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Innovative Extension Services for Technology Transfer: The Case of Aquaculture in Northern Malawi

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Abstract: *Aquaculture started a long time ago in Africa, but only in recent years did visible production systems emerge that are sustainable for rural areas. Such systems demonstrate increased fish production and higher incomes as shown by examples from Egypt, Nigeria, Zambia and 33Uganda. In Malawi, aquaculture growth has been slow and positive impacts recorded from past efforts were short-lived. This presentation outlines an innovative extension approach that gained national visibility. Examples were drawn from three districts of the Northern Region of Malawi, where per unit fish production from ponds doubled, incomes rose while the recruitment of fish farmers overshot targets. Participation by men and women, and youth indicated that the technology reached across the whole society. The GIZ Aquaculture Value Chain Project (2018-2022) implemented an approach that followed a sequence of activities that emphasised participation at all farming levels that was cupped by coaching loops. From sensitization workshops of stakeholders arranged in collaboration with the District Executive Committees of Council, to Training of Trainers {ToTs) followed by technical trainings of fish farmers arranged in groups, field activities were consolidated by coaching loops which were reflectively anchored on fish farmers providing solutions to problems they encountered. From an initial target of 400 fish farmers, which was adjusted to 700 half-way into the implementation period, the project recorded assistance to 853 by year 2022, who established farm business units. Through the project cycle of 2019-2023, there was a suite of key must-do activities which were diligently conducted with the assistance of a local NGO. During coaching purposeful questioning, mirroring and feedback were spiced by a visioning exercise. Coaching was mostly facilitated by the local NGO employing services of mostly graduate interns. The number of trained fish farmers eventually reached 1,121. The current average fish productivity of 2,090-3,800 kg/ha is the highest ever increase ever reported by fish farmers in Malawi from a baseline of 500-1,000kg/ha recorded by IMANI (2018). By* *establishing quality feed suppliers, teaching and demonstrating hatchery operations, and providing marketing support, the project established modern fish farm units that can be replicated in other countries. There was an offshoot of Peri-Urban fish farmers around Mzuzu City under Lusangazi Conservation Trust. Hatchery operations were anchored by pilot operators, who incidentally realised higher income from sales of fingerlings than from on-growing market units. To gain more control over the breeding process, some of the farmers adopted the hapa-in-pond system. Several innovations have emerged such as fish-banana and fish-sweet potato integrations; other integrations are possible as with pig or poultry. We believe that this approach could be replicated in other countries like Namibia where fish farming and related technologies have yet to be firmly established. For sustainability, the "Follow-up and Coaching Loop" and what is dubbed the "Light House Approaches" are the critical highlights. Since then, Fish Farmers' groups in Rumphi district have formed a Fish Farmers Association to work with the District Development Committee while in Mzimba district, fish farming has been adopted by District Development Committee for annual internal budgetary support. With large numbers of farmers, extension support through private sector suppliers of fingerlings and feeds can eventually emerge for a win-win situation, overcoming the limited effectiveness of government extension support. The cooler climatic similarities between Malawi and Namibia offer interesting parallels for slowness of rural fish farming development, but the approach in the northern region of Malawi demonstrates an effective approach to assisting rural farmers.*

Keywords: extension methods, coaching loops, lighthouse approach, aquaculture, Northern Malawi.

INTRODUCTION

Globally, aquaculture production has been growing steadily at an annual rate of 3.3-9.5 % for the past 10 years (FAO 2024); therefore, it is one of the fastest growing sectors in the food industry. Partly, this is prompted by the slow or no growth in the capture fisheries that is being experienced worldwide. It has been recorded that aquaculture has surpassed capture fisheries so that 51% of fish production was recently recorded from aquaculture. Most of the growth in aquaculture has been registered in Asia while Africa is only now waking up to the challenge as shown by growth recently registered in the following countries; Egypt (1,451,841 tonnes), Nigeria (296,1919 tonnes), Uganda (112, 344 tones) and Tanzania (129,415 tonnes), among the few countries who have taken up the industry seriously (FAO 2020). Meanwhile, most capture fisheries have reached the limit of growth (FAO 2024).

While recognising the need for a holistic approach to include infrastructure, markets, government policies and skills development, the need to operate aquaculture as a business has proven to be the sustainable approach for rural fish farmers. Aquaculture Value Chain Project in Malawi was implemented from 2018-2023 and put forth outreach interventions in the delivery of practical trainings and coaching to fish farmers. Messages to farmers acknowledged that the business approach might be the better approach (GIZ/COFAD/Umodzi Consortium 2018).

Malawi is one country where serious fish catch declines and stagnant capture fisheries from lakes have caused losses in per capita fish supply and where the premium fish like Chambo (Lake Malawi Tilapia species) have experienced escalated prices (M'balaka *et al.* 2020). Furthermore, the country is facing increasing demand for fish products to the extent that Malawi has turned from being a net exporter of fish products to a net importer (Tran *et al.* 2022). The country's population is also facing undernutrition among children and food insecurity (IFPRI 2018). On the other hand, Malawi has a high potential for aquaculture farm production because of abundance of water sheds having quality soils for pond construction. Furthermore, the high surface area of inland water bodies (24, 202 km^2) offers potential for cage farming. Hence, the need for supplementing fish food supply from other sources has been recognised, and aquaculture was identified to offer the greatest potential for growth. However, in spite of advances in research in developing local technology, Malawi continues to suffer from food deficits. Untapped resources include a wide range of fish species which may be suitable for aquaculture (Costa-Pierce *et al* 1993). The local tilapias have not benefited from substantial genetic growth improvement studies (Ambali *et al.* 1999, Maluwa *et al.* 2006, 2007; M'balaka *et al.* 2012; Valera *et al.* 2013) while the supply of quality feeds has partly been resolved by the establishment of fish feed manufacturers like Aller Aqua, Novatek, and Skretting in nearby Zambia (Musuka *et al.* 2023). Zambia has provided potential for feed supply; inspite of this, the sector is growing very slowly. Local technologies have also included feed formulations, water quality and hatchery management; the industry continues to be dominated by small-scale fish farmers who have no impact on the emerging local markets which are being satisfied by foreign fish from large producers including Lake Harvest (in Zambia and Zimbabwe) and ''Boss'' from China. High yields of over 3,000 kg/ha have been reported from research centres (Russel *et al*. 2008). A similar project undertaken in Cameroon showed that at average standing stock of 1,062-4, 710 kg per ha was profitable (Brummett 2011), therefore location and the object of rural development is crucial in determining whether or not particular productivity levels are profitable.

Therefore, this study is aimed at re-focussing on the extension approach to unlock the holistic potential of subsistence, small-scale, semi-commercial and commercial fish farmers. While this report is confined to activities in the Northern part of Malawi where the main author obtained most of the experiences, the whole country has benefited from the AVC Project.

Regarding extension practices, it is not the first time that extension was given prominence in fish farming technology transfer. A similar project was designed for the Northern region in 1990s with partnership funding from the EU. Recently, the WorldFish conducted a study consisting of over 751 fish ponds using the FSRP (Farmer-Scientist Research Partnership) method on which RESTORE analysis testing of the IAA (Integrated Aquaculture-Agriculture) technologies was conducted, especially highlighting the fish-rice integration (Dey *et al.* 2006).

Therefore, this project considered a different mode of delivery with a broader scope of stakeholders. Based on the "Pasteur's Quadrant" in which basic theories are merged with technological innovations, the extension method adopted here was a mixed-mode harnessing innovations where possible.

PROJECT OUTPUTS

As part of the Global Program of the German Ministry of Economic Cooperation and Development (BMZ), under the initiative of "One World, No Hunger'' which resonates with the Sustainable Development Goal No 1, the Malawi AVCP (Aquaculture Value Chain Project) was a country package prepared under the Ministry's Global Programme on "Sustainable Fisheries and Aquaculture" with the following outputs;

I. More Fish, More Work; energising fish farmers to upscale fish production from small-scale pond aquaculture with concomitant raise in incomes and employment;
II. Fish Farmers' Associations to be organized into economic units by re-organising fish farmers groups to make more them more viable and improve overall performance, and
III. Empower fish farmers to optimise integration with crops to foster sustainability and exploit market opportunities in the locations.

THE EXTENSION METHODOLOGY

The tenets of the extension methodology revolved around team work and creating a buy-in participatory approach, after assembling a team of various backgrounds and from organisations like governmental, international and local NGOs. The team easily agreed on the milestones and on the process of the framework and conceptual guidelines to promote fish farming and to ensure uniformity in the extension approach. Overall, the AVCP was planned in accordance with the Results-Oriented Approach, which basically emphasizes outputs rather the process so that the focus during delivery of services is on the end products or outputs such that the ends justify the means (Sartorius 2023). The most effective and economical process is predetermined having a clear view of the goals to be achieved. This approach has successfully been used for projects in Education, Healthcare and Business sectors where it has achieved increased productivity, enhanced decision making and improved accountability (www.linkedin.com/pulse/results-oriented-approach-amurag-huria). This extension methodology has combined the "Visit and Training" methodology which has been articulated widely by the agricultural extension services and promoted by organisations like World Bank (2023) and FAO (2019). In the main thrust, the extension programme of the Aquaculture Value

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Chain Project drew up a number of activities ranging from sensitization workshops to ongoing evaluation; annual and mid-term assessment to reset goals and an end of the

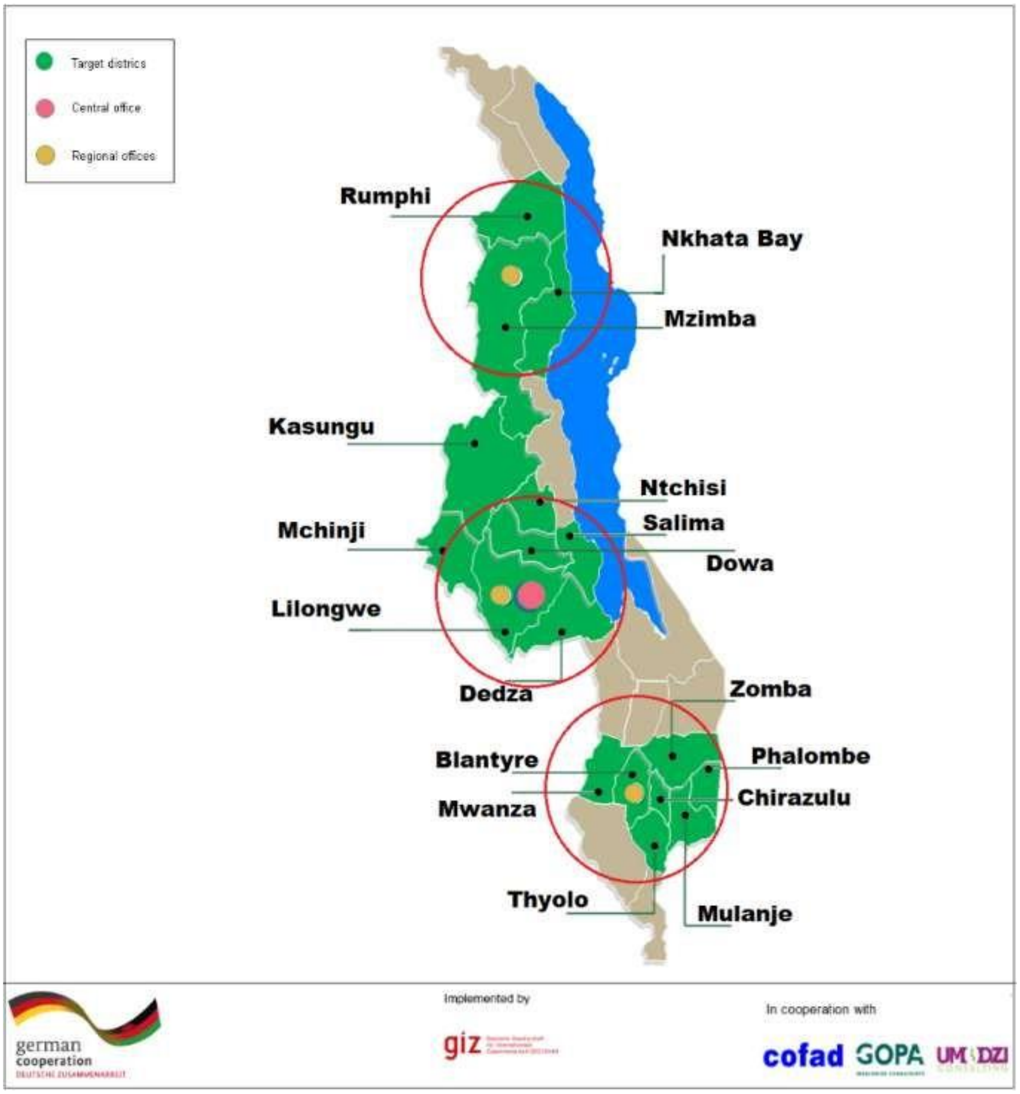


Figure 1. Districts affected by the AVCP in Malawi.

program report regarding achievement of final outputs. During implementation, the programme was energised by staff refresher courses and annual planning workshops to keep implementation focussed on goals but underscoring the ever-evolving situation while keeping the programme grounded on real-life nuances. In the Table below is a brief sequence of major trainings that were planned and carried out;

The Fish Farmers' Extension Methodology: Follow-up and Coaching Loops Concept:

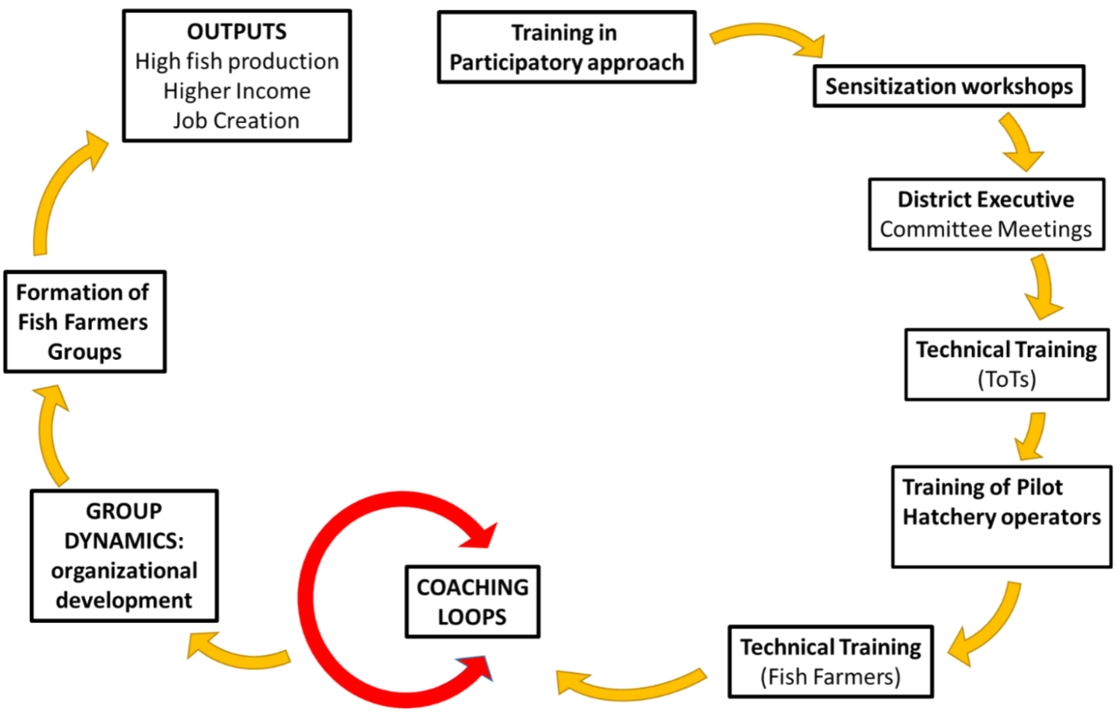


Figure 2. Flow Chart of the Extension Methodology incorporating Coaching Loops.

Table 1. Activities and Content of Message.

Type of Activity/Training	Brief description of content
1. Creating Awareness about GIZ & DoF AV Project	Cross-section representation for first contact seeking relevance
2. Training of Trainers	Strengthening of local leadership
3. Fish Farmers technical training	Being a mixed group instructions were directed at practical skills (psychomotor) and affective domains
4. Pilot hatchery training (inclusion of the hapas-in ponds system)	Inclusion of latest breeding systems like cages-in ponds systems
5. Methodology training (participatory approach) by GIZ	Participatory approach to ensure all are made to feel they have invaluable role to play

6. Tablet-Use Training by GIZ (moving towards digitilization)	Digitalization among fish farmers groups allows storage of data and demystifies use of tablets.
7. M& E Trainings and Refresher course	Refresher course topics arise from recent field observations
8. Coaching loops (FF and FG)	Coaching loops entails that fish farmers discuss solutions to identified problems under a trained facilitator
9. Group Dynamics	Organisational development, effective leadership, understanding the group, drawing the constitution, effective communication and conflict resolution.

Training started in August 2019 and was virtually finished by 2022; there were two technical packages taking 4 days using 14 modules comprising of 70-80% hands-on and 20-30% theory translated and delivered into the local dialect (chiTumbiuka and chiTonga). All the trainings were conducted in the field using fish farmers demonstration ponds instead of government stations or facilities.

Data submitted by fish farmers; the NGO were routed through COFAD staff to ensure that subsequent projects will now have access to baseline information; this was assisted by the introduction of tablets for staff. This was especially useful during the COVID pandemic, when field visits were reduced to a minimum.

OUTPUTS, RESULTS & DISCUSSION

Targets were all achieved within the period planned for the project. By the end of the project, during the end-line evaluation as many as 1,120 fish farmers participated in the overall activities of the project according to the recent evaluation report (Everest Intelligence Consult Ltd 2023).

While the original target was 400, this was more than doubled within the project period such that 887 economic units out of the 1,112 individuals that were trained had established into viable economic units in the three districts of Rumphi , Mzimba and Nkhata Bay. Each one of these fish farmers has more than two fish ponds adhering to an agreed criteria suggested at the start of the project to resolve the wide-spread scarcity of fingerlings in the region. There was need that fish breeding and on-growing are synchronized, therefore, ownership of one fish pond was inadequate to create self-sufficiency on the farm.

Table 2. Fish Farmers under AVCP, compared with DoF database (Dec 2022)

Region & Districts	Dove GoM FF Database	FF foreseen tobe trained	FF with AVCP as % of DoF census	FF trained	% FF trained of foreseen
North Region					
1. Mzimba	767	250	32%	202	80%
2. Nkhata bay	636	250	40%	393	157%
3. Rum phi	386	250	65%	258	103%
Sub-total North	**1.789**	**750**	**42%**	**853**	**114 %**

Footnotes; -FF stands for Fish farmers; GoM is Malawi Department of Fisheries

Table 3. Fish pond production from fish farmers in Northern Malawi, 2019-2022.

Year	District	No Ff	Total area m^2	Harvest Kg	Productivity Kg/ha	Price MK/kg	Value MK
2019-2020	Mzimba	4	2,915	612	2099	2,000-2,500	1,530, 000
	Nkhata Bay	4	1,940	424	2186		848, 000
	Rumphi	5	2,182	489	2241		978, 000
	Average	13	7, 082	1525	2167		3,356, 400
2020-2021	Mzimba	1	645	158	2450	2,500-3,000	375, 000
	Nkhata Bay	3	860	263	3058		612,000
	Rumphi	4	2,180	481	2206		1,130,000
	Average	8	3,685	902	2448		2,117, 000
2021-2022	Mzimba	3	1,455	692		2,5000-4,500	2, 330,000
	Nkhata Bay	4	1,644	576	4756		2,653, 550
	Rumphi	5	2,398	833	3504		1,740, 000
	Average	12	5,497	2,101	3822		6, 123, 000

The current productivity of 2, 099-4, 756 kg per hectare has never before been recorded on any fish farmers ponds outside research stations raising expectations of farmers and proving that this extension method is superior to previous ones. The highest previous fish productivity was only 900-1500 kg per hectare. This demonstrates an increase of 2.3-3.1 times of fish production translating into valuable income for fish farmers.

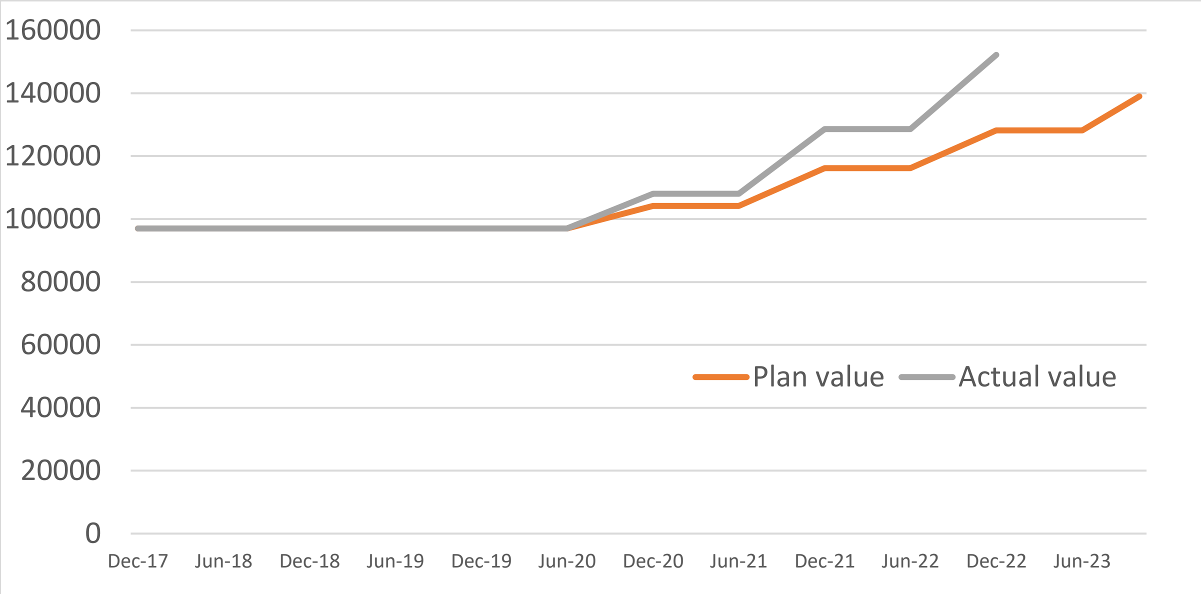
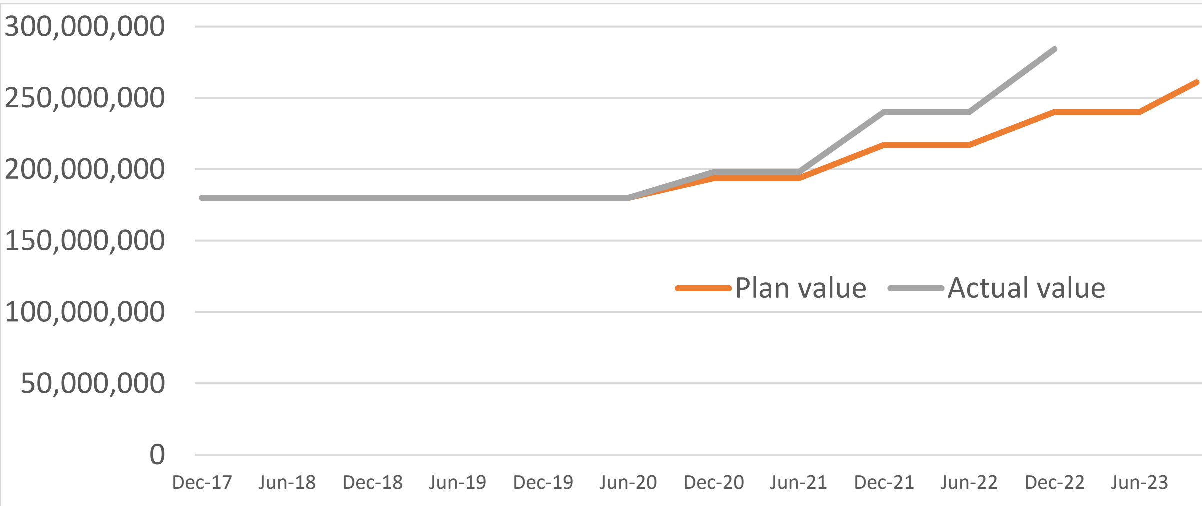


Figure 3. The increase in value of fish production over the project period, 2018-2023.

New jobs were created along the value chain for both genders as FTE (Full Time Employment).



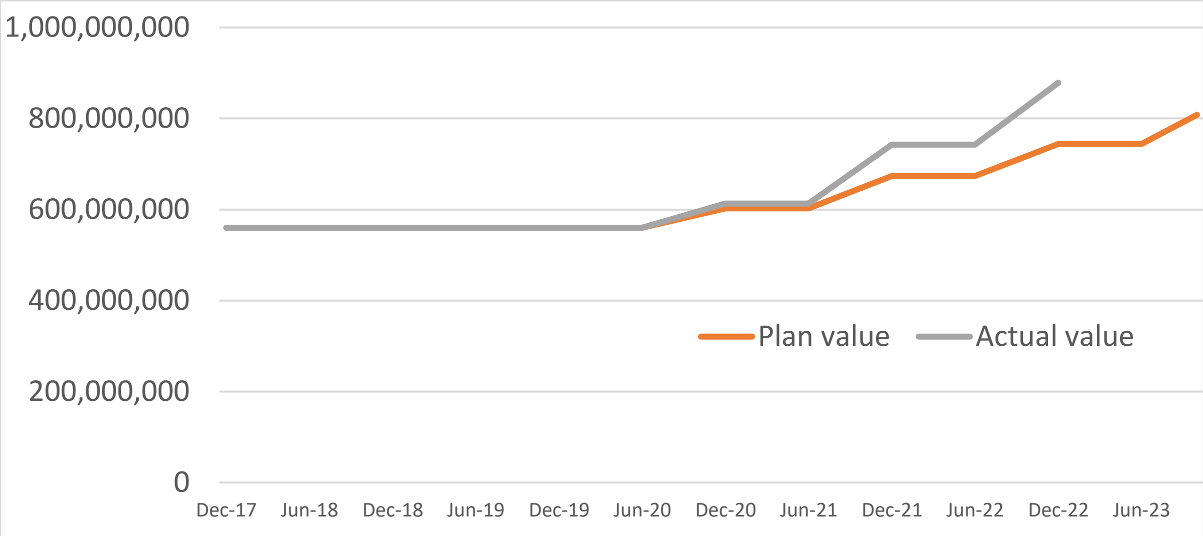


Figure 4. The creation of jobs over the project period, 2018-2023.

FISH FARMERS LED-INNOVATIONS

Partly as a result of this extension fish farmers were motivated to start options that were feasible within their localities. One of the most visible was the integration of banana plantations with fish farms; this practice organically grew into a commercial practice among fish farmers around Mzuzu City fish farmers the Lusangazi Conservation Trust. These fish farmers have access to new disease-free banana suckers sold at the nearby Lunyangwa Agriculture Research Station. Shown below is one example of a fish farms which has successfully integrated the two crops i.e. fish and bananas.

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INTEGRATED FISH-CROP FARMING:

Fish-bananas integration

Figure 3. Bananas planted in Integration with fish ponds, Mzuzu, Malawi

A simple Annual Indicative Partial Budget Analysis is given below to illustrate the economic value of this integration (Table 1 for a Fish Farm of 3.0 ha; Bananas of 2.5ha) (Engle CR 2010).

Table 4. Partial Budget Analysis, 2019-2021

ITEM	Fish (Kwacha)	Bananas (Kwacha)
Fish sales	4, 950, 000	
Fingerling sales	5,610.000	
Labor/salaries	1,602,000	1, 602, 000
Banana suckers' sales		4,300, 000
Banana fruits sales		4,541, 700
Maintenance/ repair	265,800	
Weeding		180, 000
Transport	2, 880,000	
Inputs (manure)		530, 000
Feeds for fish	1, 510,000	
Pond Construction-depreciation	800,000	NA
Tools and Equipment	250, 000	250,000
Gross (Profit) Margin	**6,932,200**	**6,529,700**

Using a partial budgeting technique proposed by Engle (2010), this integration shows great promise to generate profits from both crops. There is now a demand from fish farmers to adopt

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this farming technique. Several members of the Lusangazi Conservation Trust have taken up this integration which is meant to reduce the need for importations of bananas to Mzuzu, especially from Tanzania. This Trust forms a group of peri-urban fish farmers which is near to a ready market of Mzuzu City.

Fish-Sweet Potato Integration

In collabor3ation with the International Potato Censer (CIP) seven fish farmers were supplied with a new variety of sweet potato to multiply and sell the potato seed to other fish farmers. More than seven fish farmers have started to multiply potato seed to integrate farming of fish, specifically using the Orange Flesh Sweet Potato (OFSP) variety which has been especially bred and fortified with vitamin A.

Figure 4. The fish pond is in the background proving water to sweet potatoes.

Figure 5. Orange flesh potato developed by the International Potato Centre (CIP) fortified with Vitamin A.

These fish-crop integrations hold great potential for fish farmers conducting their business in upland areas where fish-rice farming is not feasible due to lower temperatures and conditions unfavourable to rice cultivation.

Several farmers integrated their farms with poultry and pigs thanks to the benefit of a nearby animal feed producer.

The Use of Hapas for Fish Breeding

Action research was conducted regarding comparative fingerling production between *Orechromis shiranus* (mouth-brooding tilapia) and *Coptodon rendalli* (a substrate breeder)

Hapas have been used to isolate fish by sex, species and sizes at many fish farms. A hapa appears like an inverted mosquito net as shown below. Hapas are made from durable fine mesh netting at a cost of some 36,000 MK or USD 18. This cost is for a hapa of 3m x 1.5m x 1.2m; hapas are sewn by tailors using nylon thread. A cover of large mesh netting may be required to prevent avian predation on fingerlings.

Women being trained to use hapas for fingerling production. Hapas may vary in size.

Government hatcheries and fish farms have been poorly managed in most countries. Even though they often represent a source of fingerlings, their stocks are mixed species. Their poor production and limited management brings up the old adage, "it is not enough to keep the ponds full of water and the grass cut". Good management is needed and sorely lacking bring up the needed shift to embedded extension with suppliers of fish fingerlings and feeds.

After observing that fingerlings being distributed from Government hatcheries were mixed species of *Oreochromis shiranus*, *Coptodon rendalli* and tbe wild species *Haplochromis* spp., it was decided to use hapas with a few selected fish farmers to provide fish farmers with pure stocks. The results were encouraging as shown in the Tables below.

Figure 6. Fry and fingerlings of *Coptodon rendalli* produced from hapas.

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Table 5. The Fingerling production of *Coptodon rendalli* by two fish farmers in Mzuzu and Rumphi, 2019-2020.

Name of Fish Farmer	District	Size of Hapa	Total No of brood fish vs (males)	Sex ratio	Ave. Size of fish	Total Fingerlings produced	No. of Fingerlings per female
Fish farmer #1	Mzuzu/Mzimba	5m x 2m x 1m	41 (27)	1:1	63.5 g	10, 200	378
Fish farmer #2	Rumphi	3 m x 2m x 1m	30 (20)	1:1	60g	7, 400	370

The general perception is that *Coptodon rendalli* is said to be a poor breeder but as one can see in Table 14; this need not be the fear once the fish is bred separately from *Oreochromis shiranus*. Therefore, always breed the two species in separate facilities and hapas are ideal. The key to success lies in the identification of broodfish followed by conditioning as separating sexes. Besides, when *Oreochrmis shiranus* and *Oreochromis karongae* are mixed hybrids have at times been observed in ponds, leading to forms of unknown quality.

Table 6. The Breeding of *Oreochromis shiranus* in hapas, 2019-2020.

Name of Fish Farmer	District	Size of Hapa	Tot. No. of Brood Fish vs (males)	Sex ratio of males to females	Ave. Size of Fish (g)	Fingerlings	No.of Fingerlings per female
Farmer #1	Mzimba	1.2mx3mx2m	18 (6)	1:2	162	2875	479
Farmer #2	Mzimba	1.2 x 3mx 3m	27 (9)	1:2	94	2500	278
Farmer #3	Nkhata Bay	1.2mx3mx3m	27 (9)	1:2	143	4246	472
Farmer #4	Rumphi	1.0 x3mx2m	12 (4)	1:2	94	1786	447

These results are good and an improvement over previous findings because of a combination of factors; 1) separation of sexes of broodfish and conditioning, 2) feeding quality feed and 3) the frequent removal of fry/fingerlings.

Table 7. Fingerling Production and Sales by Pilot Hatchery Operators up to May, 2021.

Name	District	Fingerlings produced and sold	Sales of fingerlings	Price per fingerling
Farmer #1	Mzuzu	185,084	MK5,580, 000	MK30.0
Farmer # 2	Mzimba	4,000	MK200, 000	MK50.0
Farmer # 3	Rumphi	3,800	MK74,000	MK19.5
Farmer # 4	Mzimba	11,000	MK550,000	MK50.0
Farmer # 5	Rumphi	10,950	MK 219,000	MK20.0
Farmer # 6	Nkhata Bay	4,300	MK 135,000	MK31.4

It was observed from these results that fish farmers make more money from selling fingerlings than raising fish to market size. However, the price of fingerlings varies widely according to demand and affordability by buyers, thus it is location specific.

c) Similarly, research regarding partial harvesting using traps proved very effective where small-scale fish farmers need to harvest small quantities where they want to satisfy home consumption other than conducting a whole catch.

b) There emerged a peri-urban subsector around Mzuzu who formed a Lusangazi Conservation Trust.

In Conclusion, the mixed extension method approach where training, coaching loops, exchange visits and dynamic group formations have been rolled out eliciting innovations among fish farmers. The Coaching loop technique seems to have been the draw-card serving as a catalyst that energised fish farmers to fully participate in the project. Therefore, this is being recommended for ensuring successful extension service delivery for future projects. We think employment of coaching loops can ginger up fish farming in Namibia as progress has been slow and faltering. The Malawi experience offers some insights on how the disadvantaged members of society might benefit from rural projects. On the other hand, this offers a very different experience from the Fishing Industry in Namibia where operations are highly industrialised offering fish products for up-markets (upper-scale markets) destined in developed countries literally crow3ding out the small-scale operators.

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