

Analysis of Farmer Capacity in the Freshwater Fish Farming Subsystem in Palas Subdistrict, South Lampung Regency

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ABSTRACT: Indonesia has great potential in the freshwater aquaculture sector, particularly in South Lampung Regency, which contributes significantly to the supply of freshwater fish. However, the inability of farmers to meet consumer and market demand has led to stagnation in the development of freshwater fish farming businesses. Based on these issues, the researchers hypothesized that there were constraints on the capacity of farmers in the freshwater fish farming process. This study aimed to determine the level of capacity of farmers in the freshwater fish farming subsystem in Palas Subdistrict, South Lampung Regency. The study was conducted in March–April 2025 with 94 respondents. The method used was descriptive analysis with a quantitative approach. The results showed that the capacity of farmers in the aquaculture subsystem was good in the stages of seedling distribution and harvest handling, but improvements were needed in the stages of seedling and pond water selection, pond preparation, feeding, water quality and fish health management, waste management, market analysis, and product promotion so that production could be optimal and sustainable.

KEYWORDS: capacity, cultivator, freshwater fish

INTRODUCTION

The fisheries sector in Indonesia is generally divided into two main subsectors, namely capture fisheries and aquaculture¹. The capture fisheries subsector is the production of fish obtained from fishing, both in marine and inland waters. This subsector relies on fish harvests from the wild, so production tends to be unpredictable. The inland aquaculture subsector has shown significant growth in recent decades. Based on data from the Ministry of Maritime Affairs and Fisheries (KKP) in 2024, aquaculture production has increased and accounts for a large portion of total national fisheries production. The most notable increase is in freshwater fish farming, which has become one of the most developed subsectors. Several major commodities such as catfish, tilapia, patin, carp, and gurame are in high demand in the local market.

Increased consumption of fishery products, both in local and international markets, provides enormous opportunities for the aquaculture sector, particularly in Lampung Province. With its rich natural resources, Lampung can utilize this potential to increase aquaculture production, which will contribute to regional economic growth and community welfare. Freshwater fish farming in Lampung has also made a significant contribution to job creation, income growth, and sustainable economic development for the fishing community. The potential for developing the capacity of fish farmers opens up greater opportunities for them to increase fish production and productivity.

In the initial observations, researchers found that farmers in Palas are currently unable to meet the daily demand of distributors/consumers. The researchers also confirmed this with fisheries extension workers and representatives from the South Lampung Regency Fisheries Office. They confirmed that there are several distributors who want to partner with farmers and farmer groups in Palas Subdistrict. However, this cannot be done properly because aquaculture production cannot meet the companies' demand on a sustainable basis. Many opportunities for cooperation with these distributors have been missed. Based on these issues, researchers suspect that there are obstacles faced by farmers in the freshwater fish farming process. Therefore, researchers are interested in conducting a study on the capacity of farmers in the freshwater fish farming subsystem in Palas District, South Lampung Regency.

METHODS

This study uses a survey method with a quantitative descriptive approach. The research location was chosen based on the consideration that Palas District, South Lampung Regency, is one of the suppliers of freshwater fish in Lampung Province,



especially South Lampung. The population of fish farmers numbered 1,449 people, and the sample was determined based on purposive sampling using the Slovin formula, amounting to 94 people. The research was conducted in March-April 2025. The types of data required included primary data in the form of observations and audio and photo documentation, and secondary data in the form of supporting documents. The data collection techniques used included observation, interviews with the help of questionnaires, and documentation studies.

RESULT AND DISCUSSIONS

The cultivation subsystem is the core of the aquaculture agribusiness system, reflecting the technical and managerial capacity of farmers in managing freshwater fish production efficiently and sustainably. In this study, activities in the subsystem include pond preparation, seedling distribution, feeding, water quality management, fish health management, harvest handling, and waste management. The success of the aquaculture subsystem is greatly influenced by the quality of production inputs and the ability of farmers to apply aquaculture technologies that are appropriate to the characteristics of the commodity and local conditions. Therefore, analysis of the aquaculture subsystem is an important basis for assessing the capacity of farmers in the fisheries agribusiness system holistically. The distribution of data on the aquaculture subsystem is described in Table 1.

Table 1. Distribution of respondent capacity in the cultivation subsystem

No	Capacity	Category	Score range	Total score (people)	Percentage (%)
1.	Pond preparation	Poor	1–2	76	80,85
		Fair	3–4	18	19,15
		Good	5	0	0
2.	Seedling distribution	Poor	1–2	31	32,98
		Fair	3–4	63	67,02
		Good	5–6	0	0
3.	Feeding	Poor	1–2	56	59,57
		Fair	3–4	38	40,42
		Good	5–6	0	0
4.	Water quality management	Poor	1–2	88	93,62
		Fair	3	6	6,38
		Good	4	0	0
5.	Fish health management	Poor	1–2	91	96,81
		Fair	3	3	3,19
		Good	4	0	0
6.	Harvest handling	Poor	1–2	11	11,70
		Fair	3–4	83	88,30
		Good	5	0	0
7.	Waste management	Poor	1	51	54,26
		Fair	2	16	17,02
		Good	3	27	28,72

Source: Primary data, processed research results 2025

The data in Table 1 shows that the capacity of freshwater fish farmers in the aquaculture subsystem is still dominated by the low category. There are only two aspects in the sufficient category, namely seedling distribution and harvest handling. This statement reflects that the aquaculture system is still conventional with a large technical gap in biological and ecological aspects. Other studies observing fish farming models in Indonesia have found them to be conventional, lacking in facilities, and not yet optimally implementing water management technology or biological inputs². In order to increase production capacity and cultivation efficiency, continuous technical training and the application of appropriate technology are required, particularly in the areas of water management and the selection of biological inputs³. Other research also reinforce this opinion by supporting



technical training in freshwater fish farming based on tarpaulin ponds (for farmers with small pond areas) to increase production efficiency and support sustainability⁴. Strengthening the capacity of farmers through technical training and incentives for input improvement is an urgent need to promote a more productive, efficient, and sustainable production system.

The application of technology in aquaculture also needs to be considered by farmers. Its application can be carried out in stages, starting with the process of introducing new technology to the farmers and then moving on to its practical implementation. One example of its application can be seen in the research results of Vikasari, Handayani, and Prasadi. They introduced and applied the Maxiras and aquaponics methods to improve water quality and farming efficiency in Kalijaran Village, showing significant results in increasing farmer capacity. A detailed explanation of each capacity in the farming subsystem is as follows⁵.

A. Pond preparation

In the fisheries agribusiness system, the initial stages of cultivation often determine the overall success of production. One of the most fundamental yet significant aspects is pond preparation. This stage is not merely a technical routine, but a reflection of the farmer's readiness to optimally manage the production environment. Pond preparation is a crucial stage in the fish farming subsystem because it determines the initial quality of the environment in which the fish will grow. This preparation can reflect the capacity of farmers in the cultivation subsystem. Meticulousness in this stage not only determines the effectiveness of fish maintenance, but also illustrates the technical and managerial understanding of farmers regarding the overall production process. The distribution of respondent capacity data in pond preparation can be seen in Table 2.

Table 2. Distribution of respondents' capacity in pond preparation

No	Statement item	Total score (people)	
		Treatment	No treatment
1	There is a process of drying the pond bottom	94	0
2	Adding lime to the pond	7	87
3	Fertilizing the pond bottom	0	94
4	Filling the pond with water to the appropriate depth	32	62
5	Checking the pond water (pH, temperature, oxygen content)	11	83

Source: Primary data, processed research results 2025

Based on the data in Table 2, it can be concluded that most farmers have carried out the very basic initial stages of pond preparation, but there are still many important technical aspects that have not been fully implemented. All farmers stated that they had dried the pond bottom before use. Pond bottom drying was done intentionally by the farmers. The practice was to remove all the water from the pond until only mud remained. Next, the mud is removed and the farmers leave the ponds exposed to sunlight to dry the pond bottom.

Generally, the drying time depends on the intensity of sunlight (about one week). This shows a high level of awareness of the importance of sanitation and breaking the life cycle of pathogens and pests that can interfere with fish growth. The results of this study are in line with the research by Pane, Arfiati, and Apriliyanti, which states that drying the pond bottom for 3–7 days aims to kill pests and diseases and oxidize organic matter to improve soil quality⁶. In practice, only 7 out of 94 people (about 7.45 percent) applied lime, which states that drying the pond bottom for 3–7 days aims to kill pests and diseases and oxidize. Other research shows that liming is very important to stabilize soil and water pH and suppress harmful microorganisms. Fertilization with manure and TSP/Urea increases pond bottom fertility and the growth of natural feed such as plankton⁷. However, farmers in Palas Subdistrict have not been able to lime or fertilize the pond bottom⁸.

According to respondents, liming and fertilization aimed at neutralizing the soil and increasing the amount of plankton can be achieved simply by resting the pond for a while (1 to 2 weeks) and allowing the pond bottom to be exposed to sunlight. This treatment is carried out during hot weather to increase the effectiveness of natural feed growth⁹. Technically, this practice is represented by the aspect of drying the pond bottom. Filling the pond with water to the ideal depth for the species has only been done by 32 respondents (around 34 percent), while the rest have not adjusted the water depth to the biological needs of the fish being cultivated. This statement is related to the lack of understanding among farmers regarding the technicalities of filling the pond to the appropriate depth for each type of fish. The pond water depth between 0.5–1.75 m greatly affects fish growth and



must be adjusted to the species being cultivated¹⁰. Only 11 farmers checked water quality (such as pH, temperature, and oxygen levels), indicating that routine monitoring of fish habitat conditions is still low. After filling the ponds with water, most respondents let the water sit for some time to neutralize it with the pond environment. This is not in line with the research by Andria and Rahmanningasih, which states that water quality parameters such as temperature, pH, dissolved oxygen levels, and brightness are very complex in fish farming, because fish are in conditions that are suitable for their environment and are determining factors for successful farming¹¹.

B. Seedling distribution

Seedling distribution is an important stage in the fish farming subsystem because it determines the survival rate and initial growth of the fish. This stage requires precision because it can affect the life and development of the fish in the pond. The distribution of respondents' capacity in seedling distribution can be seen in Table 3.

Table 3. Distribution of respondents' capacity in seedling distribution

No	Statement item	Total score (people)	
		Treatment	No treatment
1	Sorting seeds before distribution	0	94
2	There is an acclimatization process	0	94
3	Distribution takes into account pond density	63	31
4	The distribution process is carried out in stages	94	0
5	Monitoring seedling behavior after distribution	94	0
6	Providing easily digestible initial feed	0	94

Source: Primary data, processed research results 2025

Table 3 explains that farmers have implemented several important procedures, but still neglect some aspects of initial techniques that affect fish seed survival. All respondents have carried out gradual seed distribution and monitored fish behavior after distribution. This shows awareness of the potential for fish stress, as well as early monitoring efforts so that the seeds can gradually adapt to the pond environment. Arisfa et al emphasize the importance of monitoring the behavior of fish fry after stocking to measure survival and feed efficiency. This monitoring helps with early detection of stress and disease¹².

A total of 63 out of 94 people (67 percent) paid attention to pond density during stocking, which is very important to avoid feed competition and disease risk. However, what is quite striking is the absence of fry sorting practices before stocking. Sorting is crucial to ensure uniform and disease-free fry quality. Fish farmers are confident that the fry they select have undergone a sorting phase at the hatchery before being sold, so they neglect the fish fry sorting stage. In fact, sorting is an important process in fish farming because fish of varying sizes can compete for food¹³.

Similarly, none of the respondents carried out the acclimatization stage. This step is a gradual adaptation process to the temperature and water quality of the pond. Fish farmers skip this process and immediately release the fish fry into the pond. In fact, the acclimatization process is important to prevent thermal stress and increase the survival rate of the fry. The results of this study are not in line with the results of study Trimanto, which explains that acclimatization is a crucial stage in the adaptation of plants and fish before they are collected or released into ponds. The acclimatization stage involves gradual covering and monitoring to ensure survival¹⁴.

In addition, none of the respondents provided easily digestible initial feed after release. In theory, initial feed is important to strengthen the immunity and growth of fry from day one. However, in practice, newly released fish fry cannot be fed artificial feed. This is to reduce stress on the fish and allow them to adapt to the pond water. The most appropriate food for fish is the natural plankton available in the pond. This statement is also in line with the research by Masithah, which shows that the abundance of plankton in the pond greatly determines the growth of fish fry¹⁵. Ponds with soil bases have higher plankton densities than tarpaulin ponds. Therefore, the abundance of plankton in aquaculture ponds greatly determines the success of fish fry growth¹⁶.



C. Feeding

Feeding in fish farming is a vital process that affects growth, production efficiency, and pond environment quality. Feeding should take into account the type of fish being farmed and adjust the amount of feed given. The distribution of respondents' capacity in feeding can be seen in Table 4 below.

Table 4. Distribution of respondents' capacity in feeding

No	Statement item	Total score (people)	
		Treatment	No treatment
1	Feeding is adjusted according to the type and growth stage of the fish	11	83
2	There is a regular feeding schedule	0	94
3	Feeding is based on fish dosage	0	94
4	The amount of feed is adjusted according to the fish's needs	27	67
5	Feed is distributed evenly	93	1
6	Observation of fish response to feed	94	0

Source: Primary data, processed from research results in 2025

The data distribution in Table 4 shows that feed distribution practices by farmers still rely heavily on direct observation and basic habits, but lack support from a systematic technical approach and proper feed management. All respondents (93–94 people) distributed feed evenly and observed the fish's response after feeding. This shows that awareness of even feed distribution and fish behavioral responses is already high, which is very positive because it plays a role in preventing the dominance of certain fish and monitoring fish health visually. Research by Ulum et al. states that the frequency and timing of regular feeding and observation of fish responses have a significant effect on growth and survival¹⁷.

However, technical aspects such as adjusting the type of feed to the growth stage of the fish were only applied by 11 respondents (11.7 percent), indicating a lack of understanding of the different nutritional needs of fish at each stage. The lack of knowledge among farmers regarding good fish nutrition is an obstacle in determining the feed to be given. So far, the application of feeding to fish tends to be guesswork and observation of fish behavior to see whether they have stopped eating or not. The results of this study are not in accordance with the research by Rahman et al., which shows that feed with protein content adjusted to fish needs can produce absolute weight growth¹⁸.

Furthermore, no farmers have a regular feeding schedule or use feed doses based on fish biomass. Farmers stated that if they followed the rules in theory, they would not be able to do other activities outside of farming. Therefore, feeding is done during free time or after completing the farmers' main work. This is in line with the research by Hadi et al, which states that the farmers' daily activities often become an obstacle in feeding fish consistently. Feeding is done during free time, not based on a technical schedule¹⁹.

Research by Firdaus et al. shows that feeding should be done 3 times a day with a dose of 6 percent of biomass to produce the best growth and feed efficiency in fish (Firdaus, Syandri, and Azrita, 2024). When compared to other research results, Prayogi emphasizes that feeding adjusted to fish weight and regular frequency can improve FCR (Feed Conversion Ratio) and SGR (Specific Growth Rate) efficiency in fish²¹.

D. Water quality management

Water quality management in freshwater fish farming is the main foundation for successful production. This is because water is the medium of life as well as a determinant of fish health and growth. The distribution of respondents' capacity in water quality management can be seen in Table 5.

Table 5. Distribution of respondents' capacity in water quality management

No	Statement item	Total score (people)	
		Treatment	No treatment
1	Monitoring physical parameters (water temperature and clarity)	51	43
2	Monitoring chemical parameters (pH, NH ₃ , O ₂ ,NO ₂ ⁻ ,NO ₃ ⁻)	6	88



3	Regular replacement of pond water	0	94
4	Maintaining a clean and healthy pond environment	94	0

Source: Primary data, processed from 2025 research results

Based on the distribution of respondents' capacity in water quality management in Table 5, it can be concluded that freshwater fish farmers have shown concern for pond environmental hygiene, but are still lacking in the technical and comprehensive application of water quality management. Research by Sofia et al. in the ILUNG Service Journal shows that maintaining pond and surrounding environmental cleanliness significantly improves water quality and fish productivity. Farmers who clean the pond environment can have an impact on pond water cleanliness²². Therefore, this statement supports the research by Andayani, which states that clean and controlled water management increases fish productivity²³.

A total of 51 people (54 percent) have monitored physical parameters such as temperature and water clarity, although most of them only do so through visual observation without the support of adequate measuring instruments. Unfortunately, only 6 respondents (6.4 percent) monitored chemical parameters, even though these parameters are crucial for fish survival and growth. Research by Indriati and Halifudin proves that maintaining stable pH, dissolved oxygen levels, and water temperature has a positive impact on fish fry growth and survival²⁴. Regarding pond water replacement, none of the farmers reported replacing pond water regularly. The absence of this practice has the potential to cause the accumulation of toxic substances, a decrease in oxygen levels, and disruption of the micro-ecosystem balance in the pond. During the research process, the researchers only found one respondent who added water to the catfish tarpaulin pond when the water began to recede and become dirty. Taufik et al. emphasized in their research that pond water that is not replaced can cause unpleasant odors due to increased ammonia levels²⁵.

On the other hand, farmers are often not disciplined in replacing pond water. Therefore, a water replacement system is needed during the farming period to ensure that the pond water quality remains normal. Overall, water quality management practices are still dominated by basic measures and are not yet based on a scientific or systematic approach. Therefore, technical extension and water monitoring training are needed to improve sustainable farming efficiency. This is necessary to reduce the increasing levels of ammonia and TDS²⁶.

E. Fish health management

In freshwater fish farming systems, fish health is not merely a technical issue, but rather a key foundation that determines the success and sustainability of production. This approach not only aims to prevent economic losses, but is also key to maintaining a healthy and productive farming ecosystem balance. With good health management, farmers are able to maximize fish growth, reduce mortality rates, and improve production efficiency in a sustainable manner. The distribution of respondents' capacity in fish health management can be seen in Table 6 below.

Table 6. Distribution of respondents' capacity in fish health management

No	Statement item	Total score (people)	
		Treatment	No Treatment
1	Regular monitoring of fish behavior and health	94	0
2	Separation of sick fish with special treatment	3	91
3	Administration of vitamins and fish medicine	43	51
4	Sorting fish according to size in different places	0	94

Source: Primary data, processed research results 2025

Based on the data in Table 6, it can be concluded that farmers have shown high awareness of direct observation, but are still low in the application of corrective actions and follow-up health support. All farmers (94 people) have monitored fish behavior and health regularly, indicating that they are aware of the importance of early detection of health disorders, although most have not followed up with further action. This is reflected in the low number of respondents (only 3 people or 3.2 percent) who actively separate sick fish and provide special treatment. Research by Grandiosa et al in Farmers: Journal of Community Services states that early detection of fish disease through monitoring behavior and physical condition is a crucial step in fish health management²⁷.



Respondents generally do not want to be bothered and choose to take the fish for consumption or discard them if they are deemed unfit for processing. However, isolating fish that show clinical symptoms is very important to prevent the spread of disease to healthy populations. The results of this study are not in line with the research by Rahmawati et al. and A'yunin et al., which states that infected fish showing significant hematological changes need to be isolated and given special treatment to prevent the spread of disease and maintain the population^{28,29}.

Vitamins and drugs were administered by 43 farmers (45.7 percent), indicating that nearly half had adopted a preventive or curative approach based on supplements and pharmacology. A total of 51 respondents clearly stated that the use of drugs and vitamins did not have much impact on fish development or health, so fish farmers did not use drugs and vitamins. This study is not in line with Sunarto et al., which showed that the administration of vitamins, such as vitamin C, to fish can increase daily growth rates and feed efficiency, as well as increase resistance to environmental stress³⁰.

At the stage of sorting fish based on size into different places, this has not been done at all by all respondents. Fish farmers refuse to sort fish because it can increase production costs and maintain stable fish health. This process can only be done at harvest time. The results of this study are not in line with the research by Badruzzaman, which states that sorting fish based on size and quality is very important in the aquaculture subsystem to avoid feed competition, social stress, and cannibalism. Larger fish tend to dominate, so smaller fish are at risk of stunted growth or death³¹.

F. Harvest handling

In freshwater fish farming subsystems, the harvesting stage is often viewed as the climax that concludes the entire process. However, strategically, harvest management plays a central role in ensuring business sustainability and market satisfaction. This stage is not only oriented towards harvesting, but also towards maintaining product quality and maximizing economic value. This stage is a crucial point that determines the overall success of the business. This process involves strategies for timing, methods, and handling of the harvest so that the quality of the fish is maintained until it reaches the consumer or the next post-harvest process. Harvesting without proper planning and techniques can cause stress to the fish, reduce physical quality, and increase mortality rates. Therefore, harvest management must prioritize the principles of efficiency, sustainability, and quality, starting from determining the harvest time based on optimal age and size, to fish lifting techniques that minimize physical damage. The distribution of respondents' capacity in harvest management can be seen in Table 7.

Table 7. Distribution of respondents' capacity in harvest management

No	Statement item	Total score (people)	
		Treatment	No treatment
1	Preparation of harvesting plans and equipment	94	0
2	Fish are caught carefully to avoid stress	94	0
3	Fish are selected and sorted based on size and quality	0	94
4	Speed of harvesting and handling of produce	83	11
5	Use of clean containers and water or ice	0	94

Source: Primary data, processed from 2025 research results.

The data in Table 7 shows that basic harvesting practices have been carried out comprehensively, but technical post-harvest aspects and quality control are still very limited. During the harvesting process, farmers hand over this process to middlemen who are willing to buy their produce. This statement is in line with the research by Wulandari and Prasetyo, which states that there are many farmers who leave the harvesting process to middlemen or third parties who buy their produce³². This process is carried out based on an agreement on time and price, and its implementation often involves daily workers who do not have special technical training.

Then, on the specified date, the middlemen ask the fish harvesters to carry out the harvesting process. All respondents have prepared their harvesting plans and equipment well. Fish are caught carefully to avoid physical stress. Middlemen ensure speed in the harvesting process and handling of the produce to maintain the freshness and selling value of the product. The results of this study are in line with the research by Rozak et al., which states that tilapia farmers in Tasikmalaya have implemented production management functions, including systematic harvest time planning and equipment preparation to maintain the quality



of the harvest³³. Fish capture has also been carried out carefully to avoid stress due to handling and reduce the risk of fish mortality. Careful capture is crucial to maintain the physiological condition of the fish⁶.

During the harvesting process, farmers do not select or sort the fish, as all fish in the pond are the property of the middlemen. Farmers only observe the entire harvesting process and prepare harvesting equipment if necessary. All containers and clean water are provided by the middlemen. This statement further reinforces the findings of Nugroho et al., who stated that the harvesting process is often carried out by external parties (middlemen) without quality control³⁴. The presence of middlemen is very common and has led to a new phenomenon, namely the dependence of farmers on sales that tend to be monopsony in nature³⁵.

G. Waste management

Waste management is a strategic element that determines the sustainability of production and the socio-ecological impact of aquaculture. Waste produced, whether in the form of feed residues, feces, or chemical residues, has a high potential to pollute ponds, damage water quality, and cause disease if not managed properly. This waste also presents opportunities for reuse, such as for organic fertilizer, natural biofilters, or raw materials for bioconversion systems. Without integrated waste management, aquaculture productivity can be disrupted by the accumulation of toxic substances such as ammonia and nitrite, as well as disturbances to the balance of microorganisms in the ponds. The distribution of respondents' capacity in waste management can be seen in Table 8 below.

Table 8. Distribution of respondents' capacity in waste management

No	Statement item	Total score (people)	
		Treatment	No treatment
1	Waste classification	94	0
2	Management of post-harvest pond water waste before disposal	27	67
3	Removal of waste from the bottom of the pond	41	53

Source: Primary data, processed from 2025 research results

Based on Table 8, it can be concluded that awareness of waste type identification is already high, but technical practices for managing liquid and solid waste are not yet commonplace. All respondents have categorized waste types, indicating that farmers have basic knowledge about the classification of organic and inorganic waste and its potential impact on pond ecosystems. However, only 27 respondents (28.7 percent) actively manage pond water waste after harvest before disposing of it into the environment.

Respondents who did not do so tended to directly discharge pond water into the nearest river by sucking up the pond water using a water suction machine. In fact, post-harvest pond water generally contains feed residues, fish feces, and toxic compounds such as ammonia, which can pollute nearby water sources if not treated first³⁶. Pond water waste containing organic waste, nitrogen, and phosphorus can cause eutrophication and a decline in water quality if not managed properly³⁷. A study by Alvisha confirmed that fish farming wastewater contains organic compounds and ammonia that can pollute the environment if not treated first³⁸. Pond water pollution due to waste can affect fish physiology, including stress and metabolic disorders, which have an impact on farming productivity⁶.

Forty-one respondents (43.6 percent) reported removing solid waste from the pond bottom, indicating that nearly half of the farmers recognize the importance of settling and cleaning residual production materials. However, this figure still highlights the need for technical training interventions to ensure that solid waste management is carried out routinely and efficiently. The respondents' habit after draining the pond water is to dry the pond bottom without first removing the mud at the bottom of the pond. Overall, waste management in freshwater fish farming is still focused on the identification stage and has not been technically implemented at the processing and utilization stages. This opens up opportunities for the integration of the reduce-reuse-recycle (3R) approach and increased understanding among farmers of the long-term impacts of waste on the environment and pond productivity. Fish waste treatment can reduce pollution and support sustainable aquaculture³⁹.



CONCLUSION

The capacity of farmers in the cultivation subsystem has been performing well in the stages of seedling distribution and harvest handling, but improvements are needed in the stages of seedling and pond water selection, pond preparation, feeding, water quality and fish health management, waste management, market analysis, and product promotion so that production can be optimal and sustainable.

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