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Community-Led Coastal Management in the Gulf of Mottama Project (CLCMGoMP)

Small-Scale Wild Fish Aquaculture in Myanmar: A Preliminary Report from Bago Region

By

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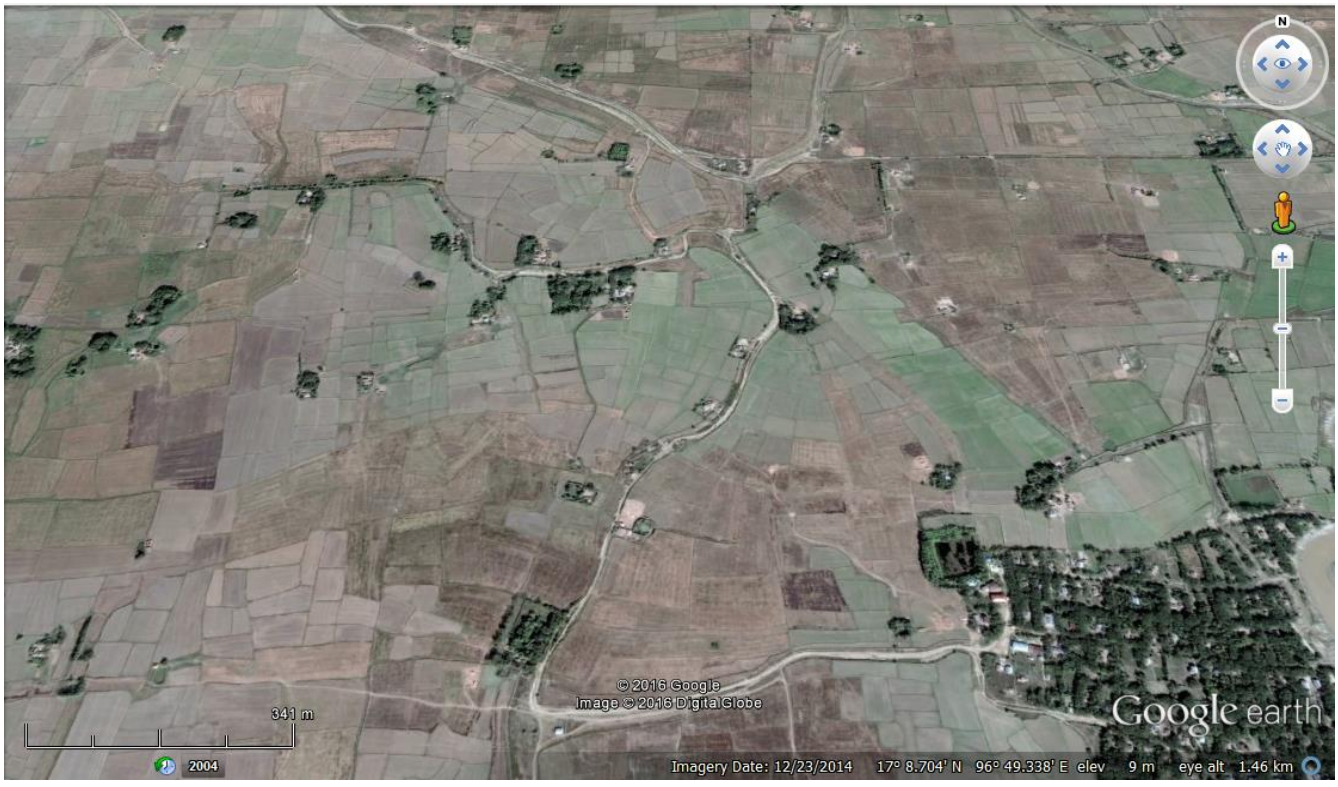

Figure 1: Google Earth Image showing numerous farm fish ponds surrounded by trees in Bago

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Introduction

Aquaculture in Myanmar is considered to be medium to large scale with little or no small scale aquaculture (Edwards 2005). The FAO/NACA(2003) report on aquaculture in Myanmar says:

> *"There is no record of small pond holdings because this information is not collected and ponds less than 8 m x 8 m do not require licensing. Based on the observations of the Mission, there appear to be very few small (less than 400 m^2) fish pond operations. This is unusual relative to other countries of Southeast Asia, where small ponds are quite popular*

A recent comprehensive study of aquaculture in Myanmar documented a large increase in medium and large scale operations but also indicted that based *on satellite imagery there are 200,000 small backyard ponds in the southern Delta some used for growing fish mainly for home consumption* (Belton et al 2015). There has, however, been no previous detailed description of small scale aquaculture in Myanmar.

During a village visit by staff of the Community Lead Coastal Management Gulf of Mottama (CLCMGoM) project[1] to Tadar Oo village, Kawa Township in Bago Region we were invited to visit an aquaculture pond. There we discovered a small scale aquaculture system using monsoon flooding of the rice fields to stock the pond with wild fish, the fish were subsequently fed and at harvest about 20% of the fish were selected as brood stock to carry over to the dry period and spawn at the start of the next monsoons. This system is similar to ricefield fisheries practices throughout floodplain areas in Asia (Gregory & Guttman, 2002; Guttman 1998; Halwart & Gupta 2004) What makes this system different is that the fish are not just trapped and then harvested but they are fed and brood stock is selected for the next year's production. We consider this a type of aquaculture as opposed to culture based fisheries and are calling it Indigenous Aquaculture.

Methods

As a result of the information from Tadar Oo further information was collected from villages in Bago Region from August 2016 to January 2017. A survey questionnaire was developed by staff of the Network Activities Group (NAG) based on knowledge of aquaculture in the Myanmar delta region and the back ground information determined from the initial visit to the pond in Tadar Oo. The questionnaire was completed based on semi structured interviews with key informants in eight villages in Thantpin, Kawa, and Waw Townships in Bago Region during August-September 2016. A summary was prepared and this lead to a follow up visit by NAG staff in October 2016 to three of the previous visited villages and an additional commercial operation to check the data and follow up on details. A final detailed survey was carried out in January 2017 during the harvest of two ponds in Kan Myint Village, Kawa Township, Bago Region. At this time information was collected on harvesting, marketing, identification of fish species, lengths and weights of fish and additional details on the operations. In general the details from the Kan Myint ponds confirmed and validated the information collected during the village interviews. The villages visited are listed in Table 1. The results reported here are the first reports of small scale aquaculture in Myanmar.

[1] CLCMGoM is a project of the Swiss Agency for Development and Cooperation (SDC) implemented by NAG, HELVETAS and IUCN

Results

Number of ponds: The survey indicated that wild aquaculture practice was very wide spread (Table 1) with 693 farmers from the eight villages managing over 775 pond. The number of ponds varied from 50 to over 150 per village. The number of farmers with ponds ranged from 40 to 150 per village with the percentage of farmers who had ponds varied from 16% in Ma Mauk to 95% in Ko Teko. Google satellite images (Figure 1 & 2) show numerous small green area that represents a small pond surround by trees that further supports the widespread nature of this system.

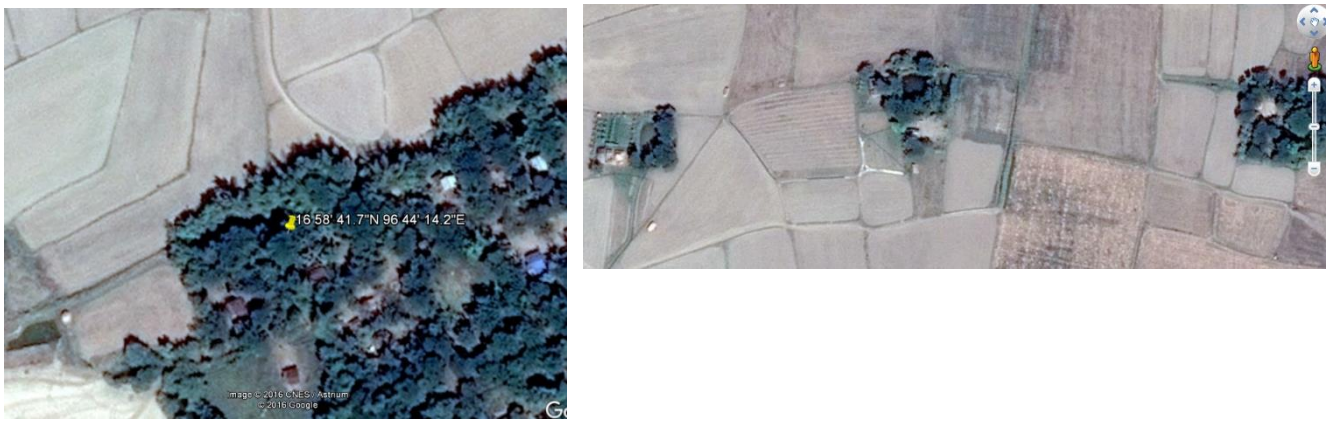
Table 1: Villages surveyed for Indigenous Aquaculture and number of ponds

Date Surveyed	Village	Track	Town-ship	Number participants male (female)	Number Farmers in Village	Number Farmers with ponds	Total No. & Size of Ponds
23-8-16	Koke Ko Tan	Min Ywar	Thanat Pin	9 (2)		50	60
25-8-16	Ko Tone Tan			5		40	50
31-8-16	Ko Teko	Ko Teko		10 (4)	94	89 (95%)	34- 0.4 acres 65—0.1 acres
31-8-16 21-10-16	Thana Tan	Thana Tan		4 (3)	250	110 (44%)	8-small 137 large
19-10-16	Htat Ka Maing			One larger scale farmer		1	5—total 12 acres
25-8-16	Ta Dar Oo	Ta Dar Oo	Kawa	7 (9)	128	48 (38%)	8–0.1-0.5 acres 48->0.1 acres
26-8-16 20-10-16	Ma Mauk	Ma Mauk		6 (6)	340	55 (16%)	64
2-9-16	Htain Tapin	Htain Tapin	Waw			150[2]	150[*]
2-9-16	Ka Daut	Ka Daut				150[3]	150[*]
Total						**693**	**774**
Harvest Survey							
18-01-17	Kan Myint 1	Kan Myint	Kawa	One farmer & harvesters		1	1 (0.20 acres)
19-01-17	Kan Myint 1	Kan Myint	Kawa	One farmer, harvesters, & fish buyer		1	1 (0.25 acres)

2 & 3 This is a conservative estimate as numbers of ponds not recorded.

Figure 2: View of aquculture ponds in Kan Myint Village: pond 1 is on the edge of the village while pond 2 is surrounded by paddy land (Google Earth)

Pond 1 **Pond 2**



Size of Ponds: Ponds are small varying from 0.01 to over 1 acre (40-4047) m^2 (Table 2) but most ponds (80%) were less than 0.25 acres (1112 m^2) and 90% were less than 0.5 acres (2023 $m^{2)}$. The two ponds surveyed in Kan Myint were 0.2 and 0.25 acres (810-1112 $m^{2)}$.

Table 2: Size of farm ponds and estimated number of farmers with each pond size in all villages

Size of Ponds		No of farmers	Percentage of farmers
Acres	**m^2**		
<0.1	<405	91	24
0.1-0. 0.25	405-1112	205	53.9
0-25-0.5	1112-2023	48	12.6
0.5-1	2023-4047	22	5.8
>1	>4047	14	3.7

Table 3 gives an example of pond size versus paddy area for one village. The total pond area for the nine farmers interviewed was about 12 acres (4.8 ha) and the average pond area was 0.45 acres (0.18ha). There was no clear trend in number of ponds and paddy area but in general interviews in other villages suggested that farmers with large paddy areas had more ponds.

Pond depth varied with location and was shallower in areas closer to the Gulf of Mottama where there was saltwater intrusion if the ponds were dug to deep. The depth varied from 6 feet (1.8 m) to over 20 ft.(6.1m). In general they all held water during the dry season with the dry season minimum depth varying from 1.5 to 6 ft (0.5-2m). One village used plastic pond liners to hold water in the ponds.

The two ponds harvested in Kan Myint had pond depths of 18 to 25 ft. (5.9-8.2 m). Additional both ponds were either adjacent to a second pond or one pond was divided into two (Figure 3). This arrangement allowed water to be pumped from one pond to the other during harvest, thus conserving water for the dry season holding of the brood stock. We did not include this question in the earlier surveys so do not know how wide spread this practice is.

Table 3: Example of Paddy Field area, number of ponds, and area of ponds from 9 farmers in Thanatan Village, ThantPin Township, Bago Region, Myanmar.

Paddy Field Area	# ponds	Pond area acres (hectare)	Total pond area acres (hectares)
6	1	0.02 (0.001)	0.02 (0.001)
10	2	0.50 (0.202)	1.00 (0.405)
30	3	0.33 (0.134)	0.99 (0.400)
40	3	0.40 (0.162)	1.20 (0.486)
40	2	0.02 (0.001) & 0.60 (0.243)	0.62 (0.251)
50	1	1.00 (0.405)	1.00 (0.405)
70	1	0.50 (0.202)	0.50 (0.202)
100	3	0.33 (0.134)	0.99 (0.400)
300	10	0.55 (0.223)	5.50 (2.226)
Total	26		11.82 (4.783)
Average			0.45 (0.182)

Aquaculture practices: The system relied on the seasonal nature of the monsoon system and the associated fish. As the rice fields flood with the monsoon rains during June and July, the fish move from the ponds, rivers, creeks and canals to the flooded rice paddies where they reproduced and feed. All the ponds relied on recruitment and replenishment of indigenous species and were essentially a trap system as the water level dropped in the flooded paddy fields at the end of the monsoons, September-October, the fish retreat to deeper areas including the farm ponds.

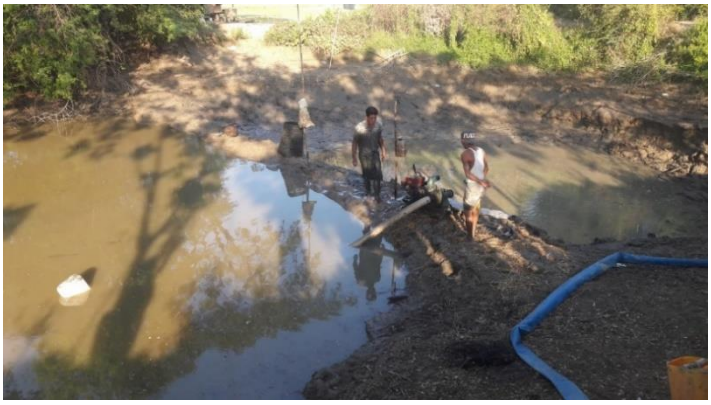
Various approaches were used to entice the fish to the ponds. Many farmers had dug canals that channeled the fish to the ponds (Figure 3). A few claimed to use attractants; horse oil (a traditional medicine); cans of tinned fish with holes punched in them; and some used what was called a schooling pond that was deeper, where the fish collected before they were channeled to the fish pond. A few claimed that feeding in the pond during July-August also attracted fish to the ponds.

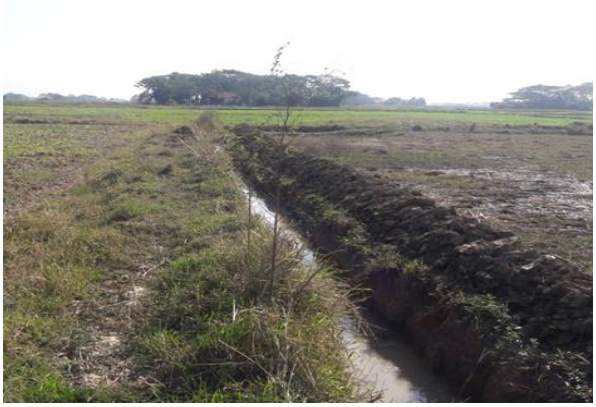
Some farmers with rice areas above 50 acres diked the whole paddy land. Some had actually developed a closed system as they used bamboo fencing or netting on the inflow/outflow drainages, resulting in little migration of fish into or out of the system. Others had a more open system only seasonally fencing or netting the outflow drainages to retain fish. Farmers with smaller rice area did not have dikes and had an open system that relied on recruitment from fish migrating into the paddy fields and recruitment from the brood fish saved in the farm ponds.

Most farmers renovated their ponds every two to three years and dug out the accumulated silt from the bottom and placed it around the pond banks. The two ponds in Kan Myint both had been renovated before the monsoons in 2016 by digging out the bottom one by manual digging and the other by digging machine.

Figure 3: Example of (a) a divided pond system & (b) canal in the rice fields in Kan Myint Village (Credit: Soe Min Oo)

(a) **(b)**

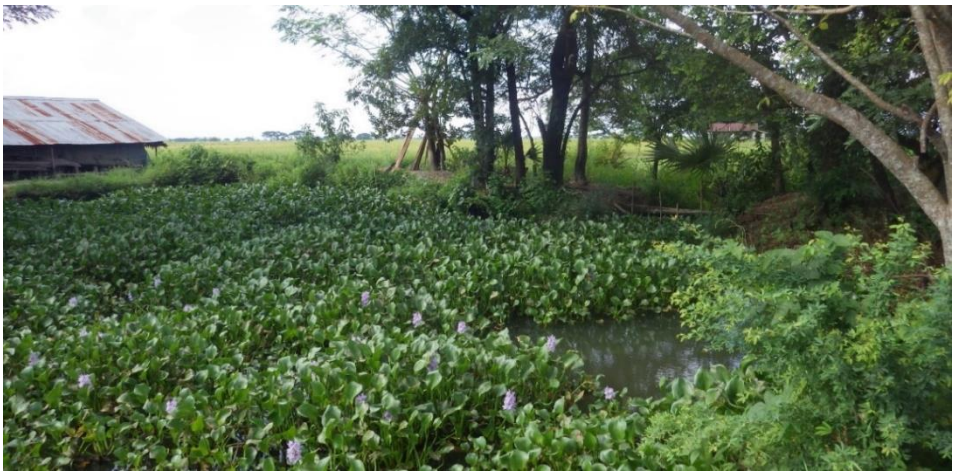




Feeding: Most of the farmers feed the fish at least when they had retreated into the ponds, this was usually October. Feeding might be for only a few weeks or up to harvest in December or January. The most common feeding method was to broadcast rice bran and occasional broken rice. Feeding was normally done once or twice a day Additional many farmers made a paste of fish paste, peanut cake, or coconut cake mixed with rice bran that was placed in either a pot, basket or net bag hung in the pond. This was replaced when consumed, anytime between daily to weekly. One village indicated that the paste was mixed with cow dung while another village added cow dung to the pond. A few farmers fed a few pellets probably duck feed, while a few indicated occasionally adding cow or horse hides. This appeared to be opportunistic as they did not buy the skins but when an animal died (or was slaughtered) they would add the skin. Apparently this was an attractant for snakeheads. Shrimp shells and horse bones were also indicated as being used in two villages. In the two ponds in Kan Myint one farmer did not feed but added rice straw. The other farmer fed from August to December. He placed rice bran into a bag and tied it to a bamboo pole in the pond and added new feed every week.

Natural feeding was enhanced by adding brush to the ponds to create a brush park and other ponds were well covered by water hyacinth (Figure 4). These acted to increased surface area for algae and microbial growth that enhance feeding, attracted small fish, shaded the pond and also prevent theft. The trees surrounding the ponds supplied cover and shade.

Figure 4: Fish pond in Thana Tan Village, Thant Pin Township, Bago Region, Myanmar covered with water hyacinth (Credit: Kenneth MacKay)



Harvesting: Prior to harvest the brush parks and water hyacinth were removed and the water level lowered with a pump. Collection of the fish was normally done by a small fish scoop, although small ponds were often harvested by hand. The smaller ponds were harvested by the farmer and family, larger ponds used labourers, while Thana Tan village used a village cooperative system so the harvesters received a share of the catch. In Kan Myint both farmers used a 7hp diesel motor to power a 4" pump (Figure 3) to pump out the ponds. The fish where then harvested using dip net, bamboo buckets and hand capture. The 10 to 15 harvesters were family members or family members supplemented by neighbours. In both cases they did not receive a cash payment but received lower value fish for either direct consumption or used for fish paste (Table 6).

Harvesting was normally done in December or January after about four to five months of growth. Harvest dates were determined by fish prices (most villagers were well aware of market prices), water level and the fact that fish tended to lose weight later in the season. Harvesting was done either by the farmer directly or by a fish trader.

Species: At least 15 species were reported as being harvested (Table 4). The most abundant species were the blackfish: Channa (snakeheads); Clarius (catfish); and Anabas (climbing perch). Various barbs are reported earlier in the season but all respondents indicated the carnivorous species feed on them and very few are harvested.

Table 4: Preliminary list of Fish Species in the wild fish aquaculture in Bago Region

Scientific	English Name	Myanmar	Language
Clarius batrachus	Walking catfish	Nga Khu	ငါးခူ
Heteropneustes fossilis	Scorpion catfish	Nga Gyee	ငါးကျည်း
Channa striata	Striped snakehead	Nga Yant	ငါးရံ့
Channa sp (Lucius?)	Snakehead	Nga Pa Naw	ငါးပါးနော်

Mystus cavasius	Gangetic catfish	Nga Zin Yaing	ငါးဇင်းရိုင်း
Anabas testudineus	Climbing perch	Nga Ppay Ma	ငါးပြေမ
Trichopodus pectoralis	Snakeskin gourami	Bee Lar (often called Til Apia)	ဘီးလား။ ဂျပန်ငါး။ တီလားပီးယား.။။
Ompok bimaculatus	Butter catfish (sheath fish)	Nga Nu Than	ငါးနုသန်း
Lates calcarifer (L. uwisara)	Sea bass	Ka Ka Tit	ကကတစ်
Notopterus notopterus	Bronze Featherback	Nga Phae	ငါးဖယ်.
Cirrhinus mrigala	Mrigil	Nga Gyin	ငါးကြင်း
Barbonymus sp , Puntius sp—will be mixed species)	Barbs	Nga Khone Ma	ငါးခုံးမလေး
Osteobrama sp	Carplet--barb	Nga Pha Ma	ငါးဖါးမ
Parambassis ranga	Indian Glass fish.	Nga Zin Zat	ငါးဇင်စပ်
Wallago attu	wallago	Nga Batt	ငါးဘတ်.

The detailed harvest from two ponds in Kan Myint village is given in Table 5. Pond 1 contained a greater diversified species mix with nine species, while pond 2 had 6 species. Two to three species make up most of the catch ranging from 78 to 94%. Snakeheads are the most numerous in both ponds, with climbing perch the second in one pond, and catfish in the other, snakeskin gourami are the next most numerous in both ponds.

Table 5: Harvest data from two fish ponds in Kawa Township Bago Region, Myanmar

Fish Names			***Weight Viss (kg)***					
			Pond 1			**Pond 2**		
Scientific	***English***	***Myanmar***	**Harvest**	***Brood Stock***	**Total**	**Harvest**	***Brood Stock***	**Total**
Channa striata	Striped snakehead.	Nga Yant.	64 (104.5)	25 (40.8)	141.5 (231)	55 (89.8)	7.2 (11.7) 10 fish	62.2 (101.5)
Clarius batrachus.	Walking catfish.	Nga Khu	7.5 (12.2)			45 (73.5)	1.8 (3.0) 10 fish	46.8 (76.5)
Anabas testudineus	Climbing perch.	Nga Pyay Ma.	45 (73.5)			1 (1.6)		1 (1.6)
Trichopodus pectoralis	Snakeskin gourami	Bee Lar	15 (24.5)		15 (24.5)	5 (8.2)		5 (8.2)
Lates calcarifre	Giant seabass	Ka Ka Tit.	3.1 (5.0)		3.1 (5.0)			
Notopterus notopterus	Feather back	Nga Phae.	0.38 (0.6)		0.38 (0.6)			
Wallago attu	Freshwater shark	Nga Batt.	13 (21.2)		13 (21.2)			

Puntioplites proctozrysom??	Smith barb.	Nga Phar Ma	5 (8.2)		5 (8.2)	1 (1.6)		1 (1.6)
Puntius sp	Barb.	Nga Khone Ma.	2 (3.3)		2 (3.3)	1.5 (2.5)		1.5 (2.5)
Total			**155 (253.1)**	**25 (40.8) 13.9%**	**180.0 (293.9)**	**108.5 (177)**	**9 (14.7) 7.7%**	**117.5 (191.9)**

Size of Fish: The sampling of the harvested fish at Kan Myint allowed data to be collected on length and weights of the harvested fish (Table 6). The weights are approximate due to the limited accuracy of the scale, the need to work around the harvesting constraints, and a many fish were weight alive thus difficult to weigh. There is considerable variability between the two ponds. The average weights varied from over 1.2 kg for snakeheads to 53 grams for snakeskin gourami. The snakeheads were the largest in Pond 1 at 51 cm and 1.2 kilos, while the catfish were larger in pond 2 at 29.5 cm length and 248 grams. The climbing perch were close to the same lengths in the two ponds but were considerably heavier in pond 2.

Table 6: Length and weights of harvested fish from two ponds in Kan Myint Village

Species	**Nga Yant Striped Snakehead**		**Nga Khu walking catfish**		**Nga Pyay Ma climbing perch**		**Bee Lar Snakeskin Gourami**	**Ka Ka Tit seabass**	**Nga Phae feather back**
	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 2	Pond 1	Pond 1
Standard Length in cm									
Average	51.36	43.84	22.28	29.48	16.85	17.50	17.33	40.40	32.00
SD	±2.059	±9.081	±3.348	±4.619	±2.409	±2.013	±2.516	±1.516	±2.828
n	25	25	25	25	13	10	3	5	2
Range	48-68	28-58	15-27	22-38	13-20	13-20	15-20	38-42	30-34
Weight in g									
Average	1,244.00	858.40	81.60	248.00	77.69	122.00	53.33	1,020.00	300.00
SD	±238.187	±595.676	±31.843	±80.000	±22.786	±43.665	±11.547	±83.666	±141.421
n	25	25	25	25	13	10	3	5	2
Range	1000-1800	200-2600	20-130	100-360	40-100	60-200	40-60	900-1100	200-400

Yield: Estimated yields for the various pond sizes are given in Table 7. The small scale farmers' yields ranged from 122 to over 2000 kg per pond and from about 1900 kg/hectare to 3000 kg/hectare. Additional data was obtained from a farmer with larger scale ponds of 12 acres who estimated yields of over 5,000 kg/ha. This was higher than the estimates from the small scale farmers but is probably related to more extensive feeding and greater control as the ponds are supplied with fish from 100 acres of rice fields that are all diked.

Table 7: Estimate yields for various sized ponds of wild fish aquaculture in Bago Region including two ponds in Kan Myint that were sampled when harvested.

Pond Size Acre (hectare)	No of Ponds	Total Yield Range Kg	Average Kg/acre (kg/hectare)
0.1-0.3 (0.04- 0.12)	4	122-245	787.5 (1,946)
0.2-0.25 (0.08-0.1) (Kan Myint)	2	192-294	1,119 (2,764)
0.4-0.5 (0.16-0.20)	4	490-1715	1,219 (3,012)
1 (0.40)	3	1633-2041	1,083 (2,677)
12 (4.9) Commercial farmer		24,494	2,041 (5,044)

Brood Stock Selection: What is unique about this wild fish aquaculture is the selection and saving of brood stock from one year to the next. Every farmer interviewed saved brood stock particularly of snakehead, catfish and climbing perch. In general we were told that 20-30% of the catch was saved. A number of farmers indicate in the first year of a pond they would not harvest fish but save all for next year's brood. The detailed harvest data from Kan Myint (Table 5) indicates that these farmers saved snakehead and catfish while one also saved climber perch. The brood stock saved ranged from 8 to 14% of the total harvest.

Various selection criteria for brood stock selection was suggested, including size (not always the biggest), and sex (some villages indicating they could determine sex of snakeheads by the shape of the head). In Kan Myint the only selection criteria for brood stock was large size. This is confirmed by the sampled fish from pond 2 (Table 6), the ten-selected snakehead brood stock averaged 1.2 kgs versus an average of 0.86 Kg for the sampled fish and the ten catfish brood stock averaging 0.30 kg versus 0.25kg for the sampled fish.

The brood fish were retained in the pond over the dry season and only in a very few cases was there feeding, some farmers did occasional add water to the ponds when the water level dropped too low.

Economics

Market: The fish were sold to the village fish collector who sold on the fish to nearby township markets, or direct to a township broker either at pond side or in the township. In many cases the fish buyers had advanced money to the farmer (interest rate 4-5%/month). The fish were transported to market via motorcycle/tricycle or local bus Three villages, and the commercial farmer sold the fish live shipping the fish in wooden buckets by car or tricycle to nearby township markets. Fish dying during harvest were iced and then sent to market. The live fish received twice the price of dead fish. One village, close to a township market shipped their fish (dead) directly to the market but did not use ice. Some fish where used for household consumption with small fish being used for fish paste and one village dried snakeheads but only for home consumption.

In Kan Myint the fish went to Thantpin Township market. One famer sent the fish (both live & dead) via motorcycle (Figure 5) to a Thantpin Township collection center while the other sold directly to a broker who collected the fish at the pond and then send them live via local bus to the market. Table

8 gives details on the disposition of the catch. Both farmers sold the snakehead and walking catfish to the market, making up 40% of the harvest in Pond 1 and 85% from Pond 2. Pond 1 sold the sea bass and wallago in the village, while both ponds distributed the other species to the harvesters and neighbours, with pond 1 distributing 37% and Pond 2 distributed 7% to the harvesters.

Figure 5: Fish loaded on motorcycle ready to be transported to township market (Credit: Soe Min Oo)

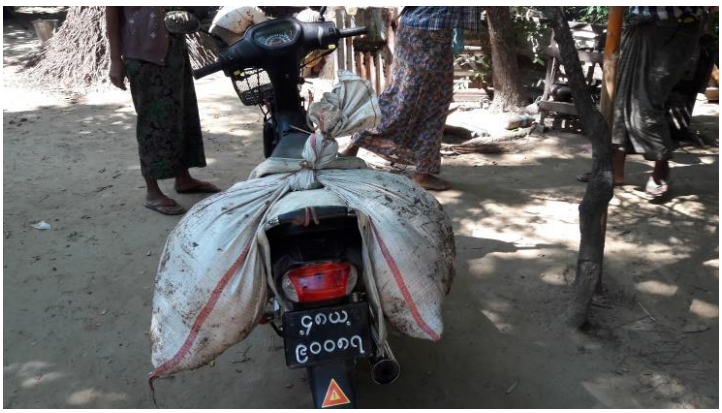


Table 8: Disposition of Harvest from Kan Myint Pond 1

Market Condition	Species.	Total Weight Viss, (kg), %		Price MMK/Viss US$/KG	Income MMK, US$	
		Pond 1	Pond 2		Pond 1	Pond 2
Live	Walking catfish.	7.50 (12.2) 4.2%		4364 $3.26	32,730 $24.43	
Sold at pond & shipped live to market	Striped snake-head & Walking catfish		100 (163.3) 85.1%	4350 $3.25		435,000 $324.63
Weight Sold Dead.	Stripped snake-head	64 (104.51) 35.6%		4021 $3.00	256,950 $191.75	
Sold at Village.	Sea bass & wallago	16 (26.2) 8.9%		4348 $3.24	70,000 $52.24	
Total Sale		87.5 (143.1) 48.7%	100 (163.3) 85.1%		359,680 $268.42	435,000 $324.63
Gift to neighbours and harvesters	All other species	67.4 (110.0) 37.4%	8.5 (13.9) 7.2%			
Total Harvest		**155 (253.1)**	**108.5 (177.2)**			
Brood Stock		**25 (104.5) 13.9%**	**9 (14.7) 7.7%**			
Total Yield		**180 (293.9)**	**117.5 (191.9)**			

Economic Returns: Detailed production costs were obtained from a few farmers. Table 9 gives an example from two different pond sizes and the two ponds in Khan Myint. While these are only estimates and all operating costs may not be included (e.g. interest cost are not included) nevertheless the returns on investment of 132 to 440% are impressive. It was possible to calculate the profit per hectare for the two Kan Myint ponds that averaged $US 2,281/ha, this compares to the net margin for monsoon rice production in Bago of $146/ha (LIFT 2016). Thus the yield from the indigenous aquaculture system was 15.6 higher than rice production. This confirms Kan Myint farmer's comments that this aquaculture system was much more profitable than rice farming.

Table 9: Example of economic returns of Wild Fish Aquaculture from ponds in two villages in Thant Pin Township, Bago Region, Myanmar

Location	Kote Ko Big pond	Kote Ko Small Pond	Kan Myint Pond 1	Kan Myint Pond 2
Expenses				
Renovation	250,000	80,000	100,000	100,000
Feed	240,000	60,000		7,500
Harvest	14,000	29,000	15,000	15,000
Ice	25,000	5,000		
Transport	6,000	15,000	20,000	
Interest	?	?		
Total Operating Costs	735,000 MMK $565	194,000 MMK $149	135,000 MMK $85.82	122,500 MMK $91.42
Income	4,000,000 MMK $3,077	450,000 MMK $346	359,680 MMK $268.42	435,000 MMK $324.63
Profit	3,265,000 MMK $2512	256,000 MMK $197	244,680 MMK $182.60	312,500 MMK $233.21
Profit/hectare			$2,256	$2,305
Return	440%	132%	213%	255%

The commercial farmer with 100 acres of flood plain has 12 acres (4.9 hectare) of wild fish, indicated a total income of over 1500US$ per hectare. This farmer has recently added 30 areas of commercial aquaculture ponds using stocked fish and intensive feeding. He indicated that the wild fish aquaculture was much more profitable than the commercial aquaculture

History

All ponds (with the exception of the large scale farmer) appear to have been initially dug for household water supply. The farmers indicated that they subsequently discovered that fish moved into the ponds and they started raising the fish. The ponds have multiple uses in addition to the fish: they are used for household water (the water is normally carried to the house for washing, cooking, etc.); some ponds also serve to water cattle; all ponds were surrounded by a variety of trees, fruit trees and bamboo (Figure 1 & 2); and many grew vegetables on the banks that were occasionally irrigated with pond water during the dry season.

All most all farmers said they had started 25-40 years ago, although two villages said they had learned from their grandparents. No one indicated that there had been any extension or training but

they stated they had learned themselves. There is, however, very similar practice across villages suggesting considerable village to village information exchange.

Discussion

This survey of eight villages and one commercial farmer has indicated a widely practised aquaculture system is present in Bago Region and has been in existence for at least 40 years. The system relies on the natural monsoon cycle in which the rice fields flood and indigenous fish species move into the flood areas from seasonal ponds, rivers creeks and canals, reproduce, feed, and grow. As the waters recede the fish are trapped in the small farm ponds, most less than 0.25 acres (1012 m^2), where they are fed and then harvested after about five months. The fish harvested are primarily black fish: Channa (snakehead); Clarius (catfish); and Aanabas (climbing perch) but at least 15 fish species have been identified. During harvest about 10-25% of the fish are selected and saved for brood stock to reproduce for the next year. In some cases the ponds are connected to the rice fields by canals or other approaches are used to attract fish to the trap ponds. The ponds have multiuse being used for house hold water, watering animals, and a variety of trees, fruit trees and vegetables are grown on the pond banks.

This system is similar to rice field fisheries in other nearby countries (Bangladesh, Cambodia and Thailand) whereas fish spawn and feed in the flooded rice fields during the monsoons, then as flooding declines the fish move to trap ponds in the rice fields and other permanent water bodies and are subsequently harvested (Gregory & Guttman, 2002; Guttman,1998). What is unique in this Myanmar system, is that the farmers feed the trapped fish, and select and maintain brood stock to spawn the next year. We are calling this system indigenous aquaculture as there is partial control of the fish. This system differs from conventional aquaculture in that there is no need to raise fish in hatcheries and stock them as this system relies on natural spawning and a range of indigenous species. In addition this system by conserving brood fish may also be playing an important role in restocking the wider flood plain area. In Cambodia there is now considerable effort to create community fish ponds as fish refuge to enhance the rice field fishery (Brooks et al 2015).

It is difficult to compare this wild fish aquaculture to commercial aquaculture yields or wild fish catches as this is a trap system and relies on collection of fish from a much larger area of rice fields. Thus the production is partial dependent on the area of rice field foraging and not just the pond size, nevertheless the yields to this low input system of 2,000-5,000 kg/ha are impressive. Yields from flood plain wild capture fisheries in Bangladesh are estimated at 119 kg/ha (Scullion 1996), rice fish farming in China averages 180 kg/ha (MacKay, 1995), and yields from intensive commercial aquaculture in Myanmar average 4,800 kg/ha.(Belton et al 2017). Additionally the yield from the small ponds (0.08-0.1 hectare) in Kan Myint of 200-300 kg per pond is close to the average household catch in the total rice field fishery in Cambodia of 321 kg (Gregory & Guttman, 2002).

Estimated economic returns are also impressive with low input costs and return on operating cost of 50-440%. The system is much more profitable (15.6 times) than monsoon rice production, and will be even more important in marginal rice areas or years when rice yields are reduced due to flooding. In addition there are other benefits of the multiuse ponds that supply household water, fruit, vegetables and timber. The system also contributes to food security with fish being marketed in local township markets, sold direct to villagers, and lower value fish distributed to village families who participate in the harvest.

The issue of licencing of the ponds is interesting. Ponds smaller than 0.016 acre (64m^2) do not need a license, but most of the ponds in this survey while small are above the size (0.028 acre, 113m$^{2)}$ that would require a license. The theoretical license fee for ponds is given in Table 10. In most villages the ponds were not licenced by Department of Fisheries (DoF) nor did they pay a fee, nor was one demanded. The two villages in Waw Township did pay a fee to the Township Administrator of 2000- 4000MMK depending on pond size. In addition, villages where the ponds are located within Leased Areas (Inns) the farmers pay a fee to the Lease Owner for the fish in their pond. As the ponds were original constructed for water storage it is assume that the farmers have not obtained the La Na 39 document (the land use title document that permits conversion to non-agricultural uses). The question is as the ponds primary purpose is for household water supply and they were constructed many years ago do they require licensing. It does appear that as a result of this survey Bago Department of Fisheries has expressed increased interest in collecting a fee from farmers.

Table 10: Annual License Fees in Bagon Region based on culture's pond size (Source DoF, Bago Region)

No	Pond Size Acres (m^2)		Fee MMK (US$)
	From	To	
1		0.028 (113) [4]	No Requirement for licensing
2	0.03 (121)	1.00 (4,047)	1500 ($1.12)
3	1.01 (4087)	2.00 (8,094)	3000 (2.24)
4	2.01 (8134)	3.00 (12,141)	4500 ($3.36)
5	3.01 (12,181)	4.00 (16,187)	6000 ($4,48)
			Late payment after 30 September 2000 ($1.49)

In addition new ponds above 0.02 acres (64m^2), in theory would require a complicated procedure (La Na 39) to request an application to convert paddy land to ponds (Khin Maung Soe et al 2015, Belton et al 2015)). Bago DoF have indicated that new ponds will require permission to convert paddy land to an alternative use such as fish ponds, unless the farm land is already classified as wasteland. This has been identified as a major constraint to small scale aquaculture expansion in Myanmar (Belton et al 2015).

This system that relies on indigenous fish, natural hatching, and low input feeding, and marketing to nearby markets would appear to be an excellent system to expand to other areas as an additional supplementary income source and food security strategy for small scale farmers .What is surprising is that the practice is widespread in Bago region and has been carried on for a long time yet appears to be virtually unknown**.** Given similar conditions in other areas of Myanmar like the Ayeyarwady Delta and Mon State[5] it is anticipated that similar systems may be in existence in these areas. It is suggested that this system should be further documented and then extended to suitable areas of Myanmar where it is not yet being practised.

[4] This is larger than reported elsewhere.

[5] Recent information from Mon State suggest there may be a similar system in some villages in northern Mon State.

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