Small-scale aquaculture of wild fish in Myanmar: A preliminary report from the Bago Region

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Introduction

Myanmar aquaculture has previously been 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 and 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 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, which were subsequently fed. At harvest about 20% of the fish were selected as broodstock to carry over to the dry period and spawn at the start of the next monsoon. This system is similar to rice field 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 broodstock 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 a form of indigenous aquaculture. CLCMGoM is a project of the Swiss Agency for Development and Cooperation (SDC) implemented by Network Activities Group (NAG), HELVETAS and IUCN.

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 background 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

Google Earth Image showing numerous farm fish ponds surrounded by trees in the Bago region.

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.

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 ponds. 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 show numerous small green areas that represent a small pond surround by trees that further supports the widespread nature of this system.

Size of ponds: Ponds are small varying from less than 0.04 to over 0.40 ha (Table 2) but most ponds (80%) were less than 0.11 ha and 90% were less than 0.20 ha. The two ponds surveyed in Kan Myint were 0. 08 and 0.11 ha.

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 4.8 ha and the average pond area was 0.18 ha. There was no clear trend in number of ponds with 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 due to saltwater intrusion if the ponds were dug too deep. The depth varied from 1.8 m^2 to over 6.1m^2. In general they all held water during the dry

Table 1: Villages surveyed for indigenous aquaculture and number of ponds.

Date surveyed	Village	Township	Number participants male (female)	Number farmers in village	Number farmers with ponds	Total number of ponds/village & size of ponds (ha)
23-8-16	Koke Ko Tan	Thanat Pin	9 (2)		50	60
25-8-16	Ko Tone Tan		5		40	50
31-8-16	Ko Teko		10 (4)	94	89 (95%)	34 x 0.16 ha 65 x 0.04 ha
31-8-16 21-10-16	Thana Tan		4 (3)	250	110 (44%)	8 x small 137 large
19-10-16	Htat Ka Maing		One larger scale farmer		1	5 total 4.8 ha
25-8-16	Ta Dar Oo	Kawa	7 (9)	128	48 (38%)	8 x 0.04-0.20 ha 48 >0.04 ha
26-8-16 20-10-16	Ma Mauk		6 (6)	340	55 (16%)	64
2-9-16	Htain Tapin	Waw			150*	150*
2-9-16	Ka Daut				150*	150*
Total					693	774
Harvest Survey						
18-01-17	Kan Myint 1	Kawa	One farmer & harvesters		1	1-810 m^2
19-01-17	Kan Myint 1	Kawa	One farmer, harvesters, & fish buyer		1	1-1,112 m^2

** This is a conservative estimate as number of ponds was not recorded.*

season with the dry season minimum depth varying from 0.5-2m^2. Only one village used plastic pond liners to hold water in the ponds.

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

Size of ponds (ha)	No. of farmers	Percentage of farmers
<0.04	91	24.0
0.04-0.11	205	53.9
0.11- 0.20	48	12.6
0.20-0.40	22	5.8
>0.40	14	3.7

Table 3: Example of paddy field area, number of ponds, and area of ponds from nine farmers in Thanatan Village, Thant Pin Township, Bago Region, Myanmar.

Paddy field area	No. ponds	Pond area hectares	Total pond area hectares
6	1	0.001	0.001
10	2	0.20	0.40
30	3	0.13	0.40
40	3	0.16	0.49
40	2	0.001 & 0.24	0.25
50	1	0.40	0.40
70	1	0.20	0.20
100	3	0.13	0.40
300	10	0.22	2.23
Total	**26**		**4.78**
Average			**0.18**

The two ponds harvested in Kan Myint were quite deep with pond depths of 5.9-8.2 m^2. Additionally both ponds were either adjacent to a second pond or one pond was divided into two. 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 broodstock. We did not include this question in the earlier surveys so do not know how wide spread this practice is.

Aquaculture practices: This system relies 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 reproduce and feed. All the ponds relied on recruitment and replenishment of indigenous species and were essentially a trap system as the water level drops 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. A few claimed to use attractants such as horse oil (a traditional medicine); cans of tinned fish with holes punched in them; and some used what was called a schooling pond which was deeper and 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 20 hectares 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.

Fish pond at the end of the monsoon season (October).

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 machine.

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. Additionally, many farmers made a paste with fish paste, peanut cake, or coconut cake mixed with rice bran which was then 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 that they occasionally added 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. They claimed this was an attractant for snakeheads. Shrimp shells and horse bones were also

Table 4: Preliminary list of fish species in the wild fish aquaculture in Bago Region.

Scientific name	English name	Myanmar language	
Clarius batrachus	Walking catfish	Nga khu	ငါးခူ
Heteropneustes fossilis	Scorpion catfish	Nga gyee	ငါးကြည်း
Channa striata	Striped snakehead	Nga yant	ငါးရံ့
Channa sp. (*Lucius*?)	Snakehead	Nga pa naw	ငါးပါးနော့
Mystus cavasius	Gangetic catfish	Nga zin yaing	ငါးဇင်းရိုင်း
Anabas testudineus	Climbing perch	Nga ppay ma	ငါးပြေပမ
Trichopodus pectoralis	Snakeskin gourami	Bee lar (often called tilapia)	ဘီးလား။ ဂ်ပန္ငါး။ တီလားပီးယား.။။
Ompok bimaculatus	Butter catfish (sheath fish)	Nga nu than	ငါးနူးသန်း
Lates calcarifer (*L. uwisara*)	Sea bass	Ka ka tit	ကကတစ်
Notopterus notopterus	Bronze Featherback	Nga phae	ငါးဖယ့.
Cirrhinus mrigala	Mrigil	Nga gyin	ငါးဂျင်း
Mixed *Barbonymus* spp., *Puntius* spp.	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	ငါးဘတ့.

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

Fish names			Weight kg (Viss)[1]					
			Pond 1			Pond 2		
Scientific	English	Myanmar	Harvest	Brood stock	Total	Harvest	Brood stock	Total
Channa striata	Striped snakehead	Nga yant	104.5 (64)	40.8 (25)	231 (141.5)	89.8 (55)	11.7 (7.2) 10 fish	101.5 (62.2)
Clarius batrachus	Walking catfish	Nga khu	12.2 (7.5)			73.5 (45)	3.0 (1.8) 10 fish	76.5 (46.8)
Anabas testudineus	Climbing perch	Nga pyay ma	73.5 (45)			1.6 (1)	-	1.6 (1)
Trichopodus pectoralis	Snakeskin gourami	Bee lar	24.5 (15)	-	24.5 (15)	8.2 (5)	-	8.2 (5)
Lates calcarifer	Giant seabass	Ka ka tit	5.0 (3.1)	-	5.0 (3.1)	-	-	-
Notopterus notopterus	Feather back	Nga phae	0.6 (0.38)	-	0.6 (0.38)	-	-	-
Wallago attu	Freshwater shark	Nga batt	21.2 (13)	-	21.2 (13)	-	-	-
Puntioplites proctozrysom?	Smith barb	Nga phar ma	8.2 (5)	-	8.2 (5)	1.6 (1)	-	1.6 (1)
Puntius sp.	Barb	Nga khone ma	3.3 (2)	-	3.3 (2)	2.5 (1.5)	-	2.5 (1.5)
Total			**253.1 (155)**	**40.8 (25) 13.9%**	**293.9 (180.0)**	**177 (108.5)**	**14.7 (9) 7.7%**	**191.9 (117.5)**

[1] Viss is a unit of weight used exclusively in Myanmar, 1 Viss = 1.6329 kg

Table 6: Standard length (cm) and weight (g) 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
					Length				
Average	51.36	43.84	22.28	29.48	16.85	17.50	17.33	40.40	32.00
SD	±2.06	±9.08	±3.35	±4.62	±2.41	±2.01	±2.52	±1.52	±2.83
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				
Average	1,244	858.40	81.60	248	77.69	122	53.33	1,020	300
SD	±238.19	±595.68	±31.84	±80	±22.79	±43.67	±11.55	±83.67	±141.42
n	25	25	25	25	13	10	3	5	2
Range	1,000-1,800	200-2,600	20-130	100-360	40-100	60-200	40-60	900-1,100	200-400

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 (hectares)	No. of ponds	Total yield range (kg)	Average kg / hectare
0.04-0.12	4	122-245	1,946
0.08-0.1 (Kan Myint)	2	192-294	2,764
0.16-0.20	4	490-1,715	3,012
0.40	3	1,633-2,041	2,677
4.9 (commercial)		24,494	5,044

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. These acted to increase surface area for algae and microbial growth that enhanced 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.

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 10cm (4") pump to pump out the ponds. The fish were then harvested using dip nets, 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.

Small-scale fish pond in the dry season.

Species: At least 15 species were reported as being harvested (Table 4). The most abundant species were the blackfish: *Channa* (snakeheads); *Clarias* (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.

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 six 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.

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 that 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.

Yield: Estimated yields for the various pond sizes are given in Table 7. The small scale farmers' yields ranged from 122 kg to over 2,000 kg per pond and from about 1,900 kg/hectare to 3,000 kg/hectare. Additional data was obtained from a farmer with larger scale ponds of 4.8 ha who estimated yields of over 5,000 kg/ha. This was higher than the estimates from the

Table 8: Disposition of harvest from Kan Myint ponds.

Market Condition	Species	Total weight Viss, (kg), %		Price US$ / kg (MMK / Viss)	Income US$ (MMK)	
		Pond 1	Pond 2		Pond 1	Pond 2
Live	Walking catfish	12.2 (7.50) 4.2%		$3.26 (4,364)	$24.43 (32,730)	
Sold at pond & shipped live to market	Striped snake-head & Walking catfish		163.3 (100) 85.1%	$3.25 (4,350)		$324.63 (435,000)
Weight sold dead	Striped snake-head	104.5 (64) 35.6%		$3.00 (4,021)	$191.75 (256,950)	
Sold at village	Sea bass & wallago	26.2 (16) (8.9%		$3.24 (4,348)	$52.24 (70,000)	
Total sale		143.1 (87.5) 48.7%	163.3 (100) 85.1%		$268.42 (359,680)	$324.63 (435,000)
Gift to neighbours and harvesters	All other species	110.0 (67.4) 37.4%	13.9 (8.5) 7.2%			
Total harvest		253.1 (155)	177.2 (108.5)			
Brood stock		40.8 (25) 13.9%	14.7 (9) 7.7%			
Total yield		293.9 (180)	191.9 (117.5)			

small scale farmers but is probably related to more extensive feeding and greater control as the ponds are supplied with fish from 40 hectares of rice fields that are all diked.

Broodstock selection: The unique aspect of this wild fish aquaculture is the selection and saving of broodstock from one year to the next. Every farmer interviewed saved broodstock particularly of snakehead, catfish and climbing perch. In general we were told that 10-20% of the catch was saved. A number of farmers indicate that 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 climbing perch. The broodstock saved ranged from 8 to 14% of the total harvest.

Various selection criteria for broodstock 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 broodstock was large size. This is confirmed by the sampled fish from pond 2 (Table 6), the ten selected snakehead broodstock averaged 1.2 kgs versus an average of 0.86 kg for the sampled fish and the ten catfish broodstock averaging 0.30 kg versus 0.25 kg 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 but some farmers did occasionally 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, transporting them 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 were 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 to a Thantpin Township collection center while the other sold directly to a broker who collected the fish at the pond and then sent 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.

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 return on investment of 132 to 440% is impressive. Data from the two Kan Myint ponds allowed calculation of the averaged profit per hectare of $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.

The commercial farmer with 40 ha of flood plain has 4.8 ha of wild fish indicated a total income of over US$1,500 per hectare. This farmer has recently added 30 areas of commercial aquaculture ponds using stocked fish and intensive feeding but indicated that the wild fish aquaculture was much more profitable than the commercial aquaculture.

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%

History

All ponds (with the exception of the large scale farmer) appear to have been initially dug for household water supply but the farmers subsequently discovered that fish moved into the ponds and they started raising the fish. The ponds have multiple uses in addition to fish culture: they are used for household water (the water is normally carried to the house for washing, cooking, etc.); livestock watering. In addition all ponds were surrounded by a variety of trees, fruit trees and bamboo 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 present in the 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. The ponds are small, most less than 0.1 ha, where they are fed and then harvested after about five months. The fish harvested are primarily black fish: *Channa* (snakehead); *Clarias* (catfish); and *Anabas* (climbing perch) but at least 15 fish species have been identified. During harvest about 10-20% of the fish are selected and saved for broodstock to reproduce for the next year. In some cases the ponds are connected to the rice fields by canals and other approaches are used to attract fish. The ponds have multiple uses 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) where 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 to be 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 broodstock 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 because this system relies on natural spawning and 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 partially 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

Table 10: Annual License Fees in Bagon Region based on pond size (source DoF, Bago Region).

Pond size (m^2)		Fee MMK (US$)
From	To	
0	0.028 (113)[1]	No Requirement for licensing
0.03 (121)	1.00 (4,047)	1500 ($1.12)
1.01 (4087)	2.00 (8,094)	3000 (2.24)
2.01 (8134)	3.00 (12,141)	4500 ($3.36)
3.01 (12,181)	4.00 (16,187)	6000 ($4,48)
		Late payment after 30 September ($1.49)

[1] This is larger than reported elsewhere.

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 113 m^2 do not need a license, but most of the ponds in this survey while small are above the size 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 2,000-4,000MMK 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 originally 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.

In addition new ponds above 113m^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 conversion process 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 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.

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