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Cover image: Fisherman pushes his boat along the channels around Inhaca Island, Mozambique (© José Paula)

Community-Based Milkfish Farming in Tanzania

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Abstract

In the 1990s the Institute of Marine Sciences (IMS) conducted an experiment on integrated earthen pond mariculture of finfish, shellfish and seaweeds in a flow through system. Among the finfish tested were milkfish (*Chanos chanos*). This species proved to have better growth, survival, tolerance to a wide range of environmental parameters, and resistance to diseases, compared to three other species tested, namely rabbit fish (*Siganus canaliculatus* and *S. sutor*), mullet (*Mugil cephalus*), and Zanzibar tilapia (*Oreochromis urolepis hornorum*). The project, supported mainly by the Western Indian Ocean Marine Science Association (WIOMSA), culminated in a stakeholders' workshop in 2004 translating the results of the experiment into community-based projects. Before this workshop there were three milkfish mariculture ponds in Tanzania, one of which was established by IMS. Following the workshop, pond milkfish mariculture took off in coastal Tanzania and by 2006 the first commercially operated farm at Bagamoyo produced 1 MT/ha/yr, earning the group 2000 USD. Ever since, finfish farming has spread to all coastal districts with the highest production of 7.5 MT/ha/yr realized at Ndumbwe, Mtwara in 2011. This paper documents the developments of community-based pond milkfish mariculture in Tanzania with a special emphasis of the effect brought about through support from the ReCoMaP Projects (2008 – 2011).

Keywords: Finfish farming, milkfish, community-based aquaculture.

Introduction

Aquaculture is the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants in brackish and seawater environments (FAO, 1990; El-Sayed, 2006). Aquaculture covers a wide range of species and farming methods. Worldwide aquaculture grew at 8.3% per year between 1970 and 2008 (FAO, 2011), the fastest-growing animal-food-producing sector over the past 50 years (Troell, 2009; FAO, 2012). Aquacultures contribution to world fish food consumption rose from 33.8% in 2000 to 45.6% in 2010 (FAO, 2011).

The Asia-Pacific region has continued to dominate the aquaculture sector, accounting for 89.1% of global production, with China alone contributing 61.5% (40,508,119 MT) in 2008 (Hall *et al*., 2011). Aquaculture production from China, South and Southeast Asia is dominated by carp (FAO, 2007 Hall *et al*., 2011), while production from the rest of East Asia consists of high-value marine fish. Aquaculture production in Central and Eastern Europe is dominated by carps while channel catfish production dominates in the United States of America, and Atlantic and Pacific salmon dominates in Canada (FAO, 2007).

African aquaculture production is dominated by finfish (99.3% by volume), with only small fractions from marine shrimps (0.5%) and marine molluscs (0.2%) (FAO, 2012). Despite the low contributions in global aquaculture production, Africa has continued to increase its overall production from 1.2 % to 2.2% in the past ten years (FAO, 2012). Production increased in volume by 56% and more than 100% in value between 2003 and 2007 due to the increase in global prices along with the emergence and spread of small and medium enterprises. Egypt has continued to dominate production in Africa producing 92% of the total

aquaculture production in the region (FAO, 2011). In recent years Nigeria, Kenya, Zambia and Uganda have made rapid progress to become significant producers in the region (FAO, 2012). Uganda and Nigeria have increased production of catfish (*Clarias gariepinus*) replacing tilapia since 2004. Other countries which have shown aquaculture progress include Madagascar with production of black tiger shrimp (*Penaeus monodon*), Tanzania which produces red seaweed (*Eucheuma denticulatum*), and South Africa with production of niche species such as abalone (Mmochi, 2015; Troell *et al*., 2011).

The increasing scarcity of freshwater, especially in the arid regions, accompanied by the decline in capture fishery stocks, has increased pressure to develop aquaculture in brackish and seawater where there is less competition and seawater is abundant (Mmochi *et al*., 2002). The target is to diversify aquaculture practices either by introducing new candidate species or by adaptation of culture methods to suit existing species (Troell *et al*., 2011).

Systematic studies on finfish mariculture in Tanzania started in 2000 at the Integrated Mariculture Pond System (IMPS) at Makoba Bay, Zanzibar. Pond milkfish farming in coastal Tanzania started in 2004 following the training in Zanzibar, which was attended by Coastal District Fisheries Officers. During the Sustainable Coastal Communities and Ecosystems (SUCCESS) Project which was run from 2004 to 2009 by the Coastal Resources Centre (CRC), WIOMSA and IMS with funding from USAID, three demonstration farms were developed in Bagamoyo (1 ha) and Mkuranga (2 ha), and 3 training workshops were conducted for all the Coastal District Fisheries Officers (Requintina *et al*., 2008; Sullivan *et al*., 2010). The highest achievement was a harvest of 1 MT/ha/yr from the Regent Group Changwahela, Bagamoyo, in 2006 (Requinitina *et al*., 2008; Mmochi, 2010; Mmochi, 2011). From 2008 to 2010 the University of Dar es Salaam (UDSM) together with WIOMSA ran a project under the Regional Programme for the Sustainable Management of the Coastal Zones of the Indian Ocean Countries (ReCoMaP) funded by the European Union during which support to community-based milkfish farming was continued. The aim of this paper is to review the effect of ReCoMaP on milkfish farming from 2008 to 2011, and its effects on mariculture development in Tanzania as a whole.

Materials and methods

During ReCoMaP 75 trainees representing farmer groups, fisheries officers, environment officers and land surveyors, from Pemba Island, Mtwara and Tanga Regions, were selected and trained in aquaculture in the areas of: 1) site selection, 2) earthen pond construction, 3) pond preparation and fingerling collection, 4) fish feed, feeding and pond management, and 5) harvesting and marketing. The five-week training programme was carried out over a two-year period. Within this period 1 Ha demonstration ponds (Fig. 1) were constructed in Mtwara, Pemba and Tanga, with each divided into six smaller ponds; the two central

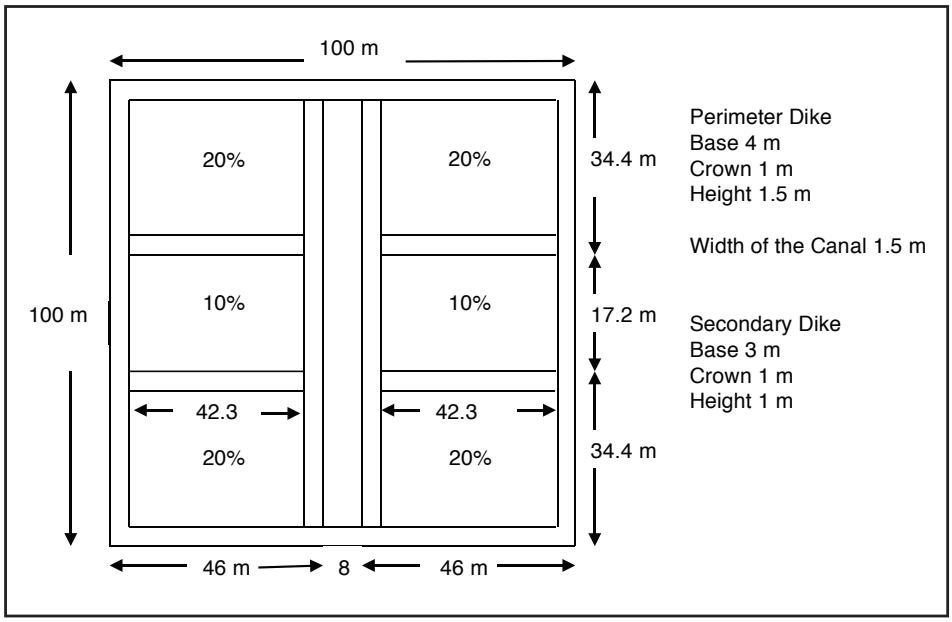

Fig. 1. Specification of the demonstration ponds constructed at Mtwara, Pemba and Tanga.

ponds (covering 20% of the pond area) being dedicated to rearing, while the remaining ponds (covering 80%) were dedicated to grow-out. A complete cycle of fish farming was then carried out during this period. Ponds were fertilized using animal manure while fingerlings were collected from the wild and stocked at 1-3 fingerlings/m^2 (Requintina *et al.,* 2008). The fish in the demonstration ponds were fed using a feed formulation of 28% protein (Mmochi, 2011). After 6-9 months the fish were harvested, weighed and sold in the respective villages. The trainees, some of whom were already working in fish farming, were encouraged to develop their own ponds to the demonstration pond specifications, and those who succeeded were rewarded by receiving assistance with the construction of the main and pond gates. The farmers were then left to continue the farming on their own. At the end of four years the farmers in Mtwara were visited, their records examined, and used as the basis for this review.

Results and Discussion

By mid-2011, a total of 43 ha under aquaculture had been developed in Pemba Island, Tanga and Mtwara Regions. The annual production per ha changed from the maximum of 1 MT/ha/yr (Requintina *et al*., 2008) to 7.5 MT/ha/yr, equivalent to 10 000 USD/year, with an average of 1.5 MT/ha/yr as shown in table 1 (Mmochi *et al*., 2010), although the data varied widely between individual farms. Based on cost estimates for earthen pond construction in Tanzania, including construction, and one cycle of milkfish production at a level of 1 MT/ha/yr, and a five year cash flow cycle, the payback period will be between 18 months to 3 years, depending mostly on the initial (construction) cost (Requintina *et al*., 2008). There are therefore very clear indications that milkfish aquaculture is feasible. However, there were several shortcomings that would need to be addressed to ensure longer-term success. Most of the ponds that were made by the farmers during ReCoMaP were not excavated, but relied on dykes being built at ground level. Accordingly, a quarter to half of the ponds remained completely dry most of the time except during spring tides. In some years, especially when there was poor rainfall, serious shortages of fingerlings were reported, and most of the ponds were under-stocked during these times.

During ReCoMaP the number of farmers increased and the area covered by ponds grew from 4.5 ha in 2008 to 43 ha in 2010, with Mtwara district alone contributing 17.6 ha in 2009. Because of the positive trends observed, and following advice from ReCoMaP project personnel, two NGOs were formed (POSIMCO - Pemba Organisation for Sea Inhabitants and Mangrove Conservation; and UWASA – 'Umoja wa Wafugaji Samaki Mtwara' or Union of Mtwara Fishfarmers), in 2010 and 2011 respectively. UWASA subsequently obtained funding from SWISSAID (Government of Switzerland Aid) ranging from 70,000 to 150,000 USD/year for 5 years to consolidate finfish farming mainly through improving the farming systems and producing fingerlings. In 2014 the newly established union had 174 members, 64 of whom were women, from 19 fish farming groups, with a pond area of 17 ha producing and average of 0.7 MT/ha/yr and earning an average of USD 650/ha/year.

The first activity undertaken by UWASA was to deepen the ponds to ensure they could hold water to a depth of at least 0.5 m, and to reshape the ponds to ensure that they could be completely drained. This had several advantages such as to control temperature and salinity ranges in the water and to reduce the chances of predation due to depth. Furthermore, record keeping charts were developed and used by specially trained field officers who also supervised the farming.

Table 1. Statistics of finfish farming during the ReCoMaP project (Extracted from Mmochi 2011)

	Number of Members	Number of Women	Cost of construction (USD)	Size of Pond (m2)	Stocking density (ind/m2)	Survival rate	Harvest (Kg)	Price/kg (USD)	Kg/ ha	Total income (USD)	Income/ ha (USD)
Total	233	107	19848	131357			14463			13728	
Maximum	14	10	5119	25375	3,67	1,00	3380,00	1,67	7500	2400	10000
Mean			1103	5711	1,50	0,44	657,41	1,26	1549	572	2073
SD	9	5	1215	5386	1,06	0,30	863,16	0,44	2363	682	4582
Median	18	11	867	3496	1,245	0,395	400	1,33	625	250	745

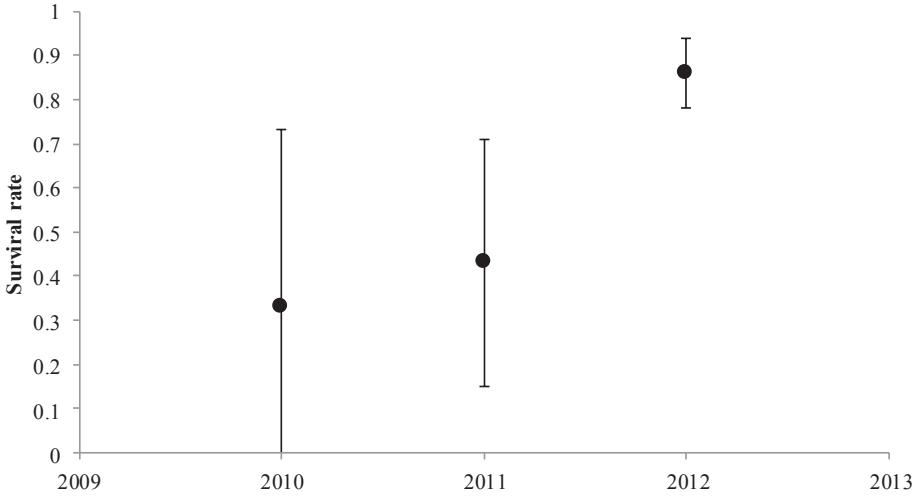

Fig. 2. Survival Rate of Milkfish in ReCoMaP and later UWASA ponds

The results of these improvements were a significant increase in survival rates (Fig. 2) and tonnage produced between 2010 and 2012.

Initially the farmers were selling their fish in bunches at the pond site within the villages; often by auction which is a typical method used in Tanzania for capture fisheries. During auctioning the weight of the fish is not considered, but analysis showed that the price realized during 2011 either through direct sale or auctioning was between 0.33 and 1.67 USD/kg with a mean of 1.26±0.44 USD/kg. In 2012 the farmers were trained in value chain analysis, packaging and marketing (Onyango, 2012), and UWASA organized a poster and radio advertising campaigns to alert the public when they would be harvesting and set a price of 3.8 USD/kg. Furthermore, UWASA purchased iceboxes to better preserve the fish. The marketing was successful and led to an improvement in the average income per farm (Fig. 3) and total income (Fig. 4). The large variation in earnings between farms in 2012 is an indicator of differences in the levels of adoption of the improved farming and marketing techniques.

With the production of around 0.7 MT/ha/yr in Mtwara, UWASA farms were producing what would be considered a 'good' harvest in Southeast Asia, where milkfish have been farmed for centuries. Production levels of 0.79MT/ha/yr in China (FAO, 2011), and 0.70 MT/ha/yr in India (Troell, 2009) are comparable to those found in Tanzania during the present study.

Conclusions

There have been many attempts by local communities to undertake brackish and marine finfish farming in ponds constructed on the landward side of mangrove forests in Tanzania. Some have been more successful than others, but indications are that improved knowledge of value chains, new marketing strategies, and the use of iceboxes to avoid post-harvest losses, will contribute to growing success in Tanzania. Challenges such as ensuring a reliable source of fingerlings

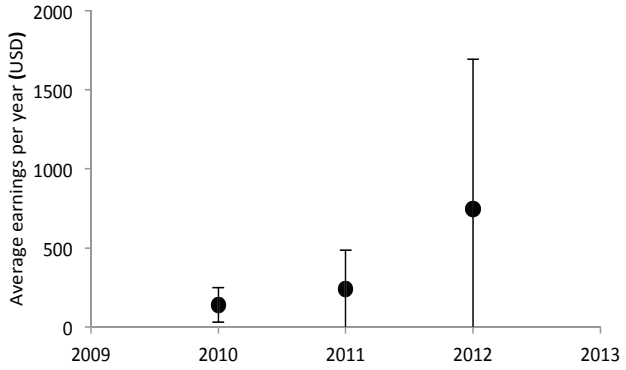

Fig. 3. Average earning per year per farming group.

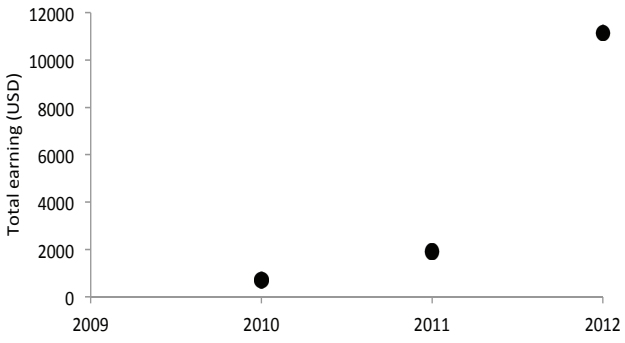

Fig. 4. Total income from milkfish farming during ReCoMaP and thereafter (2010 -2012)

remain, and the establishment of hatcheries for milkfish and other species that are low in the food chain such as mullet and tilapia, is considered as critical to support the development of the sector. In addition, further effort to consolidate farming and marketing techniques is needed.

References

El–Sayed AM (2006) Tilapia culture in salt water: environmental requirements, nutritional implications and economic potentials. In Suarez LEC, Marie DR, Salazar MT, Lopez MGN, Villareal, C., Ortega, YAG (eds.) Avances en Nutricion Aquicola VIII. VIII Symposium Internacional de Nutricional Acuicola. 15-17 Noviembre. Universidad Autonoma de Nuevo Leon, Monterrey, Nuevo Leon, Mexico

FAO (2007) The state of world fisheries and aquaculture 2006. Fisheries and Aquaculture Department, Rome. 162 pp

FAO (1990) The definition of aquaculture and collection of statistics. FAO Aquaculture Minutes 7: 4 pp

FAO (2011) World Aquaculture 2010. Aquaculture Technical Paper 500/1, Rome. 105 pp

FAO (2012) The State of World Fisheries and Aquaculture 2012. FAO Fisheries and Aquaculture Department, Rome. 209 pp

Hall SJ, Delaporte A, Phillips MJ, Beveridge M, O'Keefe M, (2011) Blue frontiers: Managing the Environmental Costs of Aquaculture. The World Fish Center, Penang, Malaysia. 92 pp

Mmochi A (2015) Mariculture. In: UNEP-Nairobi Convention and WIOMSA (eds.) The Regional State of the Coast Report: Western Indian Ocean. UNEP and WIOMSA, Nairobi, Kenya. pp 289-303

Mmochi AJ (2011) Feasibility Study for Finfish Project in Mtwara District. Report submitted to SWISSAID in June/July, 2011. 25 pp

Mmochi AJ (2010) Sustainable Milkfish Farming: Cost-Effective Methods to Increase Food Supply, Incomes and Employment in Mtwara/Lindi, Tanga and Pemba Coastal Communities. Report Submitted to WIOMSA, ReCoMaP/07/01/408. 28 pp

Mmochi AJ, Mozes N, Powell H, Dubi AM, Gordin H, Jiddawi N, Kissil G, Msuya F, Mwangamilo J (2001) Design and preliminary results of an integrated mariculture pond system (IMPS) at Makoba, Zanzibar, Tanzania. In: Richmond MD, Francis J (eds.) Proceedings of the 20th Anniversary on Advances of Marine Sciences in Tanzania. WIOMSA Book Series No. 1. pp 431-450

Mmochi AJ, Dubi AM, Mamboya F, Mwandya A (2002) Water quality variations in Makoba integrated mariculture pond system. Western Indian Ocean Journal of Marine Science 1: 53-63

Onyango PO (2012) UWASA Value Chain Analysis Report. Training Report Submitted to UWASA, April, 2012, UWASA Repository. 12 pp

Requintina ED, Mmochi AJ, Msuya FE (2008) A Guide to Milkfish Farming in the Western Indian Ocean Region. Western Indian Ocean Marine Science Association, Institute of Marine Sciences and Coastal Resources Center of the University of Rhode Island. WIOMSA book series. 38 pp

Sullivan KA, Mmochi AJ, Crawford B (2010) Food security and poverty alleviation through milkfish farming: Is Tanzania ready? World Aquaculture 2010: 50-58

Troell M (2009) Integrated marine and brackish water aquaculture in tropical regions: research, implementation and prospects. In: Soto D (ed.) Integrated mariculture: a global review. FAO Fisheries and Aquaculture Technical Paper 529, Rome, FAO. pp 47-131

Troell M, Hetcht T, Beveridge M, Stead S, Bryceson I, Kautsky N, Ollevier F, Mmochi A (2011) Mariculture in the WIO Region "Challenges and Prospects". Proceedings from the Workshop on Mariculture, December 2009. WIOMSA Book Series 11: 72 pp