the country. Of these, 30 are engaged in aquaculture and 13 are aquaculture demonstration stations with fish ponds (Figure 1.7 and Attached Table A16). The DoF has 60 staff members who are involved with aquaculture and of which 41 are dedicated aquaculture extensionists. SWOT analysis of the DOF is shown in Annex 5)

4.2 District Assembly

Once the on-going devolution plan is achieved, the aquaculture extension will be replaced under the authority of the District Assembly. As of February 2005, the fisheries officers in the Districts are located under the District Assembly, yet their salaries are being paid by the central government. Through devolution, the District Assembly will take an initiative in providing direct services to beneficiaries, whereas the central government will more concentrate on policy as well as research and education planning at the national level.

4.3 University of Malawi (Bunda College of Agriculture and Chancellor College)

Bunda College of Agriculture has been offering a BSc degree in Agriculture with an Aquaculture major since 1997 and a Masters degree in Aquaculture or Fisheries Science since 2002. By 2004, 51 BSc and 7 MSc holders have graduated (Attached Table A17). Chancellor College offers a Masters degree in Environmental Sciences in aquaculture related areas.

4.4 NGOs and Other Organisations

Various non-governmental organisations (NGOs) have for many years actively promoted aquaculture in Malawi. Most notable amongst these are World Vision Malawi, Action Aid, OXFAM, US Peace Corps, and various religious denominations, amongst others (refer to Attached Figure A7 for major NGOs' activities in respective sectors and Districts). There are some fish farmers groups which are often organized by NGOs. One of these groups, "Chingale Fish Farmers Association (Zomba District)" is the largest group that composed of 19 clubs with 329 member households. These groups are supported by World Vision Malawi in training and fingerling supply, yet not officially registered to the government. "Innovative Fish Farmers Network Trust" is an only officially registered national organisation. This new group is composed of 25 fish farmers who are expected as leaders of aquaculture development in their areas and aims at mainly sharing their experiences and knowledge among the members.

WorldFish Center (WFC), an autonomous non-profit international scientific and technical centre, unlike other NGOs, the WFC specialises in fisheries and aquaculture sector. The WFC has a branch office at Domasi adjacent to NAC since 1987. The Center implements various researches and studies in fisheries and aquaculture in collaboration with the DoF. Such researches and studies include integrated aquaculture-agriculture technologies.

4.5 Donor Organisations and Support

Malawi is heavily dependent on foreign aid. External aid flow to Malawi accounts for almost 12% of GDP. 32.75% of total government revenue comes from loans and grants. Consequently, development policy and programmes are significantly influenced by donor policies.

Donors provide aid on a selective basis and carefully choose (or select) specific areas for official assistance. This process clearly influences the scale of assistance to the fisheries sector. Consultation with major donors has revealed that their support for the fisheries sector, particularly aquaculture, has decreased substantially. Currently, fishery or aquaculture components are often integrated into projects that enhance social development as a whole (Major donor's policy on fisheries assistance is shown in Attached Figure A8). For example, GTZ in Malawi has recently decided to refocus on capacity building in three major sectors, viz. 1) Health, 2) Education, and 3) Democratisation, instead of natural resources and natural resource management. The change in focus is largely a consequence of the perceived failure of individual sector assistance. Other major donors are similarly focussing on capacity building to assist integrated rural development. For example, DFID, one of the major donors in Malawi, has shifted support towards the integration of sectors (including aquaculture and fisheries).

4.6 Current and Planned Development Assistance

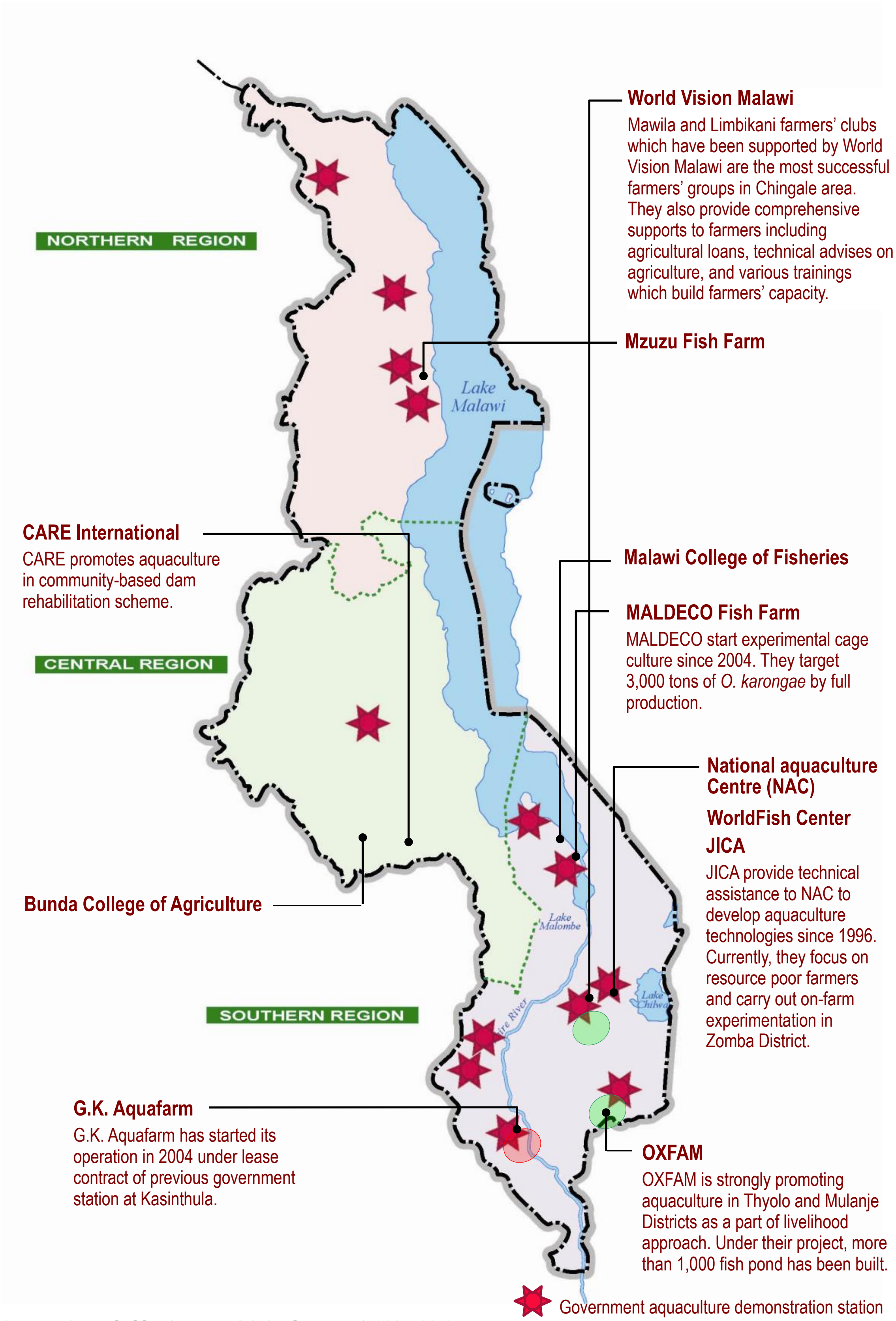
On-going and planned development assistances in the sector as of 2005 are listed below.

On-going assistances

- JICA: Project on Aquaculture Research and Technical Development of Malawian Indigenous Species (JICA) is being implemented in Zomba District
- WorldFish Center: WorldFish Center implements various researches and studies in fisheries and aquaculture in collaboration with the DoF.
- World Vision Malawi: Fisheries component is included in the Chingale Area Development Programme.
- Oxfam: Oxfam promotes fish farming in Thyolo and Mulanje Districts under the 'Shire Highlands Sustainable Livelihoods Programme.'
- African Development Bank (ADB): ADB currently implements the fisheries development project.

Planned assistances

- Malawi Investment Promotion Agency: The Malawi Development Corporation is currently seeking for a technical partner to initiate commercial aquaculture at Kasinthula.
- Canadian Marine Institute (MI): The Canadian MI collaborates with Bunda College in research and education in fisheries sector.
- Chambo Restoration Strategic Plan (2003-2015): The strategic plan was prepared with financial and technical support from USAID/COMPASS. It was initiated with 'Save the Chambo Campaign' in 2003.



Source: Compiled by ADiM JICA Study Team (2003-2005)

Figure 1.7 Location of aquaculture demonstration stations and major aquaculture activities

CHAPTER III CONSTRAINTS TO AQUACULTURE DEVELOPMENT

The current unfavourable macro-economic environment has cross cutting effects on all sectors, and this has also directly and indirectly affected the development of aquaculture. Malawi's economy holds inherent risk. The country is small and land locked, has an agricultural base, is heavily dependent on donor assistance and is prone to natural disasters such as drought. The inflation and interest rates are high and transport services are costly and unreliable (Table 1.11). Moreover, investment incentives are poor in comparison to other countries in the region. Collectively this creates a difficult business environment for commercial as well as small-holder aquaculture and also limits service delivery by the DoF in terms of extension and research.

Table 1.11 Some economic factors affecting fish farming operations

Factors	Figures	Comments
High interest rate	About 30%	It increases investment cost, erodes profit margins and seriously impacts availability of micro-finance for small-scale farmers.
High transport cost	2-3 times higher than rates in South Africa	It increases the cost of the most critical inputs for production, e.g. fertilizer, raw materials for fish feeds and manure. Fertilizer price in Malawi is three times higher than average world prices and 50% of this cost is attributable to transportation.
High inflation rate	27%	Discourages consumer spending and erodes purchasing power.
Slow land reform process	Over 80% of small-holder farmers have less than 1 ha and land is over used. A total of 800,000 ha of under utilised public land has been identified.	Many farmers claim that the size of their land is the main constraint to start fish farming.

Source: World Bank, 2004

There are several underlying reasons why aquaculture production in Malawi is erratic and why the sector as a whole is still under developed, except above macro-economic reasons.

1. Constraints to Rural Aquaculture

Rural aquaculture is characterised by low productivity and small quantity of the harvest. Current productivity of about 700kg/ha/year remains contribution of aquaculture at minimum level. Having limited resources are the major challenges. Such challenges and constraints of the current rural aquaculture in Malawi are described below.

Poor access to the land and water

Farmers who possess small land are often difficult to access to the land which is suitable for aquaculture nor water source. In Malawi, permanent water supply tends to be located only in Dambo area and such area is generally regarded as a common property by rural community. Many of fish farmers uses personal furrow (54%) and ground water (59%) for their aquaculture practices. Whereas only a few utilises communal or shared water (5%) for their fishponds. This suggests that unless farmers have their own water source within their land, it is difficult for one to start fish farming. In other words, without any system to enhance using shared water, fish farming remains a business for limited farmers with specific geographical conditions.

Scarcity of input commodities

The findings of the ADiM National socio-economic survey (ADiM Working Paper No. 3) clearly showed that small-holder fish farming is practised on a low input basis. Fish are neither adequately fed nor are ponds adequately fertilised. The reasons for this are twofold. Most farmers either do not have access to the necessary resources or cannot afford the risk of acquiring the necessary inputs. Alternatively, those farmers that do have access to resources are either ignorant as to the nutritional requirements of the fish and the quantities of manure and or compost required for adequate pond fertilisation or are faced with problems of availability and supply. Manure collected from livestock is important to maintain fertility of the pond water. However, possession rate of livestock is not high in Malawi (Attached Table A4). Households that own cattle remain 5.2%. Poultry is the most popular livestock with its possession rate of 44.7% with average number of 8.4. Furthermore, there is also a demand for manure in other agricultural activities. Some amount of chicken manure is cheaply available in poultry factories. Yet, the factories are usually located adjacent to big cities and farmers who have access to those factories are limited due to the high transportation cost. If aquaculture is to make a meaningful contribution to fish supply in Malawi, then it is critical for farmers to be educated with respect to the requirements of their fish, and that the supply chain of manure and fertiliser in Malawi is vastly improved.

Another problem of small-holder aquaculture derives in part from the poor accessibility to and the high price of fingerlings. According to the ADiM National socio-economic survey (2003), fish farmers rely heavily on the purchase and distribution of fingerlings from the DoF (40%) and other fish farmers (41%). However, fingerling production from DoF rarely meets the demand in terms of quantity and quality. Moreover, most of the DoF stations (except the NAC) lack the physical and sometimes the technical capacity to ensure the efficient delivery of fingerlings to farmers. For example, during the period 2003 to 2005 there has been a dramatic increase in demand for *O. karongae* fingerlings, which the NAC and other producers could not satisfy. The market responded accordingly and the price of *O. karongae* fingerlings rose to more than MK 10 per fish. In September 2004, the price of *T. rendalli* and *O. shiranus* fingerlings (ex NAC) was MK 5 per piece. The current price of fingerlings is considered to be an obstacle for small-holder fish farmers. In addition, the supply network is weak and in most cases, farmers have to source fingerlings by themselves.

Poor human and social capitals

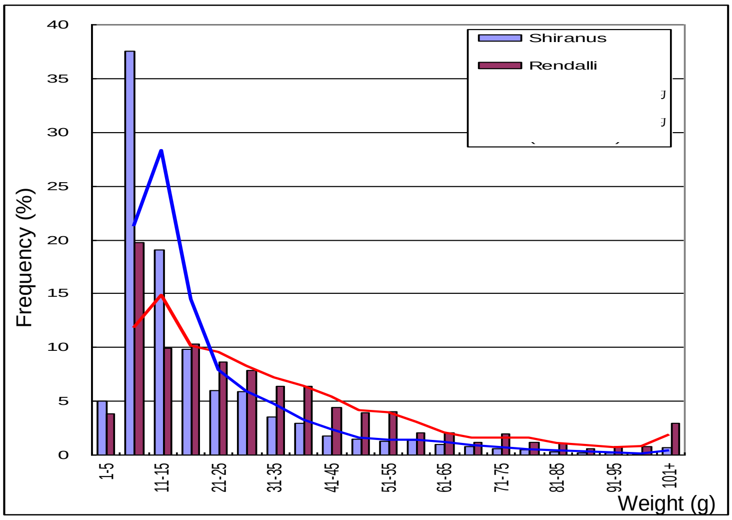
Weak human and social capital is also a constraint of small-holders. Without having basic ability in learning new technologies, effective extension will not be achieved. 40% of adult illiteracy rate becomes an obstacle in proper management of various fish farming activities. Institutional capacity and negotiation skill in order to access for extension service and credits are still weak. Such capacity can be brought by organising fish farmers into a group. However, most of farmers' lack in management skill to formulate cooperative works.

Poor understanding of small-holder fish farmers' livelihoods

In most instances fish farming is an add-on activity of small-holder farmers. The primary constraint facing small-holder farmers is access to resources and internal competition for water, land, feed, fertilizer, nets, and support services. This suggests that the development of aquaculture should be promoted within the overall context of rural, and in particular, agricultural development. To realise a greater degree of synergy in rural development initiatives requires a better understanding of the linkages between aquaculture and agriculture, poverty and rural development.

2. Constraints to Commercial Aquaculture

“Our fish do not grow” is the most common complaint by Malawian fish farmers. This is not unique to Malawian cichlids, it simply illustrates the phenotypic plasticity of tilapias in general. Figure 1.8 shows the size distribution of two species of Tilapia observed in 60 fishponds in the country. 63% of standing stock consists of fish that are less than 20g per piece. For *O. Shiranus*, the figure exceeds over 70%. The success of tilapia farming world-wide is a consequence of certain management and genetic interventions. Most important amongst these are controlling reproduction in ponds, providing appropriate and adequate quantities of feed and appropriate fertilisation, selection of appropriate species, hybridisation and development of faster growing strains and mono-sex (all male) farming. If the target is to produce large fish at the end of the grow-out cycle then either one, or a combination of the above, must be applied in conjunction with appropriate and adequate nutrition and fertilisation. To realise significant increases in fish production in Malawi requires the DoF to address these issues as a matter of priority.



Remarks: Data were based on 3,562 sample fish from 60 fishponds across 14 Districts.
Source: JICA ADiM Study Team (2003-2005)

Figure 1.8 Size distribution of two cultured Tilapia species

Antiquated technologies and poor dissemination of research results

Most Malawian fish farmers are subsistence farmers, who for various reasons cannot afford the risk of improved feeding, fertilisation and management of their fish ponds and are forced to adopt a “low input – low return” farming strategy. To change this approach, particularly in view of the high fish price, it is necessary to demonstrate the profitability of advanced higher yield technologies. However, these technologies are in most instances not available to the farmers.

It is inevitable that many will continue with current fish farming practices. The primary reasons why the current practices will persist include, amongst others, the widespread and high degree of poverty, an under-resourced and therefore inefficient extension service and antiquated extension material. The resources of the NAC are also not adequate to (i) establish a database of farmers who have the necessary resources to make the change from subsistence to commercial fish farming, (ii) to sustain a critical number of links between researchers and these farmers, (iii) to demonstrate the need for business planning and the profitability of alternative technologies that are perceived to be too risky. Moreover, several promising technologies have been developed at the NAC, but have not been disseminated to farmers. Past extension and external technical support approaches have been shown to be unsustainable. The adoption of more participatory research and extension methods since the early 1990s will go a long way towards improving the rate at which new technologies are adopted by farmers.

The past mission of the NAC was largely geared towards the promotion, support and development of small-holder aquaculture. Consequently, much of the research has no application for medium to large-scale commercial aquaculture. The lack of focus on applicable commercial aquaculture research has in the past also been one of the major reasons for investor hesitancy and the absence of any substantial and well-planned investments in this sector.

Inability to access credit and institutional support

The scale of production, non-scheduled cash flow, lack of collateral, and high transaction costs of small loans has meant that the majority of fish farmers in Malawi are not creditworthy and therefore find it difficult, if not impossible, to access credit. It is unrealistic to expect that commercial banks would be significant providers of working capital for fish farmers. For small loans farmers are essentially restricted to organisations such as MASAF and various NGOs, though the terms for substantially meaningful loans are also highly restrictive. Farmers may have greater opportunities for collective access to finance if they approach lending institutions as producer groups, associations or clubs. It needs to be recognised, however, that this mechanism stifles individual entrepreneurial spirit. Resolving the mechanisms for access to capital is probably one of the most important challenges facing the development of small and medium-scale commercial aquaculture in Malawi.

Medium to large-scale commercial investors in aquaculture are similarly constrained by the high interest rates and uncompetitive investment incentives, such as tax breaks as well as the high import duties on raw materials and machinery. Furthermore, complicated procedure for obtaining rights for starting commercial aquaculture is an obstacle for aquaculture development in Malawi (Attached Table A18).

3. Constraints to Service Providers

Limited resources of the DoF

One of the critical constraints to aquaculture development in Malawi is the weakness of the aquaculture support services, brought about by inadequate government resources (The budget of the DoF is shown in Attached Table A19). Thirteen aquaculture demonstration stations and 41 aquaculture extension staff are insufficient to meet the most basic operational requirements to assist the widely dispersed fish farmers. Furthermore, the DoF cannot afford to send extension staff on refresher courses, resulting in antiquated extension messages. Moreover, the lack of communication between extension staff at remote stations and regional offices and or the NAC, and their low level of remuneration (one third of similar staff at NGOs) has de-motivated the staff. Given the small size of the sector it is highly improbable that the DoF would be able to justify or afford an increase in budget allocation to the aquaculture sector in the short term. Clearly, this has and will continue to impact negatively on the development of the rural small-scale aquaculture sector.

Weak capacity of local government and private service providers in aquaculture extension

To overcome above constraint and to enhance aquaculture production it is necessary for local government, NGOs and other private organisations to play an increasingly leading role in providing support services to small-holder fish farmers. Given their close proximity to the farmers and their participation in demand driven initiatives, their involvement in aquaculture would be more sustainable in the long-term. However, collaborative mechanisms between the private sector, NGOs, local government and the DoF in the delivery of effective services are not well established and in many instances, there is a need to build the fish farming capacity of the partners. These are challenges that need to be addressed in the short term.

Unreliable statistics

Reliable aquaculture statistics are essential for policy making, evaluation of the service delivery by the DoF, and decision making for allocating resources to the sector. The limited operational budget and human resources of the DoF makes it impossible to collect adequate and accurate aquaculture statistics. Current information clearly suggests that the annual surveys undertaken in the past were inefficient and have led to contradictory results. This is one of the most basic challenges requiring attention.

CHAPTER IV DEVELOPMENT OPPORTUNITIES

1. Development Opportunities to Rural Aquaculture

Two opportunities are identified for the development of rural aquaculture. One is the approaches that strengthen resource base of small-holder farmers and the other is a potential technology that economises the limited pond inputs.

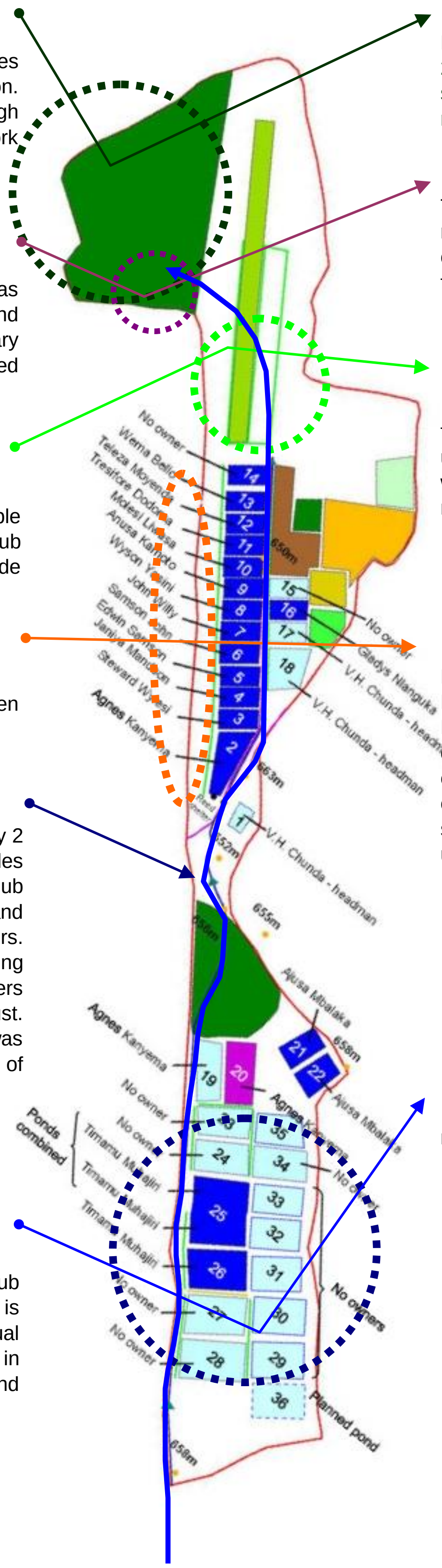
1.1 Existing Models of Integrated Approaches to Enhance the Resources of Small-holders

Table 1.12 explains a good example observed in two farmers' clubs in Chingale area, Zomba District on the utilisation of collective resources and opportunities of farmers by being members of farmers' clubs. For poor farmers, successful formation of a group can they not only utilise limited resources collectively, but also access to services. The average annual cash income for both clubs in 2004 was MK 13,506 which is more than a double of the average of other newly established clubs (MK 5,404). It also appears that the increase in the cash income from fish farming was possible by strengthening the service support. In Mawila farmers' club, after receiving various aquaculture related advises through the Pilot Project, their income from fish farming increased from MK1,736 in 2004 to MK3,470 in 2005 per member household. Figure 1.9 shows the integration of aquaculture with agriculture in the club land and its impacts. Such club acts as a potential model for supporting poor farmers through integrated agriculture with aquaculture component.

Table 1.12 Some examples in strengthening of resources for small-holder farmers by organising farmers' club in the case of Mawila and Limbikani farmers' clubs

Land and water	Both clubs have obtained new club land through negotiating with village headmen (Mawila: 3.6ha and Limbikani: 2.5ha). Constructing water cannel has provided members opportunities for establishing collective fishponds and starting aquaculture (60 HH in both Mawila and Limbikani farmers' clubs). Introduction of clubs as well as collective ponds have resulted in bigger bargaining power and efficient use of limited resources.
Feed, fertiliser, fingerlings, fish nets, etc.	Poor farmers are able to access to fish nets and wheelbarrows by joining the club. Members of the club can access to the loans for fertiliser as well as fingerlings provided by the NGO (67 % of households). Members are also able to allocate among themselves different roles in aquaculture such as broodstock rearing, fingerling production, and selected breeding, for effective aquaculture practice.
Human resources	Periodical meetings and collective club activities provide opportunities for members to share knowledge and technologies. When a representative of the club receives a training, the information will be transferred within the club through such opportunities.
Social capitals	As a collective entity, the club managed to collaborate in on-farm research with research institutes (e.g. Bunda College, Worldfish Center) and private firms (e.g. Monsanto company). Furthermore, farmers' clubs in the area have gathered together to form an association, called the 'Chingale Smallholders Farmers Association' for better access to services.

Source: Compiled by JICA ADiM Study Team (2003-2005)



Mawila farmers' club

Year established	2001
N. of members	37 HH
Area of club land	36,045 m^2
No. of fishponds	33 ponds
Area of total fishponds	7,586 m^2
Pond possession rate among club members	64.9%
	(2005)

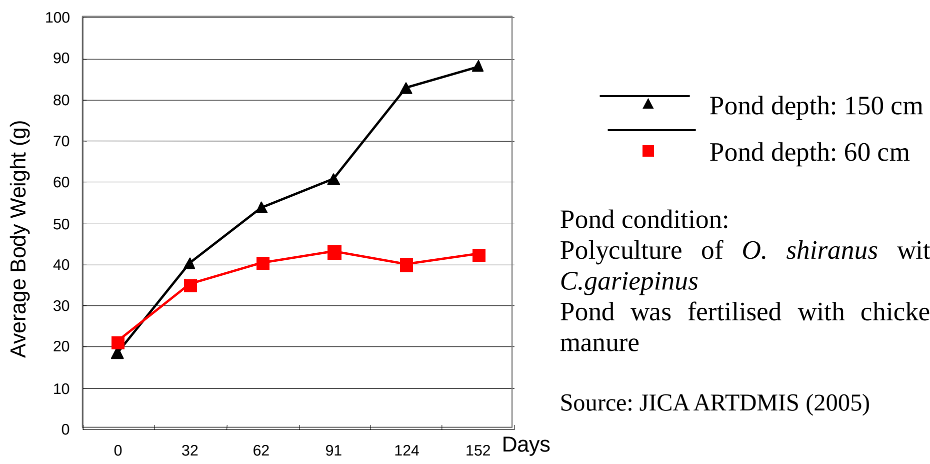
Source: Compiled by JICA ADiM Study Team

Figure 1.9 The integration of aquaculture with agriculture in the club land and their impacts (in case of Mawila farmers' club)

1.2 Progress of the Technology that Economise Nitrogen Inputs

Many fish farmers, except the more progressive individuals, are increasing the number, size and depth of their ponds as a means to increase fish production, rather than improving feeding, fertilisation and pond management. Given that most resource poor farmers rely almost exclusively on their maize crop for food security, it is not surprising that they are averse to the financial risk of improved feeding, fertilisation and management of fish ponds. It is mainly for this reason that they prefer a simple strategy towards enhanced fish production. However, this strategy may for many ultra-poor farmers be thwarted by the availability of land and access to adequate water resources.

Recent study by ARTDMIS (JICA) at NAC suggests that fish grew to a larger size in deep ponds in comparison to shallow ponds. Production of *O. shiranus* (in polyculture with *Clarias gariepinus*) increased from 18g/m^2 in 60cm deep ponds to 143g/m^2 in 150cm deep ponds. Similarly, survival rate also improved from 43% to 84% and the average body weight of fish was heavier in the deeper ponds (Figure 1.10). The reasons provided for enhanced fish growth in deeper ponds where that the increased water volume held more nutrients thus increasing feeding opportunities for the fish and that deeper ponds reduced the rate of predation and delayed sexual maturation. The shallowness of farmer ponds is either because they do not dig them deep enough at the outset or alternatively a consequence of a high seepage rate, suggesting that greater care has to be taken in selecting suitable sites for ponds.



Pond condition:
Polyculture of *O. shiranus* with *C.gariepinus*
Pond was fertilised with chicken manure

Source: JICA ARTDMIS (2005)

Figure 1.10 Growth performance of *O. shiranus* at different pond depths

Deeper ponds may therefore be one of the "best-practice" technologies that could be applied by especially resource poor farmers. Of course, production would be even further enhanced through managed feeding schedules, improved fish feeds, enhanced fertilisation regimens, higher stocking densities and species selection.

Through organising themselves into a group, poor farmers are able to strengthen their resources, in addition to inclusion of such technology which economises the limited resources, and consequently, increases their income.

2. Developing Opportunities to Commercial Aquaculture

The primary interest of Malawian fish farmers, as elsewhere, is directed towards "profit-maximisation" or cash income. This is true even among resource poor farmers, despite the fact that their behaviour and farming practices are often not geared towards this objective. The profitability (Y) of fish farming, whether undertaken on a small, medium or large-scale is basically affected by production quantity (Q), fish price (P), and production cost (C), as shown by Y = (Q x P) – C. Profit is therefore dependent on the farmers' capacity to increase production, reduce production costs and to secure a good market. Currently, in Malawi, there are some accumulation of knowledge in these factors and these knowledge is good opportunities for commercial aquaculture.

2.1 Accumulation of Knowledge on Fast Growing Technologies

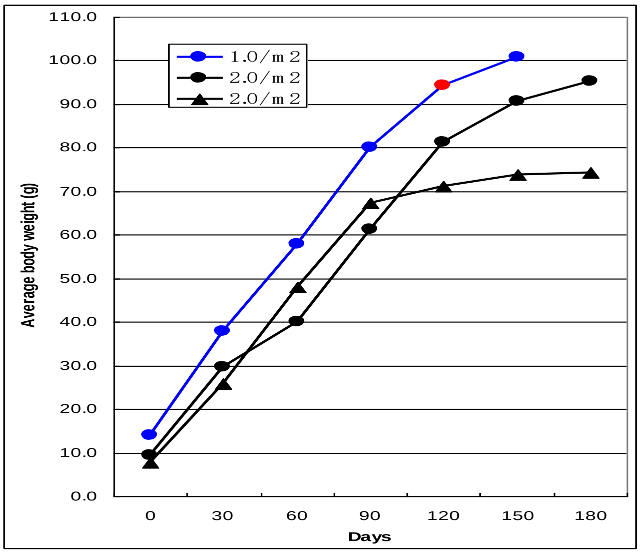
Stunting of tilapia species is the most fundamental issues for production of commercial sized fish. Currently, following three approaches are on examination and these results show the some opportunities to improve the growth of the culture tilapias in Malawi.

Introduction of alternative species

Currently, *O. shiranus* is the dominant aquaculture species in Malawi. It was selected mainly because of the ease with which it breeds in ponds. However, the species is phenotypically highly plastic such that it is able to adapt its reproductive strategies to the sub-optimal nutritional conditions in the ponds by maturing at a smaller size (<10g) and earlier age. It is not uncommon that fish <20g account for over 40% of the total harvest from farm ponds and this reduces the value of the harvest significantly (Omizo *et al.*, 2004). For these reasons farmers have expressed a desire to switch to *O. karongae* and *T. rendalli* (see Attached Figure A9; ADiM National socio-economic survey (2003); and Working paper No. 5). Considerable and valuable research on *O. karongae* was carried out during the CNRFFP during the early 1990s, which showed the superior growth performance of these species (CNRFFP, 1997). Currently there is a renewed research effort to assist farmers to switch from *O. shiranus* to *O. karongae* or *T. rendalli*, and to develop appropriate on-farm fingerling production techniques for *C. gariepinus*. *O. karongae* has also been selected as the species of choice by MALDECO for their cage culture operation and several farmers are now actively producing fingerlings of this species for grow-out.

The success of Asian tilapia farming also came about as a consequence of a shift in species, from *O. mossambicus* to *O. niloticus.* This shift occurred during the late 1970s and 1980s. However, during the early stages Asian farmers also experienced the problem of stunting in *O. niloticus*, which had a serious impact on the market since consumers demanded large fish. This provided the impetus for researchers to focus on selective breeding, as well as hormonal and genetic sex manipulation and ultimately to mono-sex all male farming of *O. niloticus*. The species is now generally regarded as the international tilapia species of choice. *O. niloticus* is also popular in countries where the market welcomes smaller fish. For example, in Egypt the market prefers fish in the 100-150g size class precluding the need for sex change. The inclusion of the above example is not to be seen to promote the introduction of *O. niloticus* into Malawi. It was merely included to illustrate the importance of applying appropriate technologies and disseminating the information to farmers. There are many valid and important reasons why *O. niloticus* must not be introduced into Malawi and these are dealt with elsewhere in the NASP.

It is important to note, however, that farmers are largely ignorant regarding the food and feeding requirements of fish and, as a consequence, may very well also be disappointed by the growth of *O. karongae* and *T. rendalli*. First and foremost, farmers need to be educated on the nutritional requirements of fish in ponds. Moreover, there is a need to aggressively promote *O. shiranus* polyculture with *C. gariepinus*. The ADiM Pilot Project results have shown that this practice leads to larger *O. shiranus* as a consequence of reduced competition for food and an increase in production of *C. gariepinus*, which feed on juvenile *O. shiranus* and the possible inhibition of spawing in *O.shiranus*.



Source: JICA ARTDMIS (2005)

Figure 1.11 Growth of *O. karongae* at different stocking density

Box 3 Use of Exotic Species in Malawi

The choice between endemic or exotic species for commercial aquaculture is largely guided by four principal factors. These are 1) the acceptability of the species on the market, 2) price, 3) growth rate and 4) available technologies. If an indigenous species cannot meet these requirements then the most common alternatives are Nile tilapia or common carp. The keen interest in these fish throughout Africa stems from the successful commercial farming of these species in Africa, Asia and elsewhere. The DoF is, however, well aware that the species are farmed in neighbouring countries.

Common and Chinese carp (grass and silver carp) were introduced into Malawi during the 1980s for experimental trials, but banned in 1991. The Fisheries Conservation and Management Act of 1997 prohibits the introduction of exotic species into Malawi. Hybrid red tilapia were brought into Malawi in 2002 from Malaysia. The fish were confiscated and not allowed for use in aquaculture.

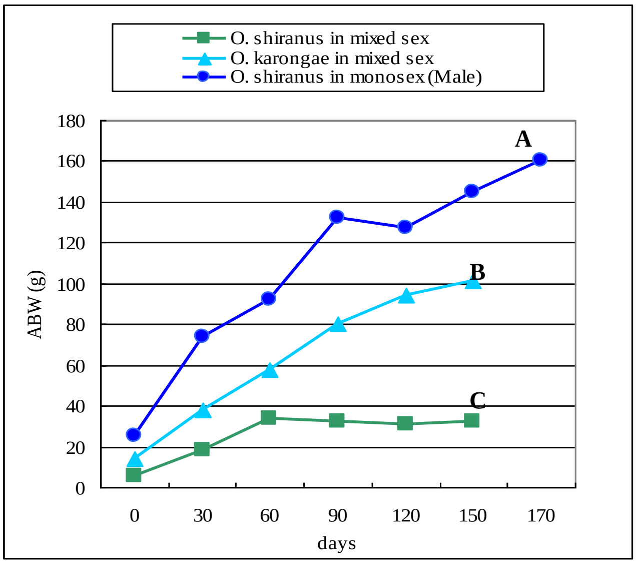
Introducing an alien species is a two-edged sword; it can either contribute towards the national fish supply or can devastate environment and cause irreparable damage to natural fish populations and community structure (e.g. the introduction of *Lates niloticus* into Lake Victoria). Alien species are recognized as one of the most significant threats to natural aquatic ecosystems. Although introductions of alien species have usually resulted in ecosystem disruption everywhere it has been tried, these species do provide opportunity to increase fish production and gaining economic benefit from aquaculture. A balance must be struck between the possible and likely ecological dangers and potential benefits. Therefore, policy makers must weigh the costs of ecosystem disruption against the possible benefits of species introductions. This requires a comprehensive risk assessment according to internationally accepted and recognised protocols (Attached Figure A10)

Mono-sex (all male) tilapia

All male, mono-sex culture is the most effective means to control reproduction of tilapia in fishponds and is widely applied throughout the world. There are four common methods to produce all male tilapia; (i) manual sexing, (ii) sex reversal using androgen hormones, (iii) hybridisation, and (iv) production of YY super-males. The only technique that has been tested in Malawi is hand sexing (ARTDMIS at NAC). However, the benefits of all male culture need to be carefully explored in relation to availability of fingerlings, associated production costs and the optimum price / size ratio, all of which may be variable depending on the location of the farm. These options need to be considered both from a small and large-scale perspective. From a small-holder perspective it is highly unlikely that hand sexing would be a sustainable option for many farmers as they would not be able to afford discarding 50% (on the assumption of a 1:1 sex ratio) of the fingerlings they produce and few have the available pond space to produce an adequate number of fingerlings to practice hand sexing. Hormonal sex change is costly and would not be sustainable by small-holder fish farmers, unless supported by donor intervention. Opportunity exists in the Lower Shire to hybridise *O. mossambicus* with *O. placidus*, however, this would have to undertaken under controlled conditions and would require evaluation before hybrid fingerlings are made freely available to farmers. Production of YY males also requires extremely controlled conditions and should be considered as a medium term option, though the cost of the fingerlings may be prohibitive.

The most appropriate options for large-scale commercial producers are hormonal sex change (though this could have an impact on the marketability, if the fish are intended for export) and production of YY supermales. Hybridisation of *O. mossambicus* with *O. placidus* could also be an avenue though under the same pre-conditions as mentioned above.

The figure below compares the growth rate among different tilapia species with different fish rearing techniques. All male, mono-sex culture of *O. shiranus* with low stocking density shows high growth rate (A). *O. karongae* shows relatively high growth rate with mixed sex culture (B). On the other hand, *O. shiranus* shows relatively low growth rate when they are stocked in high density without sexing (C).

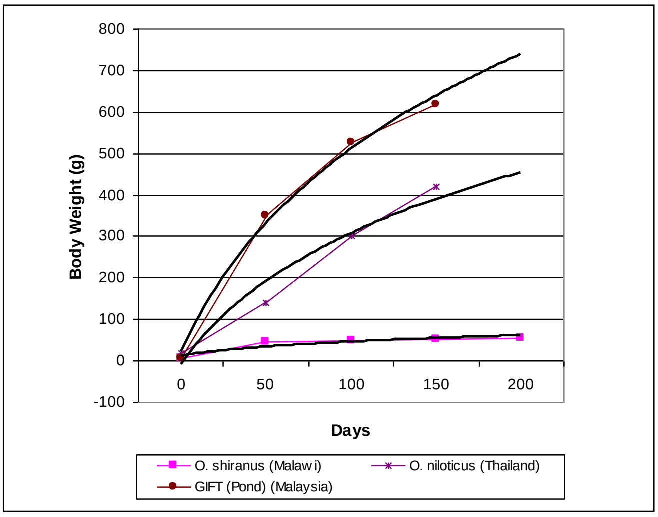


Remarks: A: SD=1.0/m^2, B: SD=1.0/ m^2, C: SD=4.0/m^2
Source: JICA ARTDMIS (2005)

Figure 1.12 Comparison of the growth rate among different tilapia species with different fish rearing techniques

Improved strains of indigenous tilapia

The GIFT tilapia (Genetically Improved Farmed Tilapia) is the most famous of the improved strains. Figure 1.13 shows the growth performance of the GIFT tilapia and *O. niloticus* in comparison to *O. shiranus*. The comparison is highly tenuous as the growth trials of the three species were undertaken under widely different environmental and feeding regimes. Nevertheless, it does illustrate the comparatively poor performance of *O. shiranus*. Many varieties are continuously being improved and show 20-80% faster growth rates than the original strain. The methods for strain selection are well developed and training is available at the WorldFish Center in Abassa, Egypt. Currently, three DoF staff, including the head of the NAC are studying genetic improvement technologies. In South Africa, research on the genetic improvement of *O. mossambicus* is ongoing at the University of Stellenbosch. The DoF should make use of these opportunities on the African continent to seek technical and financial assistance from donors to develop strains of fish with superior growth traits. Clearly, this requires a dedicated, long-term and highly controlled R&D environment and this has to be established at the NAC.



Source: Diana *et al.* 2004; Ponzoni *et al.* 2004; Bolivar *et al.* 2000; and Brummett *et al.* 1995

Figure 1.13 Growth performance of genetically improved tilapia

Stocking density

The entry point of large-scale commercial aquaculture is when a farmer sets certain production targets per unit volume of water or pond surface area. To attain a pre-determined production target requires that the pond be stocked with the correct number of fingerlings. Under-stocking may result in under utilisation of feed, high food conversion ratios culminating in higher production costs, while over-stocking may result in a decline in fish growth rate, though overall yield may increase. For example, growth of *O. shiranus* stocked at densities of 2, 4 and 8 fish/m^2 resulted in daily growth rates of 0.37g, 0.24g, and 0.13g, respectively, during a 112 day experimental period (CNRFFP, 1997), though higher yields per unit area of water were obtained under the highest stocking density. Selling smaller fish (20-40g) in villages in Malawi is not difficult and are often preferred by consumers. Thus, a greater yield of smaller fish may result in higher profits per pond, particularly in view of the observation that farmers realise a higher price per kg by selling individual fish than selling fish on a unit weight basis in urban or peri-urban markets.

An approximation of the number of fingerlings required per pond with surface area of A can be estimated by:

X = [(A x Y) / (W2-W1)] / H, where

A = Surface of pond (ha)
Y = Expected yield per ha (kg)
W1 = Average weight of initial seed (kg)
W2 = Expected average weight (kg)
H = Survival rate (%)

For example, if a farmer plans a yield of 40kg of 150g fish from a 200m^2 pond with 80% survival, he needs 357 fingerlings of 10g (1.79 fish/m^2) for stocking. The determination of appropriate stocking density is determined by target (and most profitable) fish size, and the availability of technology and inputs to realise the target.

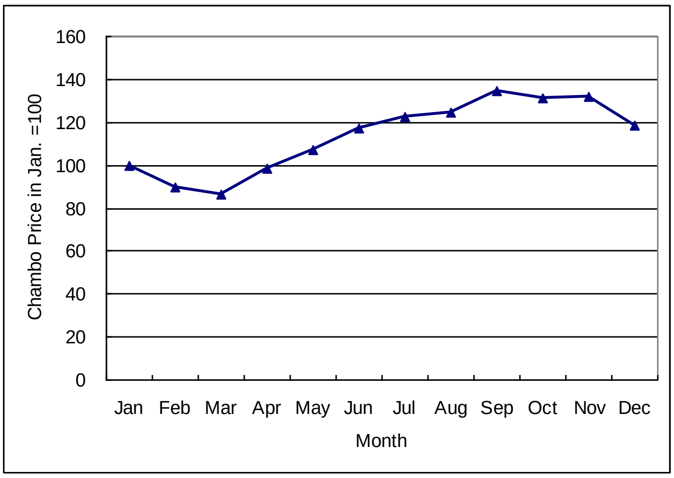
Based on experimental work undertaken by the NAC and at the Central and Northern Regions Fish Farming Centre in Mzuzu, the current recommended stocking rates in Malawi range between 2 and 4 fingerlings / m^2. However, there is no indication whether these stocking rates were recommended for optimal fish growth or yield. Moreover, there is no available mortality data to support the recommendations under farm conditions. It is highly likely that the mortality rate during the first week after stocking already exceeds 40% (Data obtained by ADiM Pilot Project). Thus, there is an urgent need to determine mortality rates during a complete grow out cycle under farm conditions. Only then can appropriate stocking densities be recommended. Based on the market price the farmer can then decide on the size at harvest and calculate an appropriate stocking rate and grow-out period to optimise profits.

2.2 Accumulation of Economic Information

Weak capacity of fish farmers in business planning is one of the constraints for commercial aquaculture. One of the reasons for such situation is inadequate information service regarding to aquaculture economy currently available in Malawi. Though not much study in this field has been done by the DoF, some existing information and knowledge may suggest a direction for future study.

Price information

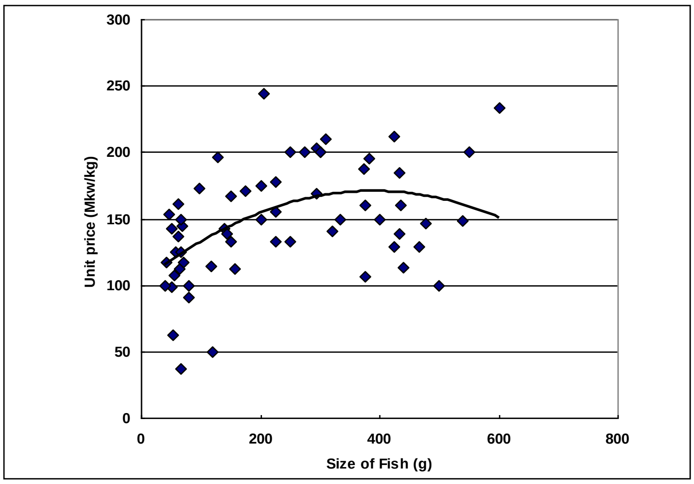
It would appear that the proximity to urban areas has a significant effect on how farmers sell their fish. In urban areas, farmers sell their fish per unit weight, while in rural areas farmers sell their fish on a per piece basis. For the more business orientated farmers in urban areas there is a clear need to understand seasonal price fluctuations (determined by lake fish supply and demand) and to schedule their harvests accordingly (Figure 1.14). Secondly, to maximise profit farmers need to understand the relationship between fish price and size upon which to schedule their production and harvesting cycles. Figure 1.15 shows that the price of tilapia in urban markets increases up to 400g, where after it decreases. Hence there is a need to build capacity in business management and planning.



Source: FRU, (2000/ 2001)

Figure 1.14 Changes of Chambo price by month (1996-2001 Average)

In rural areas, the seasonal fluctuations in demand and supply are obscure. Nevertheless, rural farmers must also be aware of the relationship between size and price and plan their production and harvesting schedules accordingly. Several of the Innovative Farmers have recognised this and are now applying this knowledge to enhance profitability.

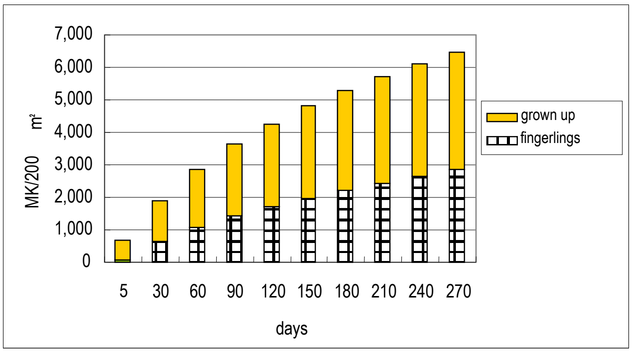


Source: JICA ADiM Study Team (2003-2005)

Figure 1.15 Relationships between size and price of fresh tilapia at Lilongwe market, May 2003

Figure 1.16 shows the simulation of fish sales under two different harvesting (cropping) strategies. The model predicts that a 4 month-cycle yields a higher gross income (MK 8,513/200m^2 pond) than a 9 month-cycle (MK 6,472/200m^2 pond). Although fish in the 9 month cycle reach a mean size of 114g (grey colour) and fetch a price of MK 142/kg, a large proportion of the biomass consists of smaller, low value fish (checked pattern). This is largely a consequence of in-pond breeding and stunting. In the 4-month cycle, fish are harvested before they begin to stunt at an average weight of 77g and sold at MK 126/kg. However, the total biomass harvested is greater, resulting in higher income. Many farmers have a protracted inter-harvest period. This behaviour has a negative effect on overall farm productivity and profitability.

The simulation model provides valuable insights into management dynamics. Clearly, there is a need for further case studies such that farmers may optimise income from their fishponds.



The two figures show a simulation model for profit differences between two different cropping schedules for *O. shiranus*. The graph on top shows a single 9 month cropping cycle. The profit is MK 6,472/ 200m^2 pond. Average individual size above 20g is 144g. Yet, half of the biomass is occupied by fingerlings. The bottom graph illustrates two cropping cycles of 4 months each. Each of the 2 harvest generates MK 4,257/ 200m^2, with a total profit of MK 8,513. The results show that the two cycle cropping pattern is more profitable.

Unit: MK

	1 cycle cropping pattern	2 cycle cropping pattern
Gross income	6,472	8,513

*fingerling and feeding costs are not included in the calculation

Data source: JICA ARTDMIS (2005)

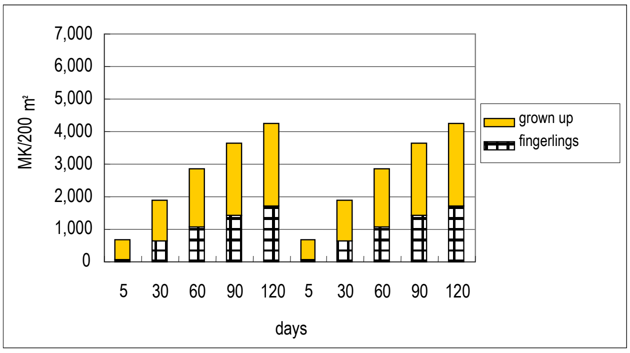


Figure 1.16 Simulation of fish sales under two different cropping systems

Cost information

The major costs in Malawian small-holder aquaculture are capital costs (pond construction) and recurring production costs, (feed, fertiliser, seed and labour). Under current farming practices the costs are minimal, which allows even resource poor farmers to enter the sector. However, they do not have the resources to maximise fish production and profit.

Feed and fertiliser: Feed and fertiliser are the most important cost items in commercial and small-holder aquaculture. In the rural aquaculture sector in Malawi, as elsewhere in the region, maize bran coupled with green compost manuring is the most common practice. Green compost manuring has been demonstrated to be ineffective in SE Asia (P. Edwards, AIT, personal communication). The current practices are largely dictated by the fact that these commodities are mostly available free at household level and farmers do not have the resources to purchase other food and or fertiliser. However, plants with high C:N ratios such as Vetifer grass, black jack, cassava leaves, papaya leaves, sweat potato leaves, coco-yam leaves, etc. are relatively well known among farmers. These provide an option for farmers to focus on the production of *T. rendalli*, which becomes almost exclusively vegetarian at a size greater than 12-14 cm. Some farmers are aware of this and survey results have shown that those farmers who regularly feed adequate plant material are able to produce large *T. rendalli*, which according to them is the preferred species in rural areas and fetch a much higher price than *O. shiranus*. However, further studies are required to optimise the production of *T. rendalli*. Moreover, the relationship between water exchange rate and water fertility is not well understood under Malawian small-holder pond conditions. Knowledge of this relationship will go a long way towards providing farmers with more appropriate advice on species selection, as well as food and feeding practices and fertilisation.

Results of ARTDMIS at NAC have shown that production could be increased to 200g-400g/m^2 under optimum fertilisation practices. Clearly, improved nitrogen and phosphorous pond inputs, such as manure, inorganic fertiliser and more appropriate feeds are necessary for aquaculture to develop in Malawi. However, this is constrained by access to adequate quantities of manure or inorganic fertilisers and the availability and cost of formulated feeds. The average number of livestock per fish farmer household is around 4 chickens and less than 1 goat. There are only two feasible options for farmers to access manure. Chicken manure is available in broiler and layer farms in Blantyre and Lilongwe (most often the manure is available free of charge). The cost of transport is however such that most individual farmers will find it extremely difficult, if not impossible, to cover the transportation costs. Farmers in peri-urban areas could however organise themselves to purchase manure as a group, thereby reducing the individual costs. For this to become feasible requires training in co-operative (group) business management. Secondly, farmers could hold more livestock. This option however requires that farmers have access to initial capital and knowledge of animal husbandry.

The new cage culture initiative of MALDECO provides an opportunity for fish feed manufacturing in Malawi, which could have spin-offs for the more aggressive small-holder fish farmers. The success of the cage culture initiative depends largely on the development and manufacture of adequately formulated feeds. The currently available fish feed in Malawi is sub-optimal, both in terms of its formulation and quality and the cost of imported feeds are as high as USD450 per ton. MALDECO has taken up the challenge and will be undertaking the necessary research to formulate and manufacture their own feeds, using locally available ingredients and a minimum quantity of fish meal. Given the rapid progress of the MALDECO project it is reasonable to predict that a least cost feed will soon be produced in Malawi. This provides a future opportunity for those small-holder farmers who are intent on making a commercial success of their fish farming activities.

In the short term, it is crucial that farmers are made aware of opportunities presented by farm made feeds. Several of the Innovative Farmers have made good progress in formulating and manufacturing their own feeds using ingredients such farm grown soya, maize, maize bran, rice bran and brewers waste, while others plant high protein vegetables on pond dykes exclusively for the feeding of *T. rendalli*.

Table 1.13 attempts to summarise and consolidate some of the currently known and or suggested "best-practice" technologies.

Table 1.13 Summary of potential "best-practice" technologies for maximising profits.

Technology	Impact	Comments
Expansion of the use of *O. karongae*	Minimum mature size is over 80g, Uniform size under mixed-sex culture up to 80g under current culture practices. Improved nutrition may well preclude the need for all male fingerlings.	Relatively little is known about the species under culture conditions, though positive results have been shown by Pilot project. Need more basic research, particularly on nutrition and reproduction.
Production of *T. rendalli* using high protein vegetable matter	*T. rendalli* matures at a larger size than *O. shiranus*. Known from elsewhere that *T. rendalli* can be produced very successfully on appropriate vegetable matter.	Farmers must begin to appreciate the daily requirements of *T. rendalli* and feed their fish accordingly.
On-farm fingerling production of *C. gariepinus*	Provides opportunity for polyculture with *O. shiranus* for higher yields.	NAC needs to initiate on-farm participatory trials to produce fingerlings.

Technology	Impact	Comments
Mono-sex culture (hand-sexing)	No stunting, resulting in yield of over 200g/m^2/annum	Requires minimum equipment such as net and buckets and knowledge, but may very well be uneconomical .
Sex changed tilapia using androgen hormones	Hormonal sex change is the most cost effective way to mass produce all male fingerlings.	Environmental and health concerns are increasing, but technology is used internationally. However, it is unlikely to be sustainable unless supported by donors. It is not suitable for small-scale farmers.
Improved strains of indigenous tilapia	4th generation shows 40% improvement in growth	Very effective technology to improve production. Needs to be applied to *O. shiranus*, *O. karonage T. rendalli and O. mossambicus*. Work on *O. shiranus* currently in progress in Malawi and on *O.mossambicus* in South Africa.
Testing of improved strains of *O. mossambicus*	Genetically improved *O. mossambicus* show 30-60% faster growth	University of Swansea (UK) and Stellenbosch (South Africa) working on strain selection of *O. mossambicus*. Information sharing might be first step.
Improved feeding, using farm made feeds (e.g. Soya, maize, and other suitable local ingredients	Enhanced growth and production, reduced FCR, reduced cost of production	Nitrogen content of maize bran too low to achieve profitable growth rates
Establishing dedicated hatcheries / fingerling producers.	More efficient use of grow-out ponds	No particular constraint. Stock large (> 5cm) and young fingerlings in 'grow-out' ponds. It is necessary to develop proper fingerling production units.
Least cost formulated fish pellets	Promote commercialisation of fish farming by local entrepreneurs (small to industrial scale).	Unstable supply of soya beans and other raw materials are possible risks
Improved pond fertilisation using inorganic fertiliser or animal manure	Enhanced growth rate, reduced FCR and lower cost of production.	Green compost does not provide the required phosphate and nitrogen levels needed for optimal primary production. Farmers need greater appreciation of the value of proper pond management.
Improved stock management, through regular grading	Enhanced growth, reduced FCR and lower cost of production	Currently farmers do not manage their stock, resulting in food and nutrient loss
Multi-cropping	May increase profits by 30-40%	Effective for *O. shiranus* mixed-sex culture under optimum fertilisation and feeding regimens. Farmers will only adopt multi-cropping if they increase their production.
Better pond site selection to reduce seepage	Reduce nutrient loss and improve primary production	Reduction of seepage is one of the most fundamental aspects of pond fish farming
Deeper and larger fish ponds	Improved fish growth and production	Experimental trials have confirmed field observations.
Group pond construction by farmers club	200m^2 pond can be constructed within 3-4 days	Need good leadership and facilitator to mobilize community/club labour force

Source: JICA ADiM Study Team (2003-2005)

3. Opportunities to Improve Support Services

The capacity of farmers to adopt some of the "best practices" as described above are largely dependent on the DoF extension staff, applied research at NAC, capacity building by and support by donors and NGOs and other farmers. However, currently, the aquaculture extension services of DoF are seriously constrained and face many challenges. Principally these include limited human and financial resources. Government has recognised the problems and has adopted several remedial actions including, (i) selection and intensification such that services are geared towards specific target zones and or target groups, (ii) devolution of the extension services as part of the Decentralisation Policy, and (iii) possible participation of the private sector in service provision. The overall lack of support services is recognised and specific strategies to address the problem have been formulated.

3.1 Selection and Intensification of the Government Services

The Department of Fisheries (DoF), being a public sector, has an obligation to provide continuous and impartial supports to all beneficiaries. Yet, its resources are limited. Considering such situation, the DoF needs to maximise the efficiency of services based on its contents, quality, and intensity reflecting on needs of beneficiaries. Selection of geographical priority zones, especially for rural aquaculture, need to be in line with the area development plan/programme. Rural aquaculture has more than one objectives and therefore being dealt as one of the components of livelihood enhancement measures. Bearing that in mind, priority areas for the DoF to enforce aquaculture have been selected (Table 1.14, Figure 1.16, and Figure 1.17).

Four aquaculture target groups, each of which requires different levels of institutional support, have been identified in Malawi. The four groups, their indicators and support needs are illustrated in Table 1.14.

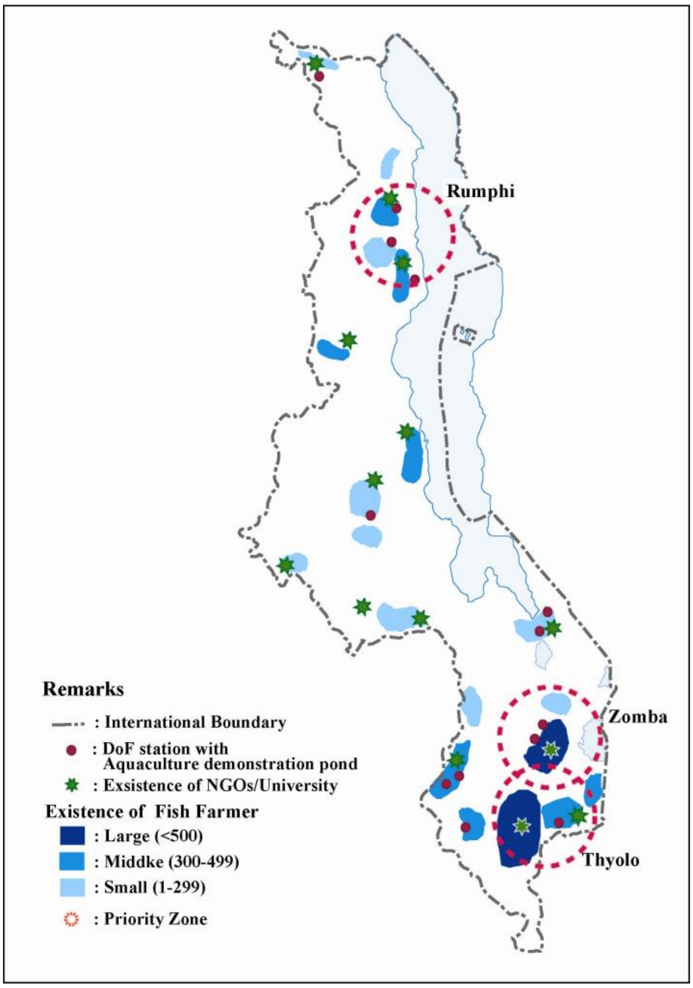
Table 1.14 Selection and intensification of the government services

Category		Indicator	Quality/intensification of services
Rural aquaculture [Priority area] • Zomba Dist. • Thyolo Dist. • Rumphi Dist.	Subsistence	• Practised by small-holder households • Low-input, low output • Un-scheduled harvesting • Fish retained as "savings" (fish keepers) • Food in-secure throughout the year • Most fish produced used for home consumption • Risk averse • Feed mainly maize bran and use green compost	• Poverty reduction and welfare • Holistic support to improve livelihood rather than fish production. Strengthen existing function of fish pond ► Role of the DoF - act as facilitator and link various supporters who are active in multi –sector agriculture development.

Category		Indicator	Quality/intensification of services
Commercial aquaculture [Priority area] • Southern part of the lake Malawi • Lower Shire	Intermediate	• Food secure throughout the year • Main purpose of aquaculture is profit • Regular feeding and fertilizing of ponds • Extensive to semi-intensive technology • Inorganic fertiliser may be used • Use farm made feeds [For example] Certain "Innovative Farmers"	• Enhanced production • Access to loans • Introduction of "profit-maximisation" technologies • Enhanced business management capacity ► Role of the DoF - provide intensive research and technical support
	Intensive	• Semi-intensive to intensive technology • Middle to large-scale where aquaculture provides >85% of income. • May be integration with commercial livestock production • Substantial and scheduled harvests and sales at urban markets • Income from aquaculture ensures self-sufficiency • Use farm made and commercial feeds [For example, G.K. Aquafarms]	• Introduction of modern technology • Financial support from private financial institutions • Legal support including tax exemption ► Role of the DoF - work together as research partners
	Highly intensive	• High investment in human capacity • High investment in hard & soft ware • Target is export market as well as domestic market • Cost of technology born by company • Generate employment • Tax payer [For example, MALDECO]	Basically independent ► Role of DoF - environmental and production monitoring ► Collaboration in technology development and training

Source: JICA ADiM Study Team (2003-2005)

Priority areas for rural aquaculture development are illustrated in Figure 1.17, and include certain areas in Zomba, Thyolo and Rumphi, followed by Mulanje and Mwanza. Criteria for prioritisation are described together with the Figure. Some physical as well as socio-economic factors that determine the priority area are illustrated in Attached Figures 11 – 15. For commercial aquaculture, the lower Shire valley have been identified as high priority areas, principally because of the favourable temperature conditions for intensive warm water fish culture (Figure 1.18). Other potential areas are specific localities within the Nkhotakota, Mchinji and Dowa Districts (along the Bua River), because of water availability and the proximity to the Lilongwe market.



Criteria for prioritisation

In the case of rural aquaculture, harvested fish is often used for household consumption or sales within community. Therefore, geographical and physical factors which affect growth of fish are not as critical as for commercial aquaculture. At the household level, factors such as labour, pond input and land availabilities as well as agricultural diversification have stronger impacts than the geographical factors.

A. Number of existing fish farmers: the number of farmers that satisfies a critical mass for efficient extension service provision is the important factor for rural aquaculture. Farmers can also actively interact each other.

B. Availability of service providers: The presence of NGOs and universities engaging in aquaculture activities is important for the DoF to provide effective extension services.

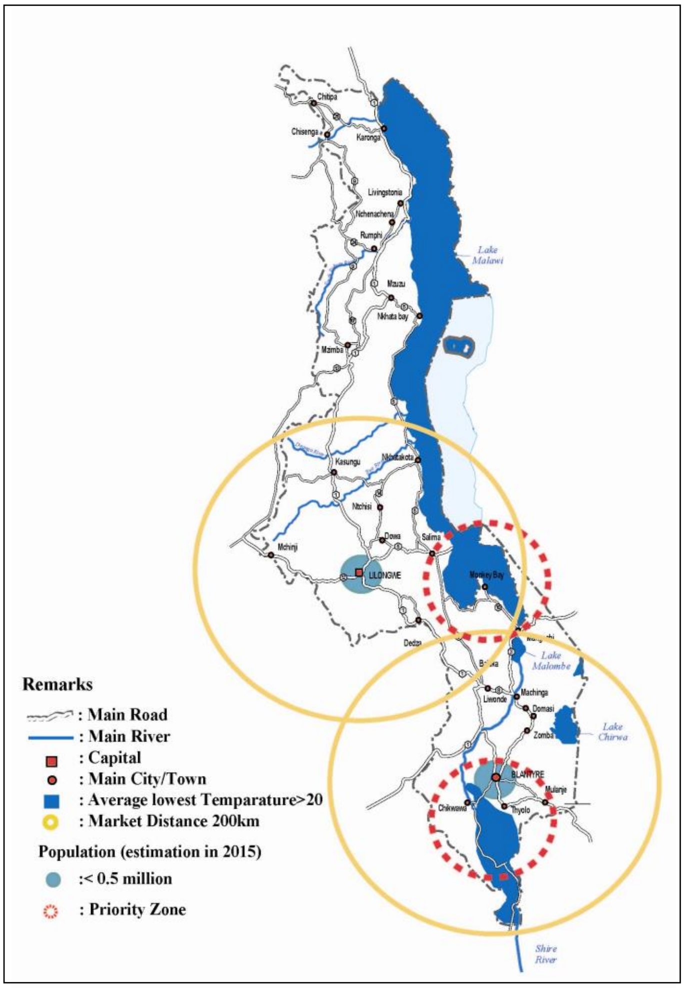
C. Rainfall: rural aquaculture is highly dependent on rainfall/ spring water. The area with annual average rainfall of less than 600mm is not selected as a priority area for rural aquaculture.

D. Air/water temperature: The growth of tilapia is influenced by water temperature. Therefore, it is ideal to select an area with minimum average temperature of 20 degrees Celsius. However, for rural aquaculture, the temperature is not an absolute requirement.

Other considerations

- Soil type and chemistry
- Conflicting activities (e.g. agriculture, mining)
- Environmentally sensitive areas
- Political factors to ensure balanced development

Figure 1.17 Potential area for rural aquaculture



Criteria for prioritisation

Commercial aquaculture targets city markets for sales of fish produced and hire inputs required for aquaculture including capital, labour and feed from the city. Therefore, the areas which are adjacent to cities with natural conditions are favourable for commercial aquaculture. Again, depending on the scale and production system, the priority area may differ.

A. Air/water temperature: Higher the water temperature, better the growth of fish. Water temperature at Lower Shire and Lake Malawi remains 20 ^{o}C in winter season.

B. Water resources: Since commercial aquaculture requires large quantity of water, the sites need to be close to rivers or lakes that can provide sufficient water throughout the year.

C. Market and accessibility to inputs: Transportation cost in Malawi is high. Therefore, farmers can substantially cut down overall cost through reducing transportation cost by being adjacent to the cities. At the same time, many of factories producing side products such as fishmeal and manure that farmers can utilise for aquaculture are found in big cities (e.g. Lilongwe and Blantyre).

D. Accessibility to services: the distance to the service centre is not critical if the farmers are benefiting enough from aquaculture that they pay for the services. However, it is convenient to be closer to the centre such as NAC which farmers can obtain various aquaculture technologies.

Other considerations

- Soil type and chemistry
- Conflicting activities (e.g. agriculture, mining)
- Environmentally sensitive areas
- Transportation and communication

Figure 1.18 Potential area for commercial aquaculture

3.2 Devolution of Extension Services

Devolution of the Government extension services to the District level is regarded as a basic instrument for more efficient service delivery. It provides the mechanism to place the service at the most appropriate point to reach the greatest number of beneficiaries. The fundamental focus of government should be to provide clear policy and direction, an institutional and regulatory framework for sustainable resource management and to support research and training (Figure 1.19).

Devolution may hold specific advantages for the development of the aquaculture sector in Malawi. The DoF could for example retain their function for the provision of “specialist” aquaculture extension services and training of other extension agents. The District Assemblies on other hand could take responsibility for more “generalised” aquaculture extension under the umbrella of agriculture extension. However, it requires that the agriculture extension officers are appropriately mobilised and effectively informed and trained such that they better appreciate the intrinsic value of aquaculture as part of agricultural diversification.

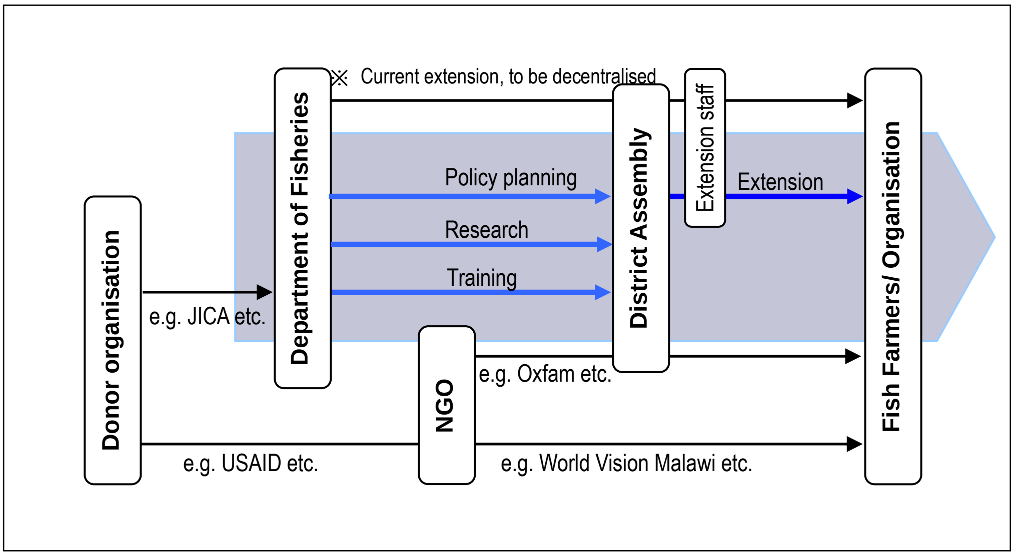


Figure 1.19 Flow of aquaculture services

3.3 Possible Participation of the Private Sector in Service Provision

Privatisation of government fish farming stations

Majority of the government demonstration stations has been constructed with supports from donors during 1980's and 1990's. However, after the withdrawal of donors, such stations are not functioning properly due to the lack of budget. Simultaneously, extension activities being implemented at those demonstration stations are loosing its importance in recent years as more attentions are paid to on-farm research. The Project, therefore, has proposed privatisation of the government stations and equipment as one of the draft strategies in 2004. Table 1.15 summarises before and after the leasing of the Kasinthula aquaculture station to the private firm. Since the lease, the firm has renovated the station and provided job opportunities for local people. Recently, the Mzuzu fisheries station has leased its pellet machine to the private firm. These cases of the 'privatisation' may increase once the NASP is implemented and be found to be effective and efficient for developing aquaculture.

Table 1.15 Impact of privatisation of Kasinthula Aquaculture Station

	Before privatisation (2003)	After privatisation (2005)
Contract	• 10 years lease contract • Leased 18 ha of pond area (rearing and grow-out ponds) including the working shed close to the ponds, yet JICA constructed hatchery facility is not leased. • Licensing of using common carp • Supply of technical information obtained from the pond to DoF	
Facilities	• Except for the ponds that are utilized by JICA staff, others were lying idle and derelict • No power connection • Over grown grass around ponds • Clogged drainage and underground broken pipes • Water was free of charge	• Rehabilitation of the ponds and the area took about 3 to 4 months • Constructed his own hatchery facility • Power connected from ESCOM • Monthly payment of water (10,000 MK) • Pick-up van, water test kit, etc.
Staff	15 staff, including 4 staff paid by JICA	• Retained three JICA staff and employed another nine from outside • DoF has retained two officers and 6 workers (including watchmen)
Activities	• Fingerlings of common carp, Mozambique tilapia and cat fish were produced; data not available • Fingerlings were sold to farm in lower shire • Some table-size fish were also produced.	• Starting experimental harvesting and sales of common carp (500g) and tilapia (50-100g) st super market in Blantyre • Applying formulated feed using by products from food factories
Financing	• Annual budget (2003) was MK 3,303,700 • Except personnel, budget for operation has largely depends on JICA finance	• 10 year lease at annual payment of USD 3,500

Source: JICA ADiM Study Team (2003-2005)

Privatisation of government fisheries stations offers a further and very practical opportunity to promote the development of fish farming in the country. At present, all government aquaculture stations are under resourced. The effect of this is that officers are not able to effectively interact with farmers in their areas, the supply of fingerlings to farmers is poor and, in general the stations cannot effectively perform their role as demonstration facilities. The lack of sufficient pond inputs for the stations, and operating costs for basic equipment such as motor cycles is common. With little contact and support from the DoF, it is apparent that officers stationed at these facilities are largely left to their own income generating activities and specifically rely on the land surrounding the ponds. This further discourages effective extension activities. However, the situation does provide an opportunity for privatisation and improved extension services. One of the models that could be considered is for the DoF to develop an arrangement whereby interested officers may apply to run the station for their own account. This would relieve the Department of having to pay his salary. In return for the privilege, they would be required to promote fish farming in their areas aggressively, failing which the station reverts to the DoF. Initially such an arrangement would have to be on a trial basis and would require monitoring by the DoF. This provides a scenario for a win-win situation.

It is believed that even the smaller stations are viable to run as independent small business operations, especially as they are all sited in localities with exceptional perennial water supply. This approach could have 4 major positive outcomes.

- The station would be operated at maximum potential, and become a good example to other farmers (Currently, the low level of fish production at most of the stations discourages, rather than encourages farmers to adopt or improve their fish farming practices).

- There would be an increased incentive to operate the station effectively.
- The DoF would no longer have the budgetary burden of supporting the facility and the staff.
- Extension support from the station would improve, as this would be a requirement in exchange for the use of the station and its agricultural land.

In order to test this approach before a nationwide privatisation process commences, it would be appropriate to include these options into the regional focus area programmes. Chisenga station may provide an excellent test case as it is currently operated more or less independently due to its geographic isolation.

The opportunities for the private sector participation in aquaculture development

Majority of farmers depend on other farmers for aquaculture information (Attached Table 20). There are often farmers in each area who are influential to other farmers due to their innovativeness. Table 1.16 summarises numbers of visitors to 25 innovative farmers and two farmers' clubs the Project have selected for its Pilot Project. Especially for 7 innovative farmers and two farmers' clubs, they receive over 100 visitors annually. An extensionist visits approximately 100 households per year providing extension services (ALCOM, 1995). The figure, therefore suggests that the farmers and farmers' clubs selected under the Pilot Project have high potentials as the extension centres within the area.

Table 1.16 Number of visitors at innovative farmers and two farmers clubs in 2004

Unit: persons

<table>
<tr><th></th><th>Innovative farmers</th><th>Farmers club*</th></tr>
<tr><td>Group visitors</td><td>30.0</td><td rowspan="2">144.0</td></tr>
<tr><td>Individual visitors</td><td>32.8</td></tr>
<tr><td>Number of farmers who had visiting of innovative farmers</td><td>7.4</td><td>-</td></tr>
<tr><td>Number of farmers who adopted new technologies initiated by innovative farmers</td><td>89.5</td><td>-</td></tr>
</table>

Remarks: *Average of Mawila and Limbikani farmers' clubs (Zomba District)
Source: JICA ADiM Study Team (2003-2005)

The private sector, consisting of producers and service providers (e.g. feed manufacturers) should be considered as a valuable resource that can effectively complement government extension services at different levels. For example, many farmers rely on their peers for information and fingerlings. Therefore, by selecting certain leading farmers and investing in building their capacity will benefit the development of the sector at minimal cost. Moreover, joint government-private sector research can lead to greater efficiency in developing new and appropriate technologies, which can be disseminated to other farmers. The above examples illustrate some of the opportunities with which to enhance the participation of the private sector in the development of aquaculture in Malawi. Table 1.17 shows how the private sector can participate in bringing the full benefits of aquaculture services to producers.

Table 1.17 The role of the private sector in aquaculture development

Roles	Descriptions
1. Fingerling production	The private sector already plays an important role in seed supply. To supply adequate numbers of high quality and healthy fingerlings of desired species on a timely basis the DoF needs to support selected farmers who have the required infrastructure and the necessary business and technical skills and capacity. Potential partners include middle-scale fish farmers and farmer clubs
2. Feed production	Development of formulated feeds is largely depended on good nutritional research and interested commercial feed companies. Such companies could be valuable research partners to develop cost effective fish feeds.
	Potential partners include animal feed and milling companies.
3. Extension	NGOs are already good promoters of aquaculture in the country. They have particular strengths and capacities for the initial stages of promoting aquaculture, such as motivating and mobilising communities and training of selected individuals. A further advantage is that NGOs have their own financial resources.
	Potential partners include NGOs and farmers who have good leadership qualities (e.g. some of the Innovative Fish Farmers)
4. Research	Farmer can identify the best and most appropriate technologies through participatory research. Such opportunities are open to all types of farmers depending on the subject. The degree of participation will vary depending on their capacities.
	Potential partners include small, medium and large scale farmers

Source: JICA ADiM Study Team (2003-2005)

3.4 Effective Extension Tools

Table 1.18 attempts to summarise some extension tools (approaches).

Table 1.18 Summary of potential extension approaches that could be adopted to enhance aquaculture development

Type of method	Strength and Constraint	Impact and Comment
Class room training	**Strength** • Intensive information can be provided **Constraint** • One-way flow of information • High cost	To expose farmers with new concepts certainly has an impact. However, it needs to be combined with more participatory methods for farmers to adopt what they learn in the classroom.
Training and Visits	**Strength** • Intensive information can be provided • High impact through actual visit **Constraint** • One-way flow of information • High cost (lack of financial sustainability) • Tight schedule	T & V is expensive and is not sufficiently participatory. However, visiting a farm has great impact on trainees and provides an opportunity to discuss ideas. For greater impact, T & V can be combined with other more participatory methods.
Decentralised system	**Strength** • Improved accountability • Improved coordination with activities of other agencies • Better political commitment **Constraint** • Greater political interference • Utilisation of extension staff for other local government duties	Despite delays the process is now in progress. Decentralised extension has definite advantages as outlined above and it is strongly recommend. Pivotal for the success of decentralised extension services is for the DoF to sensitise District Assemblies on the value of aquaculture.
Fee-for-service/ private extension	**Strength** • Financially sustainable **Constraint** • Information exchange will only occur with business oriented farmers who can pay • Will only reach a very limited number of farmers	Most of the beneficiaries would not be able to afford the service. Therefore, public funds would be required to contract private service providers. It is highly unlikely that the treasury will be able to sustain such services.
Open Field Day	**Strength** • High impact with an actual demonstration • Can accommodate many participants **Constraint** • Short duration • Often limited to small number of technical topics • Needs seed money • Restricted to a limited area	An open field day provides an opportunity for farmers to visit fishponds and learn from experts as well as fellow fishfarmers. The effectiveness of Field Open Days has been demonstrated by NAC. It has an impact on a large number of people for a short period. However, information often flows one-way.
Farmer Field School	**Strength** • Cost effective • High impact through actual visits • Can focus on technical aspects or developing decision making and business skills. **Constraint** • Need a strong leader to access expertise and support. • Restricted to a limited area	Farmer trainers can play a significant role in aquaculture extension and contribute to the existing extension system. Selection of the location of schools is critical for success. The Innovative Farmers Approach of ADiM Pilot Project provides the basis for further development.

Source: JICA ADiM Study Team (2003-2005)

4. Lessons Learned from the Pilot Project

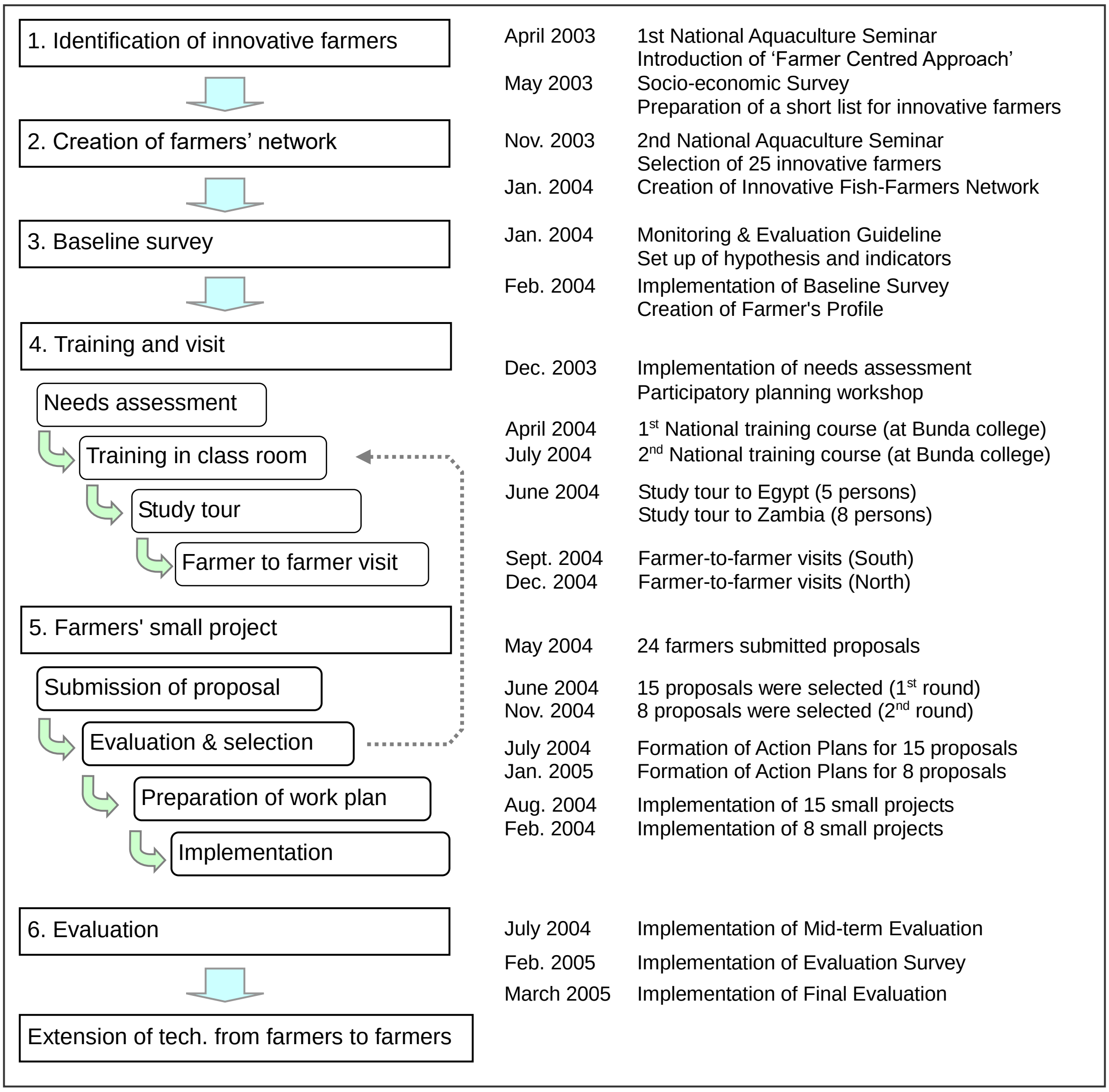
4.1 The Objective and Approaches

Fish farmers in Malawi largely depend on other fish farmers for aquaculture related information and purchase of fingerlings (ADiM Working paper No. 3). There observed a number of leading farmers in each geological area during the national survey. Promoting farmer-to-farmer extension through strengthening capacities of such farmers can largely contribute to efficient as well as effective aquaculture extension in Malawi. The farmer-to-farmer extension does not only subside the existing government extension system, but also has its own merit. Being handled by farmers by themselves, advises and information exchanged through the farmer-to-farmer extension will be more farmer-centred.

Fish farmers in Malawi are not uniform. Their objectives for initiating aquaculture are different. Their financial and social situations also vary. Therefore, to begin with, the Project targeted two different groups of fish farmers in the Pilot Project and sought possibility of farmer-to-farmer extension within each group. One group consists of farmers with relatively high income and innovative ideas that can lead their surrounding community members, whereas the other group consists of farmers' clubs having subsistence farmers for their members. The Pilot Project, through two approaches, 'innovative farmers approach' and 'farmers' club approach,' aims to promote active interaction among members of each group and verify quality of information exchanged through providing technical training. The most efficient and effective forms of farmer-to-farmer extension is identified and reflected to the NASP.

4.2 Innovative Farmers Approach

Figure 1.20 explains the process of the innovative farmers approach. The objective of the approach was to verify the effective technology development and extension on commercial aquaculture system through capacity building of so-called 'innovative' farmers who are considered to be a leading or a key farmer in the area. Under the Pilot Project, 25 innovative farmers are networked, and given opportunities to exchange their ideas. At the same time, the Project has provided various trainings to enhance their knowledge and ability in aquaculture. It was expected innovative farmers to learn and apply what they have learned into practice and share with their communities.



Source: JICA ADiM Study Team (2003-2005)

Figure 1.20 Process of the innovative farmers approach

Results

Three assumptions were set up in order to seek development potentials of the innovative farmers' approach. The assumptions are:

- Innovative farmers quickly adopt new ideas, therefore they are more productive,
- Innovative farmer's network leads information and technology transfer among the farmers, and
- Innovative farmers have an influence on their communities, therefore they promote aquaculture extension.

Table 1.19 Summary of results of the innovative farmers approach

Assumptions	Indicators	Results (comparison between before and after the implementation of the Pilot Project)
Innovative farmers quickly adopt new ideas, therefore they are more productive	1. Introduction of new technologies through trainings 2. Record keeping of fish farming activities 3. Drop out rate from the network	a. Feeding methods: farmers using soya beans have increased from 4 to 10. Among those 10, 3 formulate their own pellet using fish meal and poultry manure. b. Use of inorganic fertiliser: farmers using inorganic fertiliser have increased from 4 to 14 c. Sales of harvested fish: there was decrease in sales of fish by the fishpond and increase in the village market (24％ to 36％) d. No significant change was observed for the growth of fish e. 2 out of 25 (8%) has dropped out from the Pilot Project
Innovative farmer's network leads information and technology transfer among the farmers	4. Number of technologies shared through the network	11 out of 16 (69％) declare that they have learned from other members. 87% of such information was obtained during farmer-to-farmer visits indicating the strong impact of visiting actual sites. On the other side, 7 out of 16 farmers (44%) are said to be information provider. Despite all being 'innovative' farmers, it is less than half whom actively providing information to others.
Innovative farmers have an influence on their communities, therefore they promote aquaculture extension	5. Number of visitors farmers have received 6. Evaluation from surrounding communities	Number of annual visitors farmers have received is 62.8 in average. The farmer who has received the maximum number of visitors scores the figure of 240. There were 3 farmers whom received less than 10 visitors in 2004/2005. Majority of community members who live adjacent to innovative farmers appreciate their presence. Innovative farmers provide information and sell fingerlings and suckers. On the other hand, there has also been a report on negative impact of innovative farmers including a dispute over the water/ land usage between an innovative farmer and community members.
Others	7. Cost	Under the Pilot Project, average training cost for each innovative farmer was approximately USD 1,960. It is relatively high compared to the other training course for farmers' trainers which is approximately USD 500-100.

Source: Data obtained by ADiM Pilot Project (2004-2005)

Lessons learned and development potentials for the approach

Innovative farmers recognise following three positive aspects in networking themselves.

① Enhancement of information exchange among farmers

② Building capacity on negotiating skills against the government

③ Building up new partnership with universities, NGO, and donors

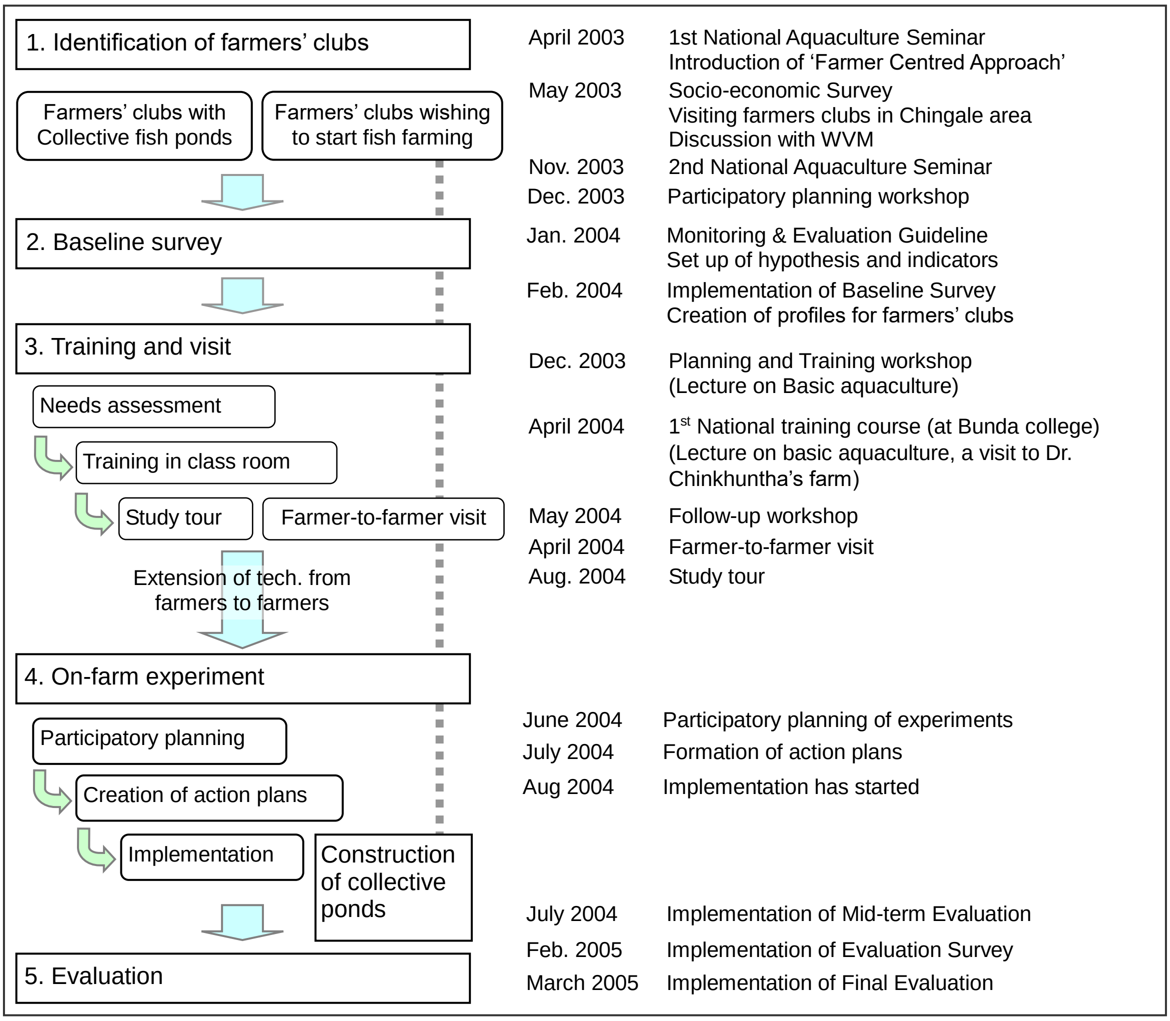
Amongst those, the expected output during the implementation of the Pilot Project was ①. Yet, ②and ③, not as direct outputs of the Pilot Project, are also critical factors for the further success of their network. It is important to enhance the network as an organisation in line with ②and ③ in the NASP as it has already established the foundation. The network, the Innovative Fish Farmers Network Trust (hereafter called IFFNT), has been legally registered to the government during the Pilot Project as an organisation that represents fish farmers in Malawi. At the same time, the members had various opportunities to discuss and integrate with other stakeholders of the sector. Through such opportunities, the DoF has announced to provide some assistance from their HIPC funds[1]. Other organisations, such as WorldFish Center and USAID are now inviting IFFNT for their workshops.

Challenges that IFFNT faces is that the IFFNT is a national organisation with small number of innovative farmers having no solid network at neither regional nor district level. In another word, IFFNT can be a lobby against the government, but is not ready to accept nor utilise the services/ assistance provided by the government. The two major reasons are the lack of accountability to receive public services/ assistance to small number of current membership, and inefficiency of providing services to members whom are scattered all around the nation. Considering such challenges, the increase in membership is one of the measures that IFFNT can take in future. However, the expansion of the membership needs to be in line with its principles. The members have to be someone who is innovative and able to guide his/her community for efficient and effective information exchange. At the same time, establishing a group at where each innovative farmer is based, and forming a cluster of members within IFFNT, for example, based on technology they want to emphasise on, can further enhance efficiency and effectiveness of information exchange. Recognition of such key farmers and financial assistance by the government are necessary for IFFNT to overcome challenges and foster into a sound independent entity.

4.3 Farmers' Club Approach

The 'farmers' club approach' seeks an effectiveness of targeting small-scale farmers in the clubs for development and extension on small-scale aquaculture system. The Pilot Project studies two existing farmers' clubs, Mawila and Limbikani farmers' clubs on their collective pond management as well as their activities as clubs. Through providing trainings, the Project aims to build further capacity of those two successful or 'model' clubs and such clubs to influence on and be duplicated to other newly established clubs. The Project also identifies the role of an NGO, the World Vision Malawi (WVM) as an effective intermediary.

[1] Budget which has been allocated aiming for the poverty reduction under MPRSP. DoF applies such fund for aquaculture development.



Source: JICA ADiM Study Team (2003-2005)

Figure 1.21 Process of the farmers' club approach

Results

Three assumptions were set up in order to verify the feasibility of the farmers' club approach. The assumptions are:

1. Farmers benefit household stability by being a member of a farmer club,
2. Aquaculture can contribute subsistence farmers in the club, and
3. Successful farmer club will be duplicated in the other area.

The results of the Pilot Project were summarised in the Table below.

Table 1.20 Summary of results of the farmers' club approach

Assumptions	Indicators	Results (comparison between before and after the implementation of the Pilot Project)
Farmers benefit household stability by being a member of a farmer club	1. Comparison between model farmers' clubs and newly established farmers' clubs on socio-economic conditions (e.g. income, productivity, etc.)	Average annual income for the model clubs is MK 29,680 whereas the income for the other three clubs is MK 17,371. Productivity for the model club is MK7,200/ha whereas it is MK6,010 for other clubs.
Aquaculture can contribute subsistence farmers in the club	1. Income from aquaculture	Two model clubs share MK 1,700 from aquaculture in 2004. For other 4 clubs, though 36 members possess fishponds, nobody generated any cash income in 2004. After the implementation of the Pilot Project, cash income from fish farming among members of Mawila farmers' club has increased from MK1,736 to MK3,470.
Successful farmer club will be duplicated in the other area	2. Process of duplication of the successful farmers' club to others 3. The roles being played by successful farmers' club	There observed appliance of new technologies in 4 clubs. There was one club, Teuka farmers' club, that has constructed 11 new collective ponds. There has been active intervention between Mawila and Teuka farmers' clubs. Members of Mawila voluntarily advised on pond construction. Mkamwalekani farmers' club being adjacent to Mawila, observed and learned how Mawila farmers' club practises.
Others		-

Source: Data obtained by ADiM Pilot Project (2004-2005)

Lessons learned and development potentials for the approach

The major positive characteristics of the farmers' club approach are explained in Chapter IV. In addition, following aspects are observed in the farmer-to-framer extension within the clubs.

<u>Diversity of technologies transferred:</u> there have been various technologies introduced into the farmers' clubs through farmer-to-farmer visits and various trainings implemented during the Pilot Project. Such technologies include not only aquaculture technologies but also technologies on small-scale irrigation, crop production, manuring, etc. Aquaculture extensionists tend to restrict their extension services in aquaculture sector whereas farmers, both club members and innovative farmers, do not specialise in aquaculture but practice agriculture as well as aquaculture. Therefore, farmer-to-farmer extension can provide more holistic extension service on rather integrated agriculture and aquaculture technologies.

<u>The role of NGO:</u> majority of members of the club understand their challenges and are very much interested in learning new information. However, their capacity to put learned information into a practice is yet still weak. The intervention of outsiders, such as NGO, is necessary for members to get together and collect some seed money. In order to do so, mutual trust needs to be built among members and between clubs and NGO which requires time.

<u>Understanding of the community</u>: in order to gain new club land, members need to obtain permission for land as well as water usage from the community, especially the village headman. Coordination and consensus building among community members is therefore a must. Once the village headman understands and become a club member, such process can be achieved rather swiftly.