NGA MYANMAR

switchasia GRANTS PROGRAMME

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BASELINE ASSESSMENT

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Daung Capital

VillageLink

MERCY CORPS

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CONTENT

LIST OF ABBREVIATION

ac	Acre	MAX	Maximum
APP	Application	MIN	Minimum
AVG	Average	MMK	Myanmar Kyat
DoF	Department of Fisheries	MSMEs	Micro, Small, Medium Enterprises
FCR	Feed Conversion Ratio	NGA	Naturing Green Aquaculture
GAqP	Green Aquaculture Practice	pc	Pieces
Govt	Government	SME	Small, Medium Enterprise
ha	Hectare	SMS	Short Message Service
IDI	Individual Interview	Tech	Technology
IP	Implementing Partners	TVC	Total Variable Cost
KII	Key Informant Interview	USD	US Dollar

UNITS

Table of Conversions and Local Units

Units	Equivalence
1 hectare	2.471 acres
1 kg	2.2 lb
1kg	0.61 viss
1 viss (a measure of weight)	1.625 kg
1 USD	2100 MMK (2022 exchange rate)
1 bag of Rice bran	27.3 kg
1 bag of Peanut oilcake	32.8 kg
1 bag of Lime	16.4 kg

SUMMARY

This study provides an updated information on the present practices of the aquaculture sector in the target locations of Nurturing Green Aquaculture in Myanmar (NGA-Myanmar) programme. It also presents the baseline values for high-level programme indicators. 377 fish farming households from the programme's target townships were engaged in the survey, which was conducted in July 2022. NGA-Myanmar aims at increasing environmental sustainability and resource efficiency in Myanmar's aquaculture sector by supporting micro, small, medium enterprises (MSMEs) engaged in fish production in the Yangon-Ayeyarwady aquaculture corridor[1] to access and adopt cleaner production practices and innovative green technologies.

The following table summarizes survey findings at baseline related to NGA-Myanmar's objective-level, specific objective-level, and outcome-level indicators:

Survey Finding at Baseline	Related Indicator	Baseline Indicator Value
Goal: To improve resource efficiency and reduce environmental degradation in Myanmar's aquaculture industry, while ensuring improved economic returns in the value chain		
Average Feed Conversion Ratio (FCR) was 3.6	% of champion MSMEs reducing feed conversion ratio (FCR) by 0.2 points or more.	0
Average income from aquaculture was MMK 1,296,330 per acre (USD 1524.73[2] per ha)	% increase in incomes of champion MSMEs adopting both critical and desirable/non-critical green aquaculture practices and tech.	0
Specific Objective: Aquaculture MSMEs adopt more resource efficient and cleaner production practices.		
None of the surveyed respondents have adopted any critical and desirable/non-critical greener aquaculture practices and green technologies	% of champion MSMEs adopting both critical and desirable/non-critical greener aquaculture practices and green tech.	0
	% of other target MSMEs (cohort of 2,000 + cohort of 12,000) adopting only critical elements of green aquaculture.	0
Outcome 1: EUR 100,000 in commercial loans are channeled to kick start adoption of green tech and green aquaculture practices by early adopter champion MSMEs.		
None of respondents reported of getting loans from any financial institution. Only 3% received loans from buyers, while 97% did not access any credit for their aquaculture business. Those who received credit from buyer will pay back either with in-kind (i.e., fish) or cash. Observations by the survey	# of target MSMEs accessing credit through newly developed, customized loan products.	0

[1] It covers Twantay in Yangon Region and Maubin, Nyaungdon, and Pantanaw in Ayeyarwady Region.
[2] Official exchange rate of Central Bank of Myanmar (1USD = 2100 MMK) was used to convert the currency units.

Survey Finding at Baseline	Related Indicator	Baseline Indicator Value
team suggested that while some micro finance institutions operate in NGA-Myanmar target areas, none offered any loans specifically design for the adoption of green aquaculture practices and technology.		
Outcome 2: Champion aquaculture MSMEs trial and demonstrate solutions for green aquaculture across different geographic clusters.		
The knowledge assessment finding is presented below.	% of champion enterprises demonstrating satisfactory knowledge of green aquaculture concepts and practices.	0
Almost half of respondents (about 46%) expressed their desire to expand their aquaculture business, however none of their plan was related to any business case for adopting green aquaculture practices.	# of unique business cases for adopting green tech & aquaculture at the pond-level developed and promoted by champion MSMEs.	0
Outcome 3: 75% of other target MSMEs in the Yangon-Ayeyarwady aquaculture corridor have knowledge & awareness to adopt solutions for green aquaculture		
The knowledge assessment finding is presented below.	% of cohort of 2,000 target MSMEs who have increased knowledge and awareness to adopt green tech & green aquaculture practices.	0
	% of cohort of target 12,000 MSMEs who have increased knowledge and awareness to adopt green tech & green aquaculture practices.	0
Outcome 4: MSME take adaptive actions to reduce water pollution in response to environmental data generated by the action		
47% of respondents claimed of carrying out regular water quality monitoring. However, only 10.4% did the water monitoring systematically using water quality parameters (like pH, ammonia, and dissolved oxygen level. Others have done it by visual monitoring of fish feeding behavior or color and smell of pondwater. Furthermore, the application of wastewater treatment before discharge wastewater was only practiced by about 5% of respondents. No respondents were having any settlement and reservoir ponds for siltation.	# of MSMEs that take adaptive actions to reduce water pollution caused by aquaculture, in response to data on water quality generated by the action & environmental screening checklists completed by champion MSMEs	0
Outcome 5: Viable & bankable business cases for replicating the green aquaculture model across the sector are developed and promoted		

Survey Finding at Baseline	Related Indicator	Baseline Indicator Value
At baseline, there was no sector-wide bankable business cases observed to greening the aquaculture sector in the survey locations.	# of sector-wide bankable business cases for the expansion & replication of green aquaculture developed & promoted	0

Meanwhile, the knowledge level (related to Outcome 2 and Outcome 3 indicators) was simply assessed by looking at responses provided by respondents to certain questions related to green aquaculture practices, if they were: "Strongly agree", "Agree", "Neutral", "Disagree", or "Strongly disagree". In all questions, the expected answers were "Strongly agree".

Knowledge check	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
It is necessary to check water quality on regular basis	53%	34%	11%	2%	0%
Some aquaculture practices (such as feeding, fertilizer application, etc.) can contaminate river or other stream water	13%	41%	29%	17%	0%
Record keeping is important to support the adoption of green aquaculture practices	34%	49%	14%	2%	0%
Improper feeding practices are harmful to the environment	13%	40%	29%	17%	0%
It is important to avoid prohibited materials even when they are cheaper	1%	4%	9%	23%	64%
It is important to regularly monitor fish health, not just to increase productivity but also to limit the negative impact of aquaculture to the environment	42%	38%	19%	1%	0%
It is important to report disease outbreak to relevant entity	19%	45%	29%	7%	1%
Checking regularly dissolved oxygen should not just be done in your pond, but also in nearby environment	43%	40%	12%	4%	0%
Average	**27%**	**36%**	**19%**	**9%**	**8%**

Two goal-level indicators, which are (i) Values of wastewater effluent parameters (reduced nitrogen, phosphorus and biochemical oxygen demand and increased dissolved oxygen), and (ii) % reduction in estimated CO2 emissions from champion MSMEs' aquaculture operations, were not included in the scope of this study but was included in the NGA-Myanmar's Strategic Environmental Assessment (SEA) that was done separately.

INTRODUCTION

This document presents findings from the Baseline Assessment of the European Union (EU) funded Nurturing Green Aquaculture in Myanmar ("NGA-Myanmar") programme. NGA-Myanmar aims at increasing environmental sustainability and resource efficiency in Myanmar's aquaculture sector. The programme supports micro, small, medium enterprises (MSMEs) engaged in aquaculture in the Yangon-Ayeyarwady aquaculture production centers to access and adopt cleaner production practices and innovative green technologies.

Objectives

The assessment consists of two objectives, they are:

(1) Providing updated information around the current practices of the aquaculture sector in the programme target locations, to understand the current conditions of production practices and access to inputs, technologies, financial services, and output markets.

(2) Establishing baseline data for high level programme indicators measurement, to be used to calculate programme indicators progress/achievement at mid-term and endline, where the logical framework of the programme covers key indicators related to farm productivity, income of the pond operators and knowledge and practices around key green aquaculture practices.

Methodology

The research methodology includes data collection for both quantitative and qualitative information, data analysis and developing the comprehensive report.

Desk review

Literatures related to green aquaculture, including programme descriptions, proposals, logical framework, indicators plan, and other related reports, were reviewed.

Primary Data Collection

Key Informant Interviews (KII): The community leaders and relevant key actors in the targeted areas participated in KIIs. For KII, semi-structured questionnaires and the KII data format were used.

Individual Interviews (IDI): The IDI questionnaire was used to conduct interviews with respondents in the four NGA-Myanmar target townships of Nyaungdon, Pantanaw, Twantay, and Maubin. Sample size was calculated by using the following formula:

$$n' = \frac{n}{1 + \frac{z^2 \, x \, \hat{p}(1-\hat{p})}{\varepsilon^2 N}}$$

Whereby:

z is the z score

ε is the margin of error

N is the population size

p̂ is the population proportion

With the following parameters:

- Confidence level: 95%
- Margin of error: 5%
- Population proportion: 50%
- Population size: 20,000

Since there was no exact population size (therefore 20,000 was used as per good practice), non-probability (i.e., purposive) sampling method was used to select respondents in the target areas. Respondents were selected from the initial aquaculture villages identified by NGA-Myanmar as its target communities. A list of 41 villages across the 4 target townships of NGA-Myanmar was provided by Village Link (NGA-Myanmar's implementing partner). From each village, about 9 to 10 MSMEs were interviewed, giving us a total 377 respondents, the minimum number required to meet the required survey parameters. For better quality control in data collection, storage, and processing, these questionnaires were created using Kobo Toolbox.

Limitations

Given the unfavorable political situation and considering the security and safety of the survey team members and participants, interviews with respondents were done at gathering locations, determined by community leaders. The survey team members were therefore not able to visit and directly observe the ponds.

In addition, as it was rainy season, movements to the gathering place of some respondents were constrained by rains or impassable road. Moreover, for many respondents, rainy season coincides with harvesting, while for others, they were busy with regular work at their pond during daytime.

Since respondents do not have proper records (i.e., written book), they rely on their memory to recall past data and information about their aquaculture, and on some occasions, they were not able to provide the data needed. As a result, nonresponse errors occurred in data analysis, at item level. In this case, such data was removed to allow the analysis to proceed. As data was collected based on respondents recall, the questions were only referring to the previous year of growing season (2021).

RESPONDENTS PROFILE

Study respondents are the owner of aquaculture farms or MSMEs. In the NGA-Myanmar program, and therefore also in this assessment, the terms of “aquaculture farmer”, "aquaculture household", “aquaculture farm” and “aquaculture MSME” are used interchangeably. This section presents the profile of study respondents, covering their demographic information and economic characteristics.

Demographic Information

Gender and Age of Respondents

The majority of respondents are men which represents 82.5% of the total number of samples and the remaining 17.5% represents women. The respondents ranged in age from 19 to 77, with the average age being 47.5 years.

Figure 1: Respondents by gender (n=377)

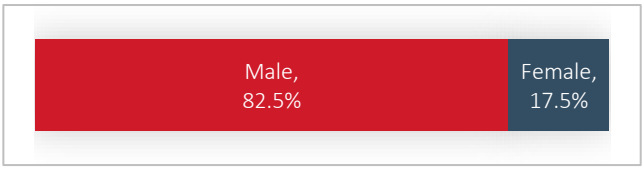


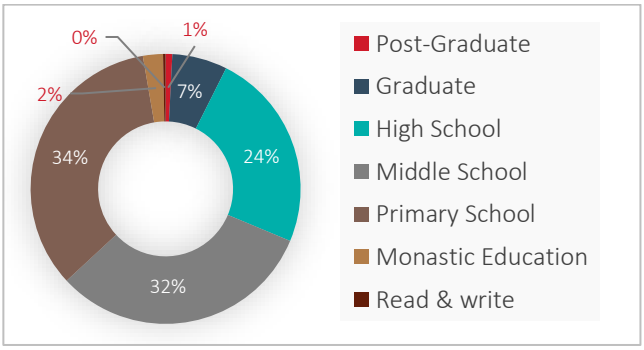
Table 1: Age of respondents (n=375)

	Average	Min	Max
Age	47.5	19	77

Respondents Education

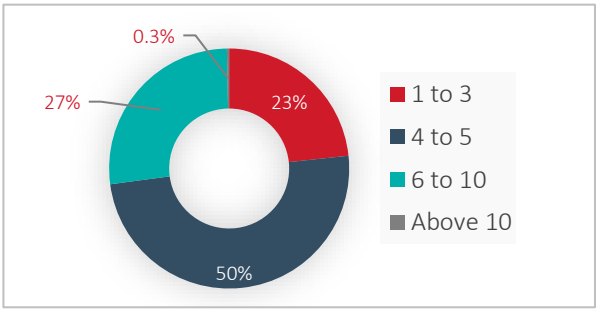
When asked about their level of education, 34% of them had completed primary school, and 32% and 24% had finished middle and high school respectively. 2.4% of respondents attended monastic education, while only 6.6% and 0.8% received degrees and had post-graduate degrees. About 0.3% of the respondents has not finishing any formal education level, but they are able to read and write. The data indicates a very high literacy rate among participants.

Figure 2: Education of respondents (n=377)



Household Composition

Figure 3: Household size (n=377)



The respondents had an average family size of 5 people, with a range of 1 to 15 family members. Nearly 50% of sample households in the surveyed areas had 4 to 5 household members, compared to 23% who had 1 to 3 and 27% who had 6 or more. One household was with more than 10 members. The average number of men in a household was 2, with a maximum of 6, and a minimum of 1. Meanwhile the average number of women was 2, with a maximum of 10.

Table 2: Number of household members by gender (n=376)

	Average	Min	Max
Total family member	5	1	15
Male	2	1	6
Female	2	0	10

When further asked how many members of their families were involved in aquaculture, and the responses ranged from 1 to 9, with an average of 2 family members. Aside from that, the average number of men engaging in the aquaculture farming was 2, with a maximum of 5 and a minimum of 1, while the average number of women working in the aquaculture was 1, with a maximum of 6.

Table 3: Number of family member engaged in Aquaculture (n=375)

	Average	Min	Max
Engaged in aquaculture	2	1	9
Male	2	1	5
Female	1	0	6

Economic Characteristics

Household Income

All respondents engaged in aquaculture, but only 89% of them stated that aquaculture is their household primary source of income. The primary source of income for about 6% of the sample households was farming and about 1% of them operated businesses related to fishing, raising livestock, and trading.

When asked about any secondary source of household income in addition to the primary one, 17% of respondents also earned money from crop farming. 11% of respondents had secondary or other incomes generated from aquaculture activities, while 6% from livestock rearing. Moreover, a small percentage of households (2%) engaged in fishing in nearby rivers. 6 respondents engaged in trading, 2 in food processing, and 5 as paid employees (4 with private sector actors and 1 as government officer). About 13% of participants participated in other livelihood activities such as boat transportation service, self-employed business (grocery shop, traditional mat production, betel shop, etc.), and/or received remittance.

Figure 4: Primary sources of income (n=377)

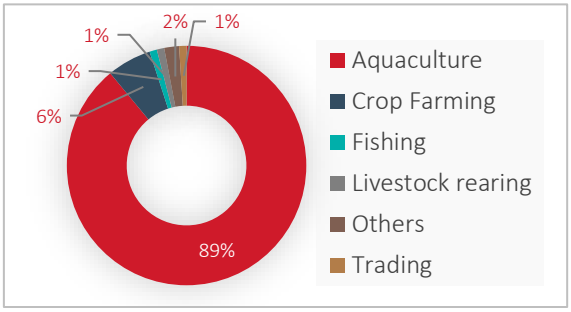
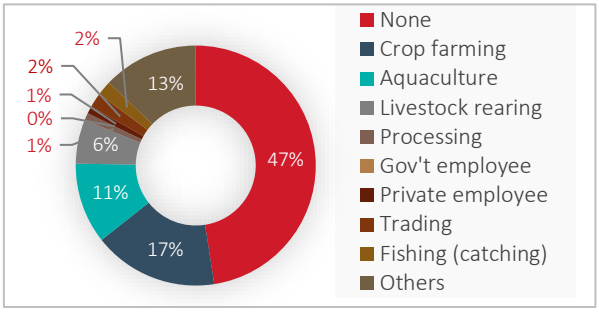


Figure 5: Secondary sources of income (n=377)



The average annual household income in 2021 for the sampled households was over 21.7 million MMK (or over 1.8 million MMK per month). A further analysis of the data suggested that the collected data was not distributed normally. For that reason, the median value was also calculated. The median annual income was only 5,5 million MMK. The average household income from aquaculture activities, which represented 20.3 million MMK annually (with the median value of just 5.5 million MMK), was undoubtedly the largest share of all household income sources.

Apart from the income from the aquaculture, agriculture contributes the second largest share of household's income that covers almost 4% of the total respondents. The average income from agriculture was about 4.3 million MMK (with median value of 2.7 million MMK). This was then followed by other sources of income, like from livestock rearing, etc.

Further analysis of the income from aquaculture was done to assess its contribution to the overall household income. It is found that the larger the ponds, the higher aquaculture contribution to overall income.

Table 4: Household income in 2021 (n=377)

Source of income	Average	Median	Min	Max	Frequency
Aquaculture	20,309,211	5,478,800	- 143,600,000	403,500,000	376[3]
Agriculture	4,293,675	2,658,000	- 2,800,000	20,000,000	86
Livestock rearing	9,876,250	2,000,000	- 40,000,000	90,000,000	16
Self Employed	2,206,923	1,200,000	- 3,430,000	13,500,000	13
Perennial Crops	2,066,667	1,500,000	300,000	5,500,000	9
Skill Labor	6,655,556	2,400,000	500,000	38,400,000	9
Trading	6,144,444	5,000,000	500,000	15,000,000	9
Fishing/fisheries	1,184,333	1,470,000	129,000	2,000,000	9
Transporting Service	9,114,286	7,200,000	1,300,000	27,000,000	7
Remittance	7,250,000	1,900,000	1,000,000	30,000,000	6
Rental service of	9,672,000	8,800,000	360,000	20,000,000	5
Others	5,277,727	2,300,000	300,000	36,000,000	22
Total HH Income	21,747,633	5,478,800	388,586,400	403,500,000	376

[3] One outlier was removed.

Table 5: Average Income from Aquaculture by pond size

	Avg income from aquaculture (MMK)	Total household Income (MMK)	Contribution to household income
Less than 1 ac	11,637,733	15,415,000	75%
1 to 10 ac	13,974,338	15,798,059	88%
10 to 50 ac	30,015,423	33,713,222	89%
> 50 ac	39,811,111	42,414,444	94%
Average	23,859,651	26,835,181	87%

Pond Ownership

The largest percentage which contributes about 41% of respondents owned only one pond which was followed by 31% who owned two ponds. About 14% owned 3 ponds and over 5% of them owned 4 ponds. The rest of respondents owned 5 or more ponds.

Figure 6: Percentage of Sample Respondents who own different number of ponds (n=377)

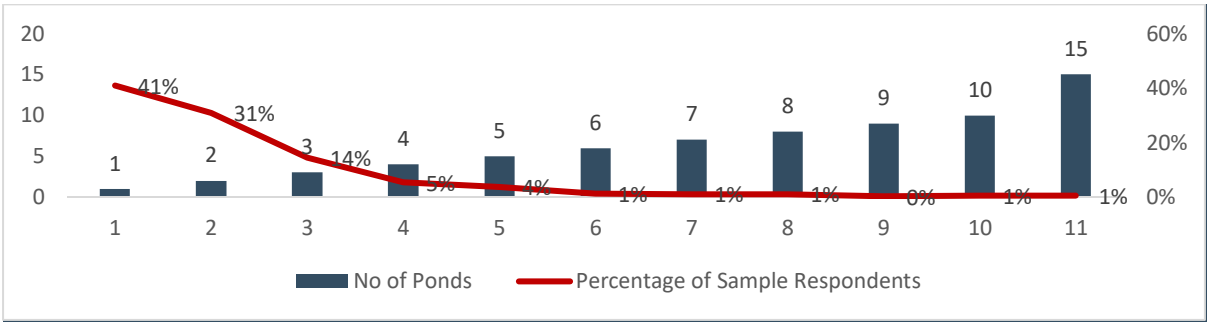
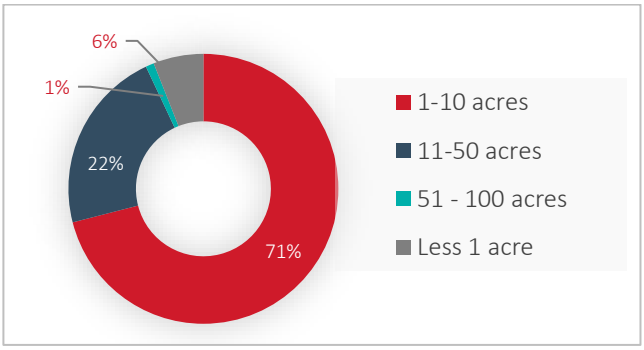


Figure 7: Respondents by pond size (n=377)



In terms of acreage or size, on average respondents owned 14.49 acres (5.87 hectares). The majority of aquaculture households (71%) had 1 to 10 acres (0.4 to 4 ha) of fishpond. About 22% owned 11 to 50 acres (4.5 to 20.2 ha), a very small percentage owned 51 to 100 acres (20.7 to 40.5 ha) and only 6% of sample households have less than one acre.

In terms of category of ponds, about 36% of the total number of ponds are nursery and hatchery while about 64% of these ponds are grow-out ponds.

Equipment Ownership

The use of surface water pump is very popular. 92% respondents had surface water pump. This was then followed by the ownership of power generator set, whereby 25% of respondents owned, mainly to pump water to or from the ponds. It was observed that access to electricity grid is limited, therefore pond water exchange is done by power generator set. Meanwhile, only 10% respondents owned tractor, 7% owned

ground water pumps and only 1% had mechanical backhoe. During the study, there was no fish processing machine has been observed.

Table 6: Production assets owned by the respondents (n=377)

Assets	Frequency	% Household	Average
Surface water pump	346	92%	3.4
Generator set	93	25%	2.4
Tractor	38	10%	2.1
Ground water pump	28	7%	2.5
Oxen/Buffalo	7	2%	4.8
Harvester	4	1%	1.6
Mechanical backhoe	2	1%	1.3

Transportation Asset Ownership

The most frequently used modes of transportation in the target communities are bicycles or motorcycles. In the surveyed townships, 70% respondents had bicycles or motorcycles and 12% owned car. To support their aquaculture, motorcycle or bicycle are used to transport inputs to the ponds or their harvested fish to markets, and for other purposes. 60% and 59% respondents had motorized and non-motorized boat respectively, dedicated to transport fingerlings and feeding. Only 2% of respondents owned cars or trucks, whereas 7% owned tractor-motored cart (called *trawlargyee*) for transporting fish, inputs, and other things.

Table 7: Transport assets owned by respondents (n=377)

	Frequency	Percentage	Average
Bicycle/ Motorbike	264	70%	2.5
Car	44	12%	2.1
Non-motorized boat	224	59%	3.1
Motorized boat	226	60%	2.7
Trawlargee	28	7%	2.1
Truck	7	2%	1.9
Other transport means	4	1%	2.6

Communication Asset Ownership

Mobile phones are extremely important for accessing information. The majority of participants accounted for 95% had smartphone for communications and only 6% participants were still using keypad mobile phone. Only 1 respondent own computer or tablet.

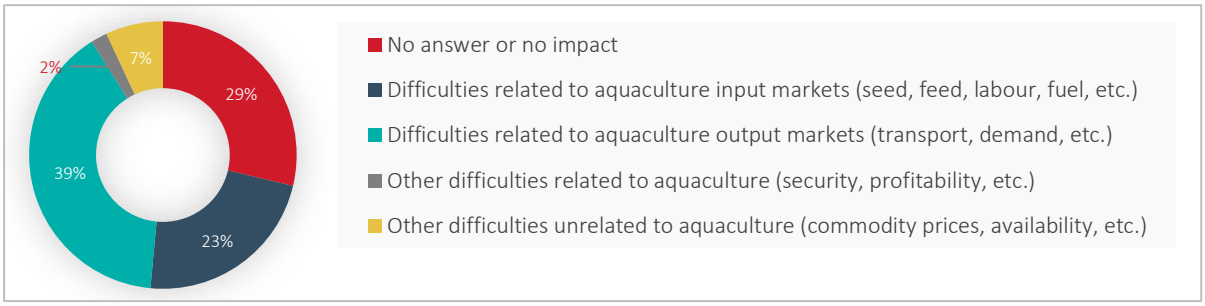
Even though access to mobile data is broadly available in the NGA-Myanmar target townships, it was observed that digital literacy is still an issue, whereby community members tend to use internet only to access social media (i.e., Facebook). When asked whether they use internet regularly, about 38% of them used internet on a regular basis through their mobile phone.

Table 8: Communication assets (n=377)

	Frequency	Average	Min	Max	Percentage
Smart phone	357	4.2	1	7	95%
Keypad mobile phone	21	3.9	1	7	6%
Computer/tablet	2	1.3	1	1	1%
Accessing internet regularly	143	4.2	1	7	38%

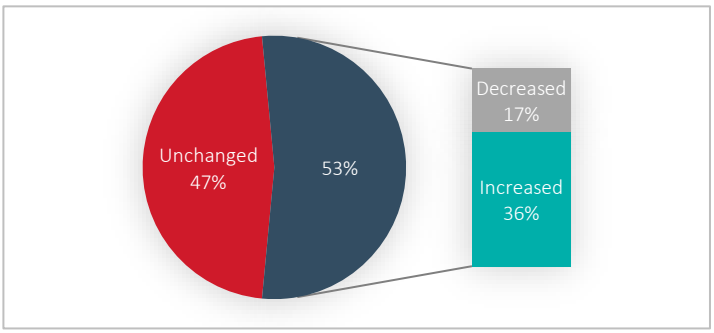
Impact of the Double Crisis

Figure 8: Impacts of the double crises (n=377)



Many aquaculture farmers suffered negative impacts of COVID-19 and events after the government takeover by the military. Only 29% of all respondents did not provide answer or answered that the pandemic and political crisis had no effect on their business. On the other hand, about 23% of them expressed difficulties related to accessing inputs, like seed, feed, labor, and fuel due to price increase, lack of availability, etc. While 39% challenged with accessing markets due to reduced demand, transportation disruptions, etc. Furthermore, 9% of respondents experienced other difficulties, both related to aquaculture (increased incidents of fish theft, etc.) and unrelated (other commodity prices, availability, etc.).

Figure 9: Impact the crises on revenue (n=191)



When asked if they reduced or increased their pond size since the pandemic, only 2 respondents reduced their pond size, while 3 has increased it. Although only 5 respondents changed their pond size, 191 respondents (accounted for 53% of those answering the question) experienced revenue change from aquaculture. Interestingly, the average revenue from 2021 season has been increased by 16% from the prior year. Out of those 191 respondents, 32% reduced their revenue, compared to 68% increased their revenue. This might be due to a combination of unfavorable overall market situation in 2020 due to the pandemic and the increase of fish price in 2021.

AQUACULTURE PRACTICES

The favorable ecological conditions in NGA-Myanmar target locations make it one of ideal places for aquaculture development. While the past decades marked a rapid expansion of the sector, the communities have been engaged in aquaculture for generations. However, adoption of good practices is still relatively limited. This section presents about existing management practices used by respondents, including seed, feed, water, and other key elements in aquaculture operations.

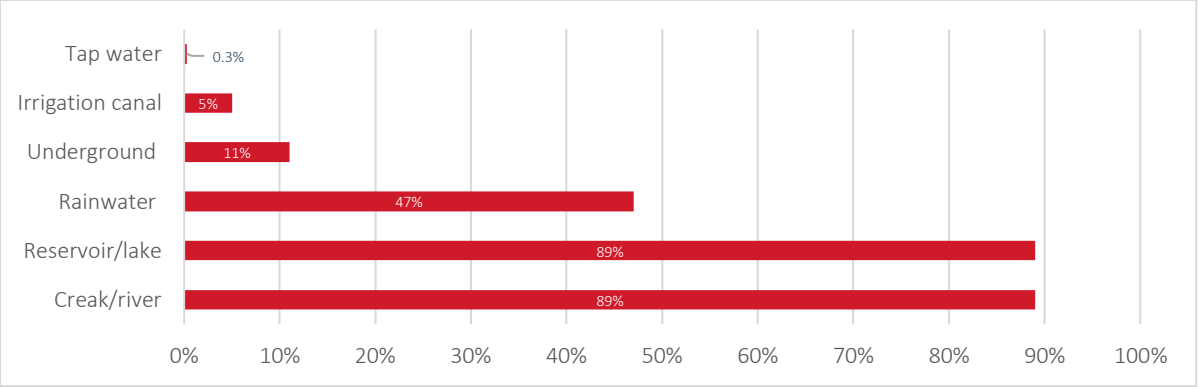
Water

Amongst the respondents, the average size of grow-out ponds and integrated ponds were 14 acres per household. Meanwhile, nursery pond was averaged around 3.5 acres. Good supply of water, adequate in both quantity and quality, is essential to the successful fish farming.

Water Sources

In the surveyed areas, the sampled fish farmers supplied water to their pond from the various sources. The most common sources of water used for aquaculture are rivers, underground water via tube wells, lakes, and irrigation.

Figure 10: Water sources for ponds (n=376)



Most of aquaculture ponds rely on creak/river and reservoir/lake to supply water, whereby each accounted for 89% respondents. This was then followed by rainwater which 47% of respondents rely upon. About 11% of respondents sourced their aquaculture water from the underground water via tube wells, and 5% from nearby irrigation canals. Only 1 respondent mentioned that he also used water from tap water.

Water Management

When they reach 3-5 inches, fingerlings are stocked to raise in large grow-out ponds. According to the information from KII and IDIs, normally, the density of fingerlings is about 5,000-6,000 pieces per hectare. About 80% of stocked fingerlings survive until harvest, but it would be depending on their feed, feeding practices, quality of water, and other factors. In grow-out ponds, fingerlings are fed with peanut meal, rice bran, wastes of fishery products and other meals. Some farmers use commercial feed pellets due to higher quality than homemade ones.

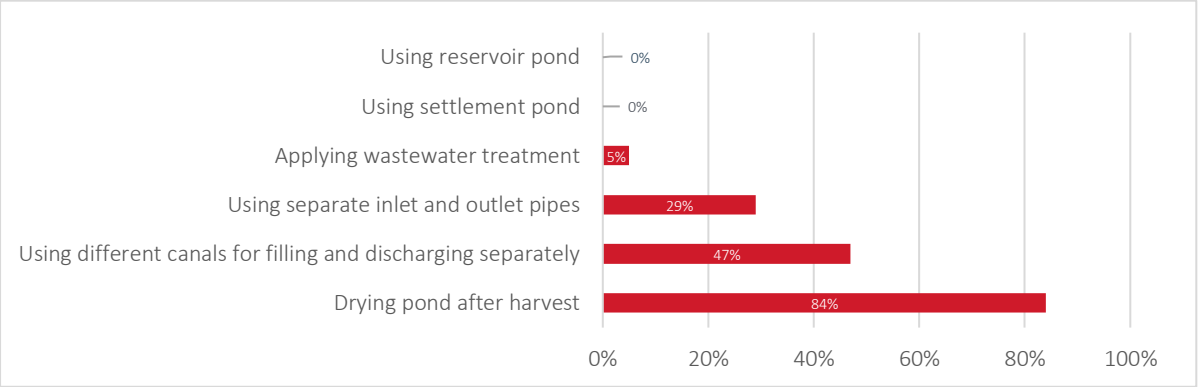
Some of the grow-out farms were integrated with poultry farm. Interviews with key informants suggest that while it promotes the reuse of resources, its efficacy has been questioned especially around hygiene and food safety concerns.

Figure 11: Integrated poultry and fish system

One of key pond management practices include cleaning and drying pond. Cleaning and drying remove unwanted waste and organisms and microbes from the previous culture. It helps to mineralize the organic content of the bottom and oxidizes the harmful substance like sulfates. In the surveyed areas, most of the respondents, accounted for 84% dried the ponds after harvesting or before water is filled up.

The data also shows that 47% of respondents had separate canals for filling pond water and for discharging the used water after harvest. About 29% of respondents utilized different pipes as outlet (to drain) and inlet (to fill) pond. Meanwhile, the application of wastewater treatment before discharge wastewater was only practiced by about 5% of respondents. No respondents were having any settlement and reservoir ponds for siltation.

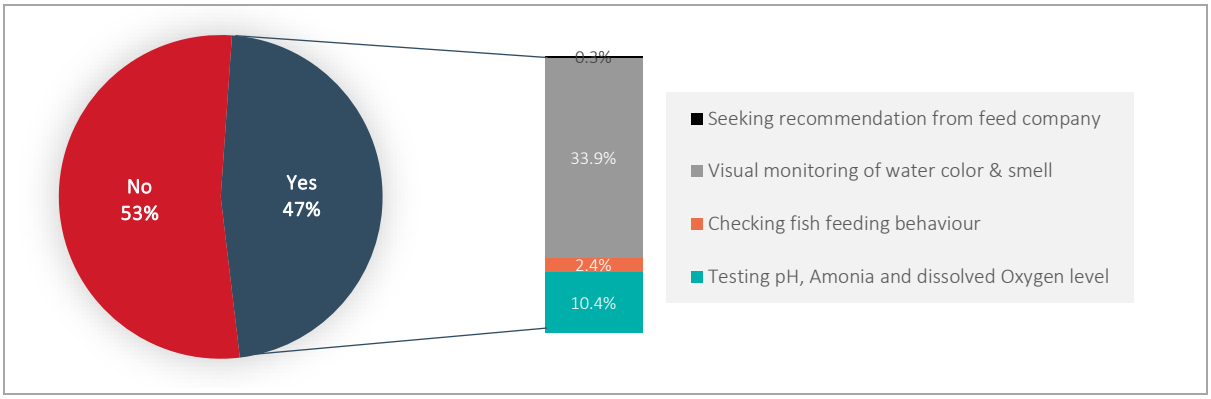
Figure 12: Water management practices (n=376)



Water Quality Monitoring

Water is also one of the main key factors in aquaculture. Therefore, it is important to monitor its quality on a regular basis. However, when asked if they monitor the pondwater quality regularly, only 47% of total respondents said yes. For those said yes, when further asked what kind of regular water monitoring, they have been doing, only 22.2% of them (which accounted for 10.4% of all respondents) did the monitoring systematically using water quality parameters (like pH, ammonia, and dissolved oxygen level. Others have done it by checking fish feeding behavior, visual monitoring of color and smell of pondwater, and using expert judgement by feed company staff.

Figure 13: Respondents if they do regular water quality monitoring (n=377)



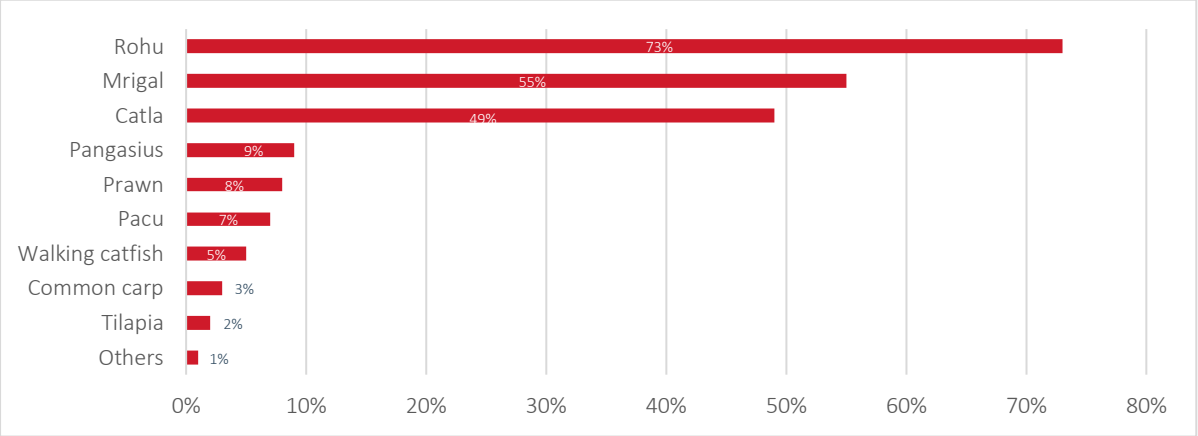
Seed

In grow out and integrated ponds, the average fingerlings stocked was 3,257 per acre. While in nursery ponds the average of fries stocked was 173,485 per acre.

Species Commonly Raised

In the surveyed areas, it was found that more than eight different fish species were being raised in aquaculture farming. Rohu (*nga myit chin*) is most raised species (by 73% of respondents), followed by mrigal (*nga gyin phyu*) at 55%, and catla (*nga gaung pwa*) at 49%. The remaining fish species, such as the pangasius (*nga dan*), pacu (*nga mote*), walking catfish (*nga khu*), common carp (*shwewar nga gyin*), and freshwater prawn, were also raised by less than 10% of the sample households.

Figure 14: Species raised by respondent (n=377)



Seed Sizes

The most typical sizes of fingerlings being raised in the fishponds for the catla, mrigal, rohu, and pangasius species were 3–4 inches, 4-5 inches, and 5-6 inches. For walking catfish, 1-2 inches, 3-4 inches, and less than 1 inches were widely used. Meanwhile for pacu, tilapia, and common carp, fingerlings being raised in the study areas were 2-3 inches and 3-4 inches.

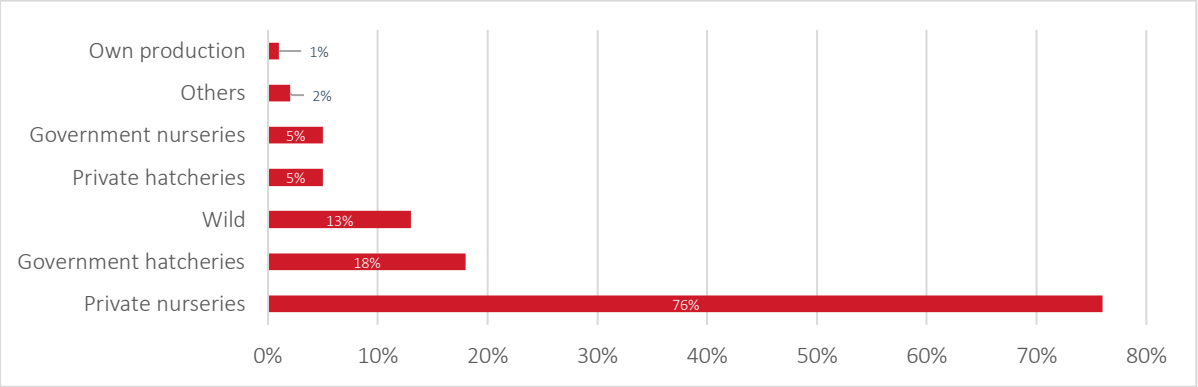
Table 9: Species and size of fingerlings raised (n=377)

	> 1"	1-2"	2-3"	3-4"	4-5"	5-6"	6-7"	7-8"	8-10"	>10"
Catla	3%	6%	8%	22%	32%	15%	5%	5%	1%	1%
Mrigal	7%	13%	9%	16%	23%	22%	5%	4%	1%	0%
Rohu	8%	13%	7%	9%	19%	22%	12%	7%	2%	0%
Pangasius	0%	3%	6%	18%	26%	44%	0%	3%	0%	0%
Walking catfish	32%	37%	5%	21%	5%	0%	0%	0%	0%	0%
Pacu	0%	7%	19%	44%	7%	15%	7%	0%	0%	0%
Common carp	8%	0%	50%	8%	8%	8%	8%	8%	0%	0%
Tilapia	0%	0%	33%	50%	17%	0%	0%	0%	0%	0%
Prawn	90%	10%	0%	0%	0%	0%	0%	0%	0%	0%
Others	0%	60%	0%	0%	20%	20%	0%	0%	0%	0%

Sources of Seed

Regarding the source of the fingerlings, 76% of the sample households purchased them from private nursery farms. It is not clear where these nurseries procured the fries from. This was then followed by the government hatcheries, that was used to supply seeds by 18% of respondents. The rest of respondents procured fingerlings from other sources, including private hatcheries, government nurseries, catch from wild, etc.

Figure 15: Fingerling sources (n=377)



The Department of Fisheries (DOF) operates about two dozen hatcheries around the country and sells fry and fingerlings to farmers. In NGA-Myanmar target areas, there are at least 2 government hatcheries located in Nyaungdon and Dedaye. There are also a number of private owned hatcheries which produce fingerlings for own supply or for sale to other grow-out farms. Among the survey respondents, 4 of them run hatchery business. Since there have been shortages of hatchery-produced fry and fingerlings, wild seed stock is still commonly sourced in the study areas. However, it was reported that more and more operators operate nursery and hatchery to mitigate against the depletion of wild stocks.

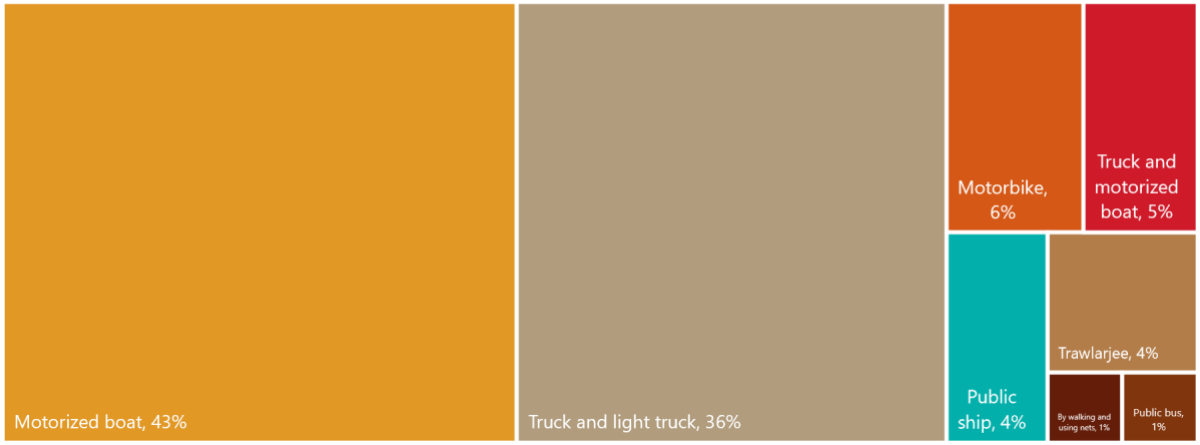
For nurseries, fries are usually bought from hatcheries when they are about 30 days old and 2cm long. They are fed with ground peanut meal, with other soft protein sources some chicken or duck-egg yolk. Fry survival rate is very low at about 20-30% thanks poor quality of feeds, limited knowledge, and capabilities of nursery operators.

Figure 16: Manual harvesting of fingerlings

Seed Transportation

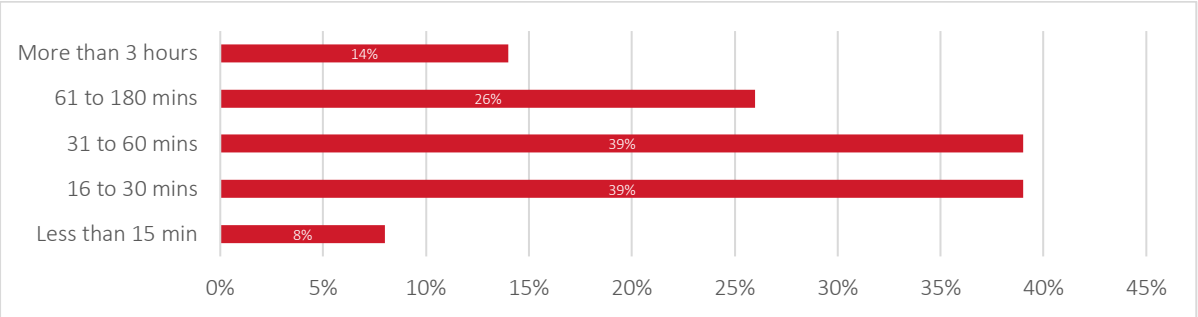
When asked about how they bring fry or fingerling to their farms, 36% of households used truck or light truck, while 43% used motorized boat as the primary mode of transport. Likewise, 6% of farmers said they transported fingerling on their personal motorcycle, and 5% they used both motorized boat and truck.

Figure 17: Modes of transport for carrying of fingerlings (n=377)



Proper handling of fingerlings before and during transportation is very critical. Given the relatively traditional method of fingerling transportation in Myanmar (i.e., using non-aerated tank), transfer time is therefore crucial. Most of surveyed households (39%), reported that the time it took to bring fry or fingerling to the farms was between 16 and 30 minutes, while another 39% claimed it took 30 minutes to an hour – which is great. 26% of sample respondents said that the time for bringing fry or fingerling was up to 3 hours, whereas 14% mentioned it was longer than 3 hours to get fingerlings from the hatchery to their farms. However, only 8% of households said it took only 15 mins when they brought them to their farms. Normally, they directly stock it after buying from the different sources.

Figure 18: Time taken to bring fingerlings to the ponds (n=346)



Seed Prices

The average fingerling price per piece for mrigal was 158 MMK, ranging from 10 to 600 MMK; for catla was 183 MMK, ranging from 10 to 550 MMK; for pacu was 139 MMK, ranging from 20 to 450 MMK; for pangasius was 128 MMK, ranging from 15 to 450 MMK; and for common carp was 112 MMK, ranging from 10 to 300 MMK. Meanwhile the fingerling price of walking catfish, mixed sex tilapia, and freshwater prawn per piece were less than 50 MMK, with a range of 7 to 130 MMK.

Table 10: Price of fingerlings (MMK/pc)

	Average	Min	Max
Mrigal	158	10	600
Catla	183	10	550
Pangasius	128	15	450
Walking Catfish	42	7	100
Pacu	139	20	450
Common carp	112	10	300
Freshwater prawn	25	9	130
Tilapia (mixed sex tilapia)	48	30	70

The following table presents the price of fry – 3-4 days after hatching. Rohu fry per cup was the most expensive averaging 40,000 MMK, with a maximum of 50,000 MMK and a minimum of 30,000 MMK. For mrigal and catla the prices per cup were 23,600 MMK (ranged from 15,000 to 40,000 MMK) and 22,000 MMK (ranged from 10,000 to 35,000 MMK).

Table 11: Price of fry (MMK/cup)

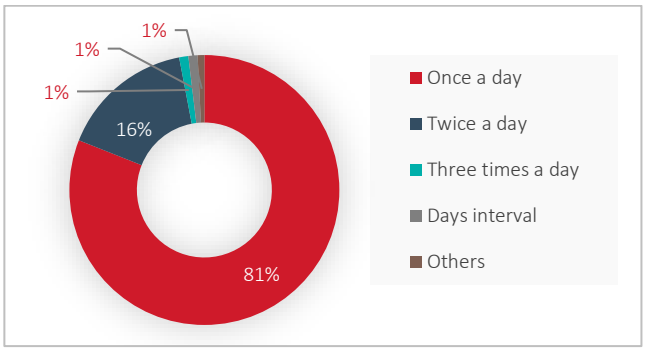
	Rohu	Mrigal	Catla
Average	40,000	23,571	21,889
Min	30,000	15,000	10,000
Max	50,000	40,000	35,000

Feed

Feed and Feeding Practices

Most respondents, accounted for 81%, only provided feed once a day, while about 16% fed their fish twice a day. Only about 1% of respondents provided feed three times a day.

Figure 19: Feeding intervals (n=366)



Majority of respondents (accounted for 67%) used combinations of various supplemental feeds, that also include fish waste (like fish heads, fish meal, and tiny or other non-marketable fishes). Interestingly, 57% of respondents applied other inputs (i.e., fertilizers) to support the production of natural feeds (i.e., micro-algae). Meanwhile, rice bran is among the popular supplemental feed with over 61 % of the respondents used it. This was then followed by peanut oilcake where 25% of respondents used. Around 18% of respondents fed their fish using commercial pellets (10% sinking, 8% floating).

Figure 20: Type of feeds used (n=346)

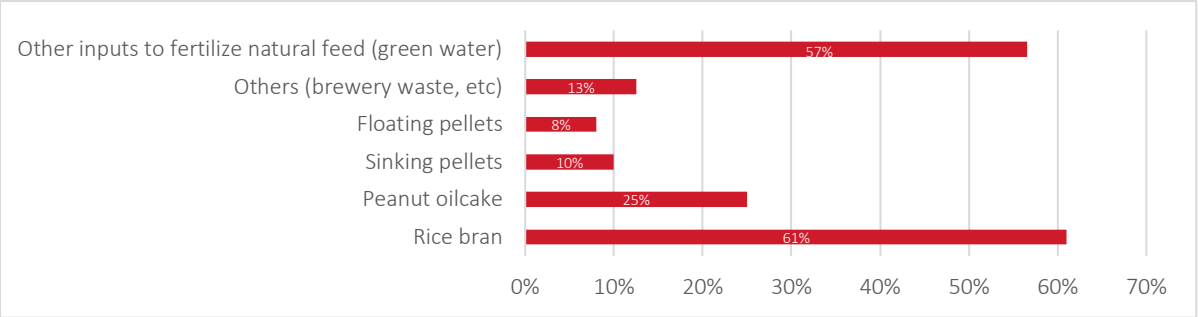


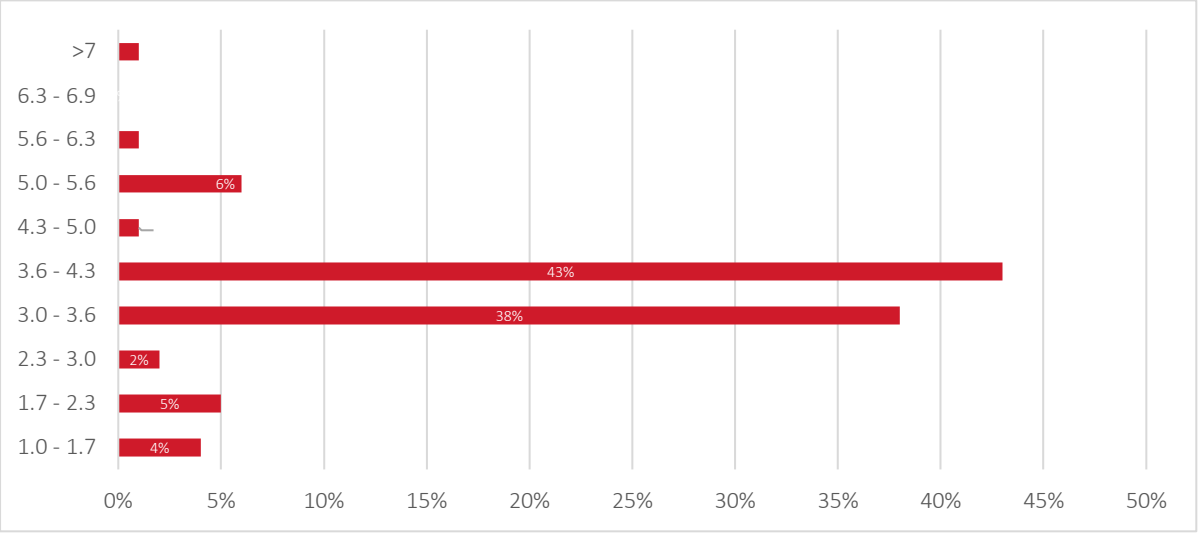
Figure 21: Commercial feed pellet

Figure 22: Transporting fish feeds using a boat

Feed Conversion Ratio

The feed conversion ratio (FCR) is simply the amount of feed it takes to grow a weight of fish. The average FCR was about 3.6 ranging from 1 to the maximum of 8.3.

Figure 23: FCR (n=346)



The data indicated that the majority of respondents had an FCR of 3.6 to 4.3 which represents about 43% of the total samples. It means that for every 3.6 to 4.3 kg of feeds given, it transformed into 1 kg of fish weight. About 38% of the total sample farmers had an FCR of 3 to 3.6.

Table 12: Average, minimum and maximum FCR based on size of ponds (n=346)

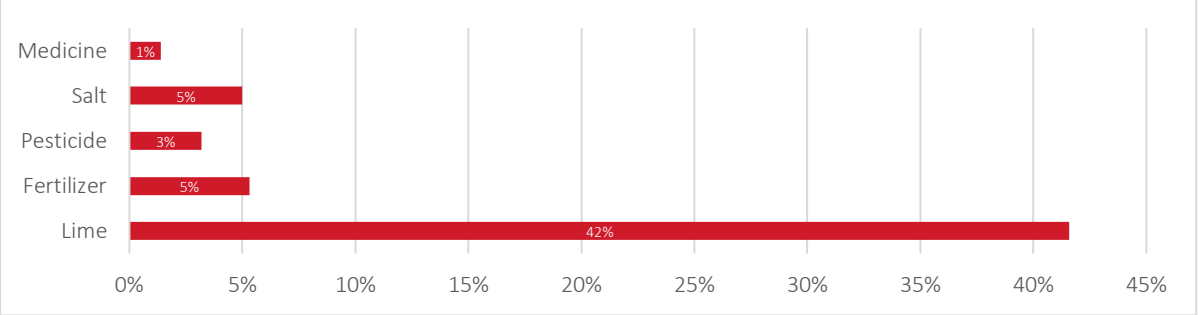
	Average	Min	Max
Less than 10 ac	3.5	1.0	5.6
11 to 50 ac	3.6	1.3	6.0
51 to 100 ac	4.2	4.0	5.0

Table 29 summarized the minimum, average and maximum ratio of FCR for different pond sizes. The average FCR for the farmers who has less than 10 acres was 3.6, farmers with 11 to 50 acres pond size was 3.6 and farmers with more than 50 acres was 4.25.

Non feed inputs

Non- feed inputs were also applied for various reasons, such as to maintain pondwater quality. Lime is most single non feed input used by respondents, accounted for 41.6% of them.

Figure 24: Non feed inputs used (n=346)



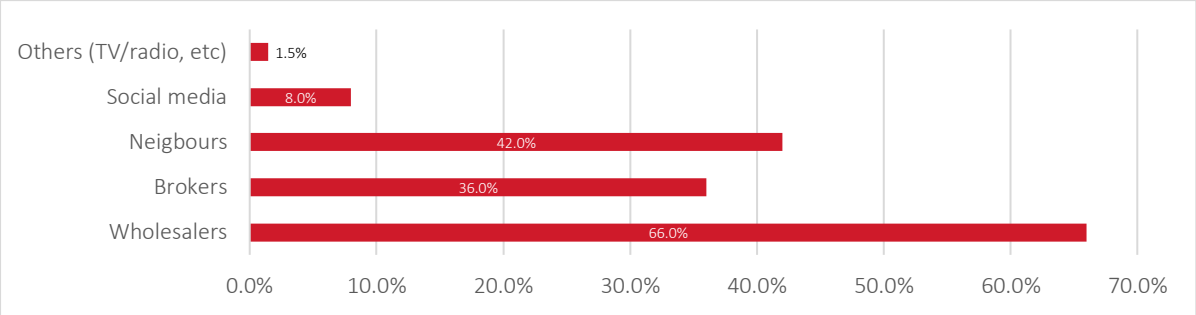
Price Information

When asked if they have access to market information, 93% of respondents reported that they had it. This market information was only information related to price. No other information beyond price was available.

Figure 25: Access to price information (n=344)

Most of respondents (accounted for about 66%) relied on regular price information provided by their buyers, specifically from wholesalers. About 42% of the total sample respondents received such information from their neighbors while about 36% received from the brokers or retailers. Only about 8% of interviewed farmers accessed price information from social media.

Figure 26: Price information sources (n=344)

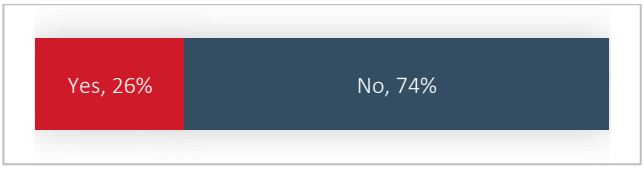


Disease

Disease Infestation

About 26% of respondents reported that their pond was infested by disease. This was mainly due to poor pond management practices.

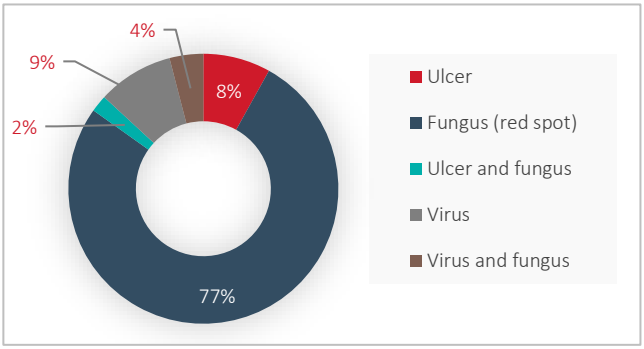
Figure 27: Disease infestation on pond (n=375)



Disease Types

Fungus, virus, and bacteria were the common diseases found in the surveyed areas. Among others, red spot disease infestations by fungus were the most common one, accounted for 77%. Based on the KII with an aquaculture expert, it was argued that virus infestations are more common in prawn pond than fish. If infected by virus, disease outbreak usually follows that can resulted in major loss for operator.

Figure 28: Disease types (n=375)



Disease Calendar

Based on expert KII and farmer interviews, red sport fungus usually happened throughout the year. Meanwhile, virus and other fungus infected in the months of January, February, March, April, May, November, and December. Ulcer disease used to occur in the months of February, March, April, May and December.

Table 13: Disease calendar

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ulcer		X	X	X	X							X
Fungus (red spot)	X	X	X	X	X	X	X	X	X	X	X	X
Virus (in prawn)			X	X	X	X	X					

Disease Preventions and Treatments

Only less than a quarter (24%) of respondents who mentioned that they put measures to prevent from and treat of diseases infested their fish. Application of lime was the common preventive and treatment methods used by respondents. 79% of them used lime (sometimes being combined with salt) as the main method to prevent disease. The use of lime (combined with salt, tobacco, or others) was also reported by 79% of respondents as the main measure to deal with disease infestation.

Figure 29: Disease prevention methods (n=89)

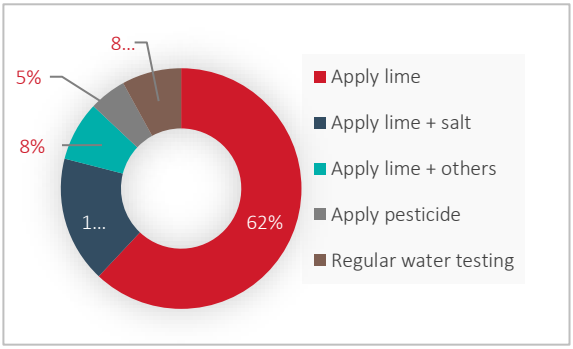
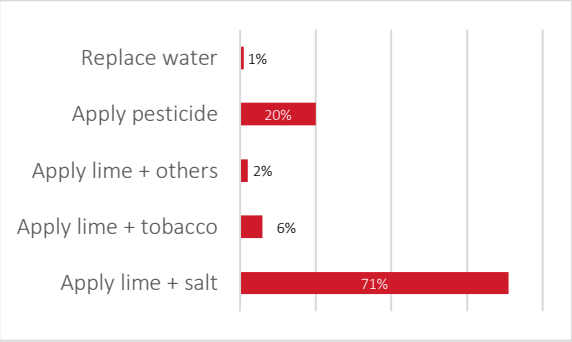


Figure 30: Disease treatment methods (n=89)



Labor

To complement family labors, aquaculture farmers/MSMEs hired casual labors. In Myanmar, aquaculture provides direct employment for about 215,000 part-time and full-time workers.

Casual Labor

According to the survey data, the average number of causal labors hired by farmers was 16 male and 2 female. The following table summarized the causal labor requirement per season for average size of 14 acres. On average, daily wage of causal labor was 7,226 MMK (3.44 USD) per person- day for male and 5,318 MMK (2.53 USD) per person-day for female labor. Mostly casual labors were hired during harvesting. Male labors used a lot more due to the physical nature of most of pond work. Aside from engaging in harvesting,

male casual labors also engaged in buying and transporting feed, repairing pond, stocking seeds, etc., while female labors also engaged in fish marketing and pond maintenance.

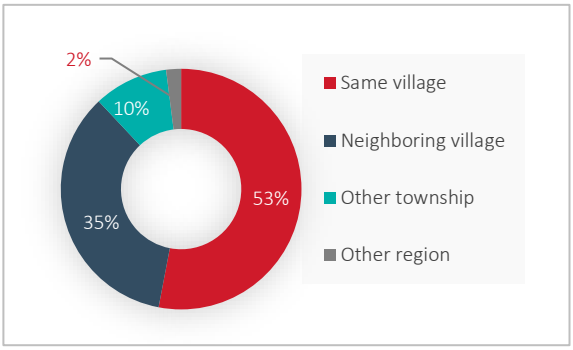
Table 14: Causal labor requirements per season (n=377)

	Man	Women
Average no of causal labors	16	2
Average hiring days per season	5	1
No person-days per season	84	2
Average daily wage	7,226	5,318
Minimum daily wage	4,000	3,000
Maximum daily wage	15,000	9,000

Permanent Labor

In average, about 2 permanent labors were employed by respondents. They received monthly wage averaged at MMK 166,000 per month (79 USD/month). Over 64% of respondents mentioned that they provide accommodation for the permanent labors, while the rest did not provide it, since these labors were from the same village. These labors were mostly male. About 53% of the permanent labors came from the same village of the pond location, while 35% from neighboring villages. 10% were from other townships, while 2% were from the other regions.

Figure 31: Permanent labor home (n=377)



Harvest and Post-Harvest

Harvesting

According to the KII and secondary data, harvesting was done by using nets. The harvested products were then transported to local markets, town markets or to wholesale markets in Yangon. While refrigerated facilities were limited, but many used ice (produced by ice factories) to maintain fish quality during post-harvest handlings. While some fish were sold locally (i.e., common carp), but some also go to export markets, such as China. The yield of fish is very much variance from farm to farm depending on the FCR, species of fish/ prawn, duration, and disease incidence, etc.

According to the results of the survey data, the average yield of fish was about 1,213 *viss*/acre (or 798.03 kg/ha) in grow-out ponds and integrated ponds. Meanwhile for nursery ponds, the average harvested yield per acre was 100,786 pieces.

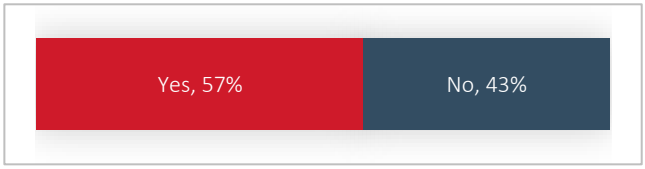
Table 15: Average, minimum and maximum yield of fish from different ponds (n=344)

	Pond area (acre)	Stocking density (no/ac)	Average yield
Grow-out and integrated ponds	14.0	3,257	1,213 *viss*/acre
Nursery pond	3.5	173,486	100,786 pieces per acre

Post-harvest

57% of respondents reported that they used ice after harvesting to maintain quality of harvested fish/shrimp. When asked if they need to comply with any standards set by markets, none of them reported of complying any marketing standards, since buyers tend to buy most harvested products. None of respondents also did any forms of fish processing.

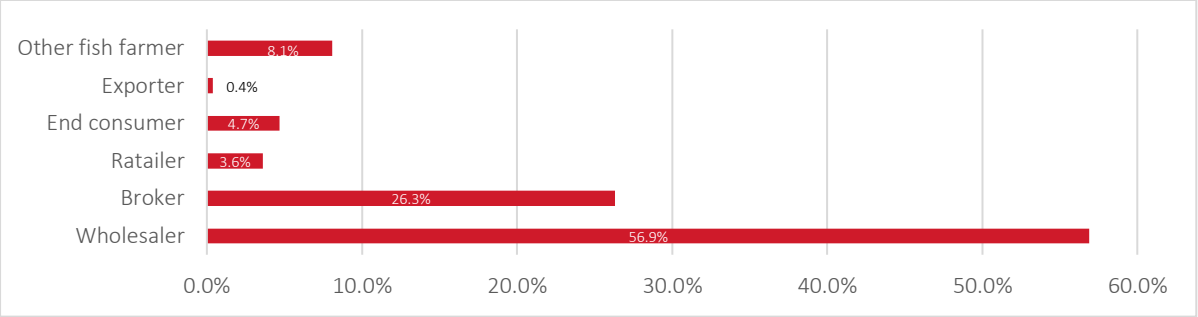
Figure 32: Used ice for transporting (n=344)



Buyers

The interviewed fish farmers reported that the main buyers of their fish were wholesalers which represented about 57% of the total respondents. Meanwhile, about 26% of respondent farmers sold fish to local collectors or brokers. The rest sold harvested fish directly to retailers, consumers, exporters, and other fish farmers.

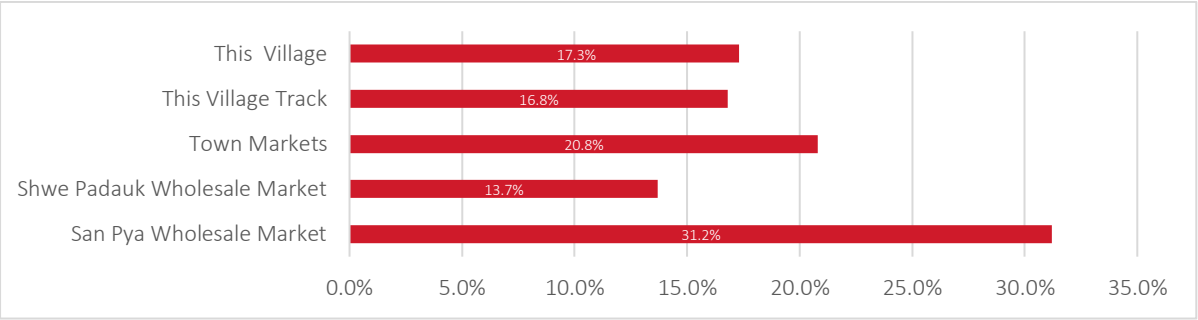
Figure 33: Where did respondents sell harvested products? (n=344)



Market Locations

When further asked the locations of their main buyers, 31% respondents said that their buyers were from the San Pya wholesale fish market in Yangon, and 14% of buyers were from Shwe Padauk fish wholesale market, also in Yangon. Meanwhile 21% of buyers were from town markets, 17% in their same village tract and another 17% in their village.

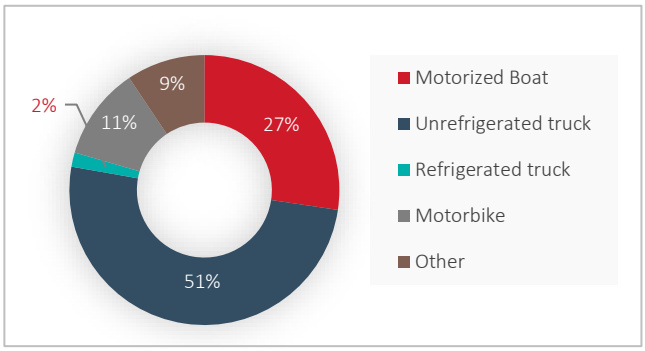
Figure 34: Locations of main buyers (n=344)



Transportation to Markets

59% of respondents transported their fish to markets by unrefrigerated truck. Only 2% used refrigerated truck. Meanwhile 32% transported fish by motorized boat. The percentage of fish farmer who transported their fish using motorbike was 13%. Finally, 11% of respondents used other transportation modes, like bicycle, *trawlajee*, unmotorized boat, on foot, etc.

Figure 35: Transportation modes to markets (n=370)



When asked who did arrange the transport, 61% of respondents informed that they arranged themselves. Meanwhile for 34% respondents, the transport was provided by buyer. The rest 5% respondents both provided by themselves and their buyer. In terms of ownership of the transportation modes, 74% of transport modes were rented. Meanwhile, 29% of the transport mode were owned by the respondents. Only 5% used both rented and owned transport modes.

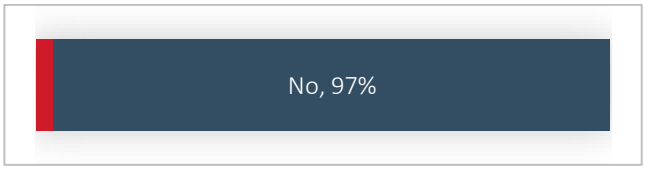
Based on the responses provided by 34 respondents (the rest was not able to recall), 32 of them said that the cost of transportation was between MMK 10 to 107 per *viss*. While the rest mentioned between MMK 204-301 per *viss* and MMK 495- 592 per *viss*. The average transport cost was therefore MMK 53 MMK per *viss* (0.04USD/kg) ranging from the minimum of MMK 10 per *viss* (0.01 USD/kg) to the maximum of MMK 500 per *viss* (0.39 USD/kg) based on the miles they transport, size of vehicle and the capacity of the vehicle.

Financing

Access to Credit and Willingness to Invest in Green Solutions

None of respondents reported of getting loans from any financial institution. Only 3% received loans from buyers, while 97% did not access any credit for their aquaculture business. Those who received credit from buyer will pay back either with in-kind (i.e., fish) or cash.

Figure 36: Access to credit (n=377)



Observations by the survey team suggested that while some micro finance institutions operate in NGA-Myanmar target areas, none offered any loans specifically design for the adoption of green aquaculture practices and technology. In addition, the team could not fine in the survey locations of any sector-wide bankable business cases to greening the aquaculture sector.

When asked if they plan to expand their aquaculture business, almost half of respondents (about 46%) expressed that they want to expand their aquaculture business, however none of their plan was related to any business case for adopting green aquaculture practices.

When further asked if they are willing to make investment in technology or practices to reduce impacts of aquaculture to the environment but at the same time will improve farm productivity, only 33% who responded that they would do that. Among of respondents who were willing to do, 76% did not mention how much money they could invest for that, but some said that they could pay at reasonable price (46%), or it would be depending on the technology and projected return (30%). Meanwhile, about 7% of respondents could make an investment up to MMK 100,000 per month. Another 7% will pay MMK 10,000 per month, about 4% could pay MMK 20,000 MMK per month, 2% would pay MMK 42,000 MMK per month, and another 2% would pay MMK 50,000 per month.

GREEN AQUACULTURE KNOWLEDGE AND PRACTICE

In NGA-Myanmar target locations, the aquaculture involves cultivating different species of fish and other aquatic products (i.e., shrimp, mud crab) in ponds. To sustain its existence, the aquaculture sector is required to embrace more sustainable practices to safeguard an increasingly fragile environment. This section presents NGA-Myanmar baseline figures and aquaculture operators' knowledge and practices on green aquaculture, that can be used to measure programme's successes and achievements against its indicators at midterm and endline.

Knowledge

Knowledge level was simply assessed by looking at responses provided by respondents to certain questions related to green aquaculture practices, if they were: "Strongly agree", "Agree", "Neutral", "Disagree", or "Strongly disagree". In all questions, the expected answers were "Strongly agree".

Table 16: Score of Knowledge level on green aquaculture practices (n=377)

Knowledge check	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
It is necessary to check water quality on regular basis	53%	34%	11%	2%	0%
Some aquaculture practices (such as feeding, fertilizer application, etc.) can contaminate river or other stream water	13%	41%	29%	17%	0%
Record keeping is important to support the adoption of green aquaculture practices	34%	49%	14%	2%	0%
Improper feeding practices are harmful to the environment	13%	40%	29%	17%	0%
It is important to avoid prohibited materials even when they are cheaper	1%	4%	9%	23%	64%
It is important to regularly monitor fish health, not just to increase productivity but also to limit the negative impact of aquaculture to the environment	42%	38%	19%	1%	0%

It is important to report disease outbreak to relevant entity	19%	45%	29%	7%	1%
Checking regularly dissolved oxygen should not just be done in your pond, but also in nearby environment	43%	40%	12%	4%	0%
Average	**27%**	**36%**	**19%**	**9%**	**8%**

NGA-Myanmar plans to expand the function of Htwet Toe app, a mobile technology-based agricultural extension system operated by Village Link to include relevant information around green aquaculture practices. It is expected that by doing this, information around green practices can be accessed by more fish farmers beyond NGA-Myanmar target locations and that programme target participants will continue to be able to access this service beyond the programme timeframe. At the baseline, so far only 9% of respondents knew about the app.

Practice

Interestingly, none of surveyed respondents reported to adopt any green aquaculture practice. None of them also reported of participating in any workshop, training, nor demonstration on green aquaculture practices. When asked, if any challenges to carry out green practices, they mentioned about lack access to investment fund, relevant skills, and technologies. Moreover, small pond size and unstable political situation (that has resulted in input price increase and labor shortage) were also mentioned.

Annex 1: Cost-Benefit Analysis

Based on the data from the 377 respondents, the average cost of production (Total Variable Cost/TVC) of fish farming (grow-out and integrated ponds) was MMK 2,907,928 MMK per acre (USD 3,716 USD per ha). Cost of feeds contributes the largest share to the total variable cost which was about MMK 2,080,955 MMK per acre (USD 2,448 per ha) and covers about 66% of the TVC. Average cost of fingerlings was MMK 413,773 pre acre (USD 487 per ha) that contributes about 13% of TVC, cost of labors covers about MMK 290,056 per acre (USD 341 USD per ha) that contributes about 9% of the TVC.

Table 18: Cost of Production (Grow out and Integrated ponds)

	Cost (MMK/ac)	Cost (USD/ha)	Percentage
Fingerlings	413,773	487	13%
Feed	2,080,955	2,448	66%
Labor	290,056	341	9%
Pond Maintenance	113,840	134	4%
Transport	73,830	87	2%
Marketing	186,487	219	6%
Total Variable Cost (TVC)	2,907,928	3,716	100%

When compared, pond size about 10 to 50 acres had experienced the highest cost of production especially due to the cost of feeds and average cost of production per acre was the lowest for the farmers who have more than 50 acres of farm size since they saved unit cost of labor and feeds.

Table 19: Average Cost of Production by Different Sizes of Ponds

Pond size	Fingerling	Feed	Labor	Pond Maintenance	Transport	Marketing	Total Cost (MMK/ac)
Less than 1 ac	302,756	1,250,313	379,580	37,795	36,000	219,217	2,009,443
1 to 10 ac	387,130	1,696,128	188,860	114,940	88,894	153,337	2,315,964
10 to 50 ac	348,179	1,914,847	185,382	104,955	66,362	185,186	2,656,329
> 50 ac	729,667	891,229	102,229	92,625	59,667	60,083	1,774,457
Average Cost	441,933	1,438,129	214,013	87,579	62,731	154,456	2,398,840
% to TVC	18%	60%	9%	4%	3%	6%	100%

In the studied areas, the weighted average selling price of fish was MMK 3,466 per *viss* and the average selling price of fingerlings was MMK 34 MMK per piece.

Weighted average selling price was calculated as:
$(P_1 \times V_1) + (P_2 \times V_2) + \ldots + (P_n \times V_n)/ V_t$

With:
P_1 = First sale price,
P_2 = Second sale price,
P_n = Last sale price,

V_1 = First sale volume
V_2 = Second sale volume
V_n = Last sale volume
V_t = Total sale volume

Based on the analysis, the average revenue of grow-out pond and integrated pond were MMK 4,204,258 per acre (USD 4,945.01 per ha) by using the average yield and weighted average selling price of the 377 respondents. In this regard, the average gross profit or gross income from aquaculture was about MMK 1,296,330 per acre (USD 1,524.73 per ha). Therefore, the C/B ratio was 1.45.

Table 20: Cost/ Benefit Analysis

	Variables	Local Unit		International Unit	
	Pond area	ac/pond	14	Ha	5.7
	Population	no/ ac	3,257	number/ha	1,318.46
A	Harvest yield	viss/ac	1,213	kg/ha	798.03
B	Weighted average selling price	MMK/viss	3,466	USD/kg	1.02
C	Average Revenue (A x B)	MMK/ac	4,204,258	USD/ha	4,945.01
D	Average Cost	MMK/ac	2,907,928	USD/ha	3,420.28
E	Average Gross Income (C- D)	MMK/ac	1,296,330	USD/ha	1,524.73
	Cost/Benefit (C/D)		1.45		1.45
	Unit Cost (D/A)	MMK/viss	2,397	USD/kg	0.70
	Unit Margin (E/A)	MMK/viss	1,069	USD/kg	0.31

Based on the different sizes of ponds, cost benefit analysis was conducted. By saving the cost of production, the farmers who has more than 50 acres of pond have the highest gross profit at MMK 2,429,801 per are (with C/B ratio of 2.37). While farmers who have less than 1 acre of fishponds had the second highest gross profit of MMK 2,194,815 per acre (with C/B ration of 2.09).

Table 21: Cost/ Benefit Analysis of Sample Respondents by Different Pond Size

Pond size	Total Cost (MMK/ac)	Revenue (MMK/ac)	Gross Profit (MMK/ac)	Cost benefit ratio
Less than 1 ac	2,009,443	4,204,258	2,194,815	2.09
1 to 10 ac	2,315,964	4,204,258	1,888,294	1.82
10 to 50 ac	2,656,329	4,204,258	1,547,929	1.58
> 50 ac	1,774,457	4,204,258	2,429,801	2.37
Average	2,189,048	4,204,258	2,015,210	1.92

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