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AQUACAGE SEMERAK: EMPOWERING RURAL COMMUNITIES THROUGH CAGE FISH FARMING

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Abstract:

Community-based aquaculture may strengthen rural livelihoods through technical capacity and alternative income opportunities. AquaCage Semerak is a cage-farming training programme for residents of Semerak, Pasir Puteh, Kelantan. Although earlier studies have addressed aquaculture production and rural livelihoods, limited attention has been given to rural Malaysian programmes integrating

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hands-on training, assigned follow-up monitoring and entrepreneurship preparation. This qualitative case study used semi-structured interviews, programme observation, document analysis and evaluation records. It involved 25 participants: 8 local residents, 15 community representatives, 5 facilitators or trainers and 2 aquaculture stakeholders. Thematic analysis generated five themes: technical knowledge development, experiential learning, follow-up monitoring, perceived income opportunities and sustainability challenges. Participants reported exposure to cage construction, fish husbandry, feeding and routine monitoring, supported by observations of practical activities. Project facilitators monitored technical application during training and early implementation. Because no pre- and post-assessment or longitudinal income measurement was reported, the findings indicate perceived learning and livelihood potential rather than verified causal improvement. AquaCage Semerak may therefore be considered a promising community-based aquaculture model requiring further evaluation.

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Keyword:

Aquaculture; Cage Fish Farming; Community-Based Entrepreneurship; Community Training; Rural Livelihoods

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Introduction

Rural communities in coastal and riverine areas often possess strong potential in fisheries and aquaculture-related activities. These communities may have access to water resources, local knowledge of fishery activities and interest in income-generating projects. However, the ability to transform these resources into sustainable livelihood opportunities depends on technical knowledge, organised management, access to training and continuous support.

Aquaculture has become an important sector for supporting food security, income generation and rural economic development (Béné et al., 2016; FAO 2020; FAO, 2022). Among various aquaculture practices, cage fish farming is suitable for communities located near rivers, lakes, ponds or coastal water bodies. Cage fish farming allows fish to be reared in controlled floating or fixed cages within natural water systems. It can be implemented on a small or community scale and has the potential to provide additional income when managed systematically (Little et al., 2016).

The AquaCage Semerak initiative was introduced as a community engagement programme to empower local residents in Semerak, Pasir Puteh, Kelantan through structured training in cage fish farming. The initiative aimed to enhance participants' knowledge and practical skills in cage construction, fish husbandry, feeding management, water monitoring, maintenance and

business planning. The programme was designed using a training model that combined theoretical exposure, hands-on practical sessions, continuous monitoring and evaluation.

The initiative is important because rural communities often require practical interventions that go beyond awareness programmes. Community members need direct exposure, demonstration and follow-up guidance to develop confidence in managing aquaculture activities independently. Through AquaCage Semerak, participants were introduced to a systematic approach to cage fish farming that could support alternative income generation and sustainable rural livelihood.

This study examines AquaCage Semerak as a qualitative case study of community-based aquaculture empowerment. It focuses on programme implementation, participants' learning experiences, perceived benefits, follow-up monitoring, sustainability challenges and strategies for strengthening community ownership.

Problem Statement

Although the Semerak community has potential in the fisheries and aquaculture sector, limited technical knowledge and lack of organised cage-farming practices have affected its ability to fully benefit from local aquatic resources. Many rural residents may have interest in fish farming but lack exposure to systematic methods of cage construction, fish care, feeding, water quality monitoring and harvesting (Saini et al., 2023).

Community-based aquaculture projects also face sustainability challenges. These include limited capital, weak technical skills, irregular monitoring, unclear task distribution, high feed costs, disease risks and lack of market planning (Krause et al., 2015; Joffre et al., 2018). Without proper training and follow-up support, cage fish farming may become a short-term activity rather than a sustainable livelihood project.

Another issue concerns community confidence. Participants may hesitate to engage in aquaculture if they perceive fish farming as technically difficult, risky or costly. Therefore, structured training and hands-on demonstration are needed to help participants understand the process and build confidence (Krause et al., 2015; Peredo and Chrisman, 2006).

Previous research has examined aquaculture production, rural livelihoods and technical efficiency, but less attention has been paid to how a community-based cage-farming programme combines experiential training, follow-up monitoring, university-community collaboration and entrepreneurship preparation (Iliyasu et al., 2016; Olaganathan & Kar Mun, 2017). There is therefore a need to examine not only whether participants receive training, but also how learning is supported after training and what conditions are required for community ownership and longer-term continuation.

Accordingly, this study explores AquaCage Semerak to understand participants' experiences of cage-farming training, the perceived learning and livelihood opportunities arising from the programme, and the technical, organisational and market conditions that may influence its future sustainability.

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Research Objectives

The objectives of this study are:

1. To explore the implementation process of the AquaCage Semerak cage fish farming training programme.
2. To examine participants perceived learning and practical skill development through the AquaCage Semerak programme.
3. To identify the perceived benefits of cage fish farming as an alternative income-generating activity.
4. To analyse the challenges faced in sustaining community-based cage fish farming.
5. To propose strategies for strengthening AquaCage Semerak as a potential community entrepreneurship model.

Research Questions

This study is guided by the following research questions:

1. How was the AquaCage Semerak training programme implemented?
2. What knowledge and practical skills did participants report gaining through the programme?
3. What are the perceived socioeconomic benefits of cage fish farming for the Semerak community?
4. What challenges affect the sustainability of community-based cage fish farming?
5. What strategies may strengthen AquaCage Semerak as a potential rural livelihood model?

Literature Review

Community-Based Aquaculture and Rural Livelihood

Community-based aquaculture refers to aquaculture activities that involve local communities in the planning, implementation, management and benefit-sharing processes (Peredo & Chrisman, 2006; Krause et al., 2015). This approach is different from conventional aquaculture because it places the community at the centre of development rather than treating them only as beneficiaries. Through community-based aquaculture, local residents are encouraged to participate actively in decision-making, resource utilisation and project management (Castillo et al., 2025). This is important because rural communities often possess local knowledge, social networks and access to natural water resources that can be developed into productive economic activities.

Aquaculture is widely recognised as a livelihood strategy because it enables communities to use available water resources for food production, income generation and local economic development. In rural settings, aquaculture can support household income, create employment opportunities and strengthen food supply, particularly among communities with limited access to formal employment. It is highlighted that fisheries and aquaculture contribute significantly to food security, poverty reduction and rural livelihoods (Béné et al., 2016). Therefore, community-based aquaculture can function not only as an economic activity but also as a

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practical mechanism for improving community wellbeing and reducing livelihood vulnerability.

Unlike commercial aquaculture, which often focuses mainly on productivity and profit, community-based aquaculture emphasises empowerment, participation and capacity building. The success of such initiatives depends not only on fish production or financial returns but also on community ownership, cooperation, technical skills and long-term sustainability (Ateweberhan et al., 2018). When communities are equipped with proper training, monitoring and management support, aquaculture projects can become a platform for strengthening local entrepreneurship and collective responsibility. However, without strong community participation and organised management, aquaculture initiatives may face challenges such as weak commitment, poor maintenance and limited sustainability.

Cage Fish Farming as a Community Enterprise

Cage fish farming involves rearing fish in enclosures placed in water bodies such as rivers, lakes, ponds or coastal areas. This method allows fish to be cultivated in a controlled environment while still utilising existing natural water resources. Compared to pond-based farming, cage fish farming may require less land area, making it suitable for rural communities that have access to rivers, coastal waters or other aquatic environments. It also allows farmers to monitor fish growth, feeding patterns and harvesting activities more systematically (Nzaligo et al., 2026).

As a community enterprise, cage fish farming has the potential to generate additional income and support rural livelihood diversification. Communities can manage cage farming collectively by sharing responsibilities such as feeding, cage maintenance, water observation, record keeping and marketing. This collective approach can encourage cooperation, strengthen local entrepreneurship and create opportunities for small-scale economic participation. When properly managed, cage fish farming may provide income through the sale of fish to local markets, restaurants, traders and community networks. Therefore, it can function not only as an aquaculture activity but also as a practical community-based enterprise model.

However, cage fish farming requires adequate technical knowledge and consistent management. Farmers must understand cage design, stocking density, feeding schedule, fish health, water quality and harvesting methods. Poor management may result in slow fish growth, disease, fish mortality or financial loss (Yusoff et al., 2019). Feed cost, water quality and disease prevention are also important factors that influence the success of cage farming (Boyd & Tucker, 2014; Tacon & Metian, 2015). Therefore, structured training, technical guidance and continuous monitoring are necessary before communities can manage cage fish farming independently and sustainably.

Experiential Learning in Community Training

Experiential learning is an important approach in community training because it emphasises learning through practice and direct involvement. In the context of rural community development, participants often learn more effectively when they are given opportunities to observe, practise and apply new knowledge in real situations. This approach is particularly relevant for technical activities such as aquaculture, where understanding cannot depend only on classroom explanation. Instead, participants need to experience the actual process of

constructing cages, handling fish, managing feeding routines and observing water conditions (Saha & Adnan, 2024).

In aquaculture training, experiential learning may include practical activities such as cage construction, feeding demonstrations, fish handling, water observation and cage maintenance. These activities allow participants to connect theoretical knowledge with practical application. For example, participants may understand the importance of cage design more clearly when they are directly involved in assembling the cage structure. Similarly, feeding demonstrations can help them understand proper feeding frequency, feed quantity and the relationship between feeding practices and fish growth. Through this process, participants are not only exposed to new information but also trained to develop confidence in performing aquaculture-related tasks.

A structured training programme that combines theory and practice can improve participants' understanding, skills and confidence. Theoretical sessions provide basic knowledge on aquaculture principles, fish husbandry and project management, while practical sessions allow participants to develop skills through direct involvement. This combination is important because community participants need both conceptual understanding and technical ability before they can manage cage fish farming independently. Therefore, experiential learning can strengthen community capacity by transforming passive learning into active participation, practical skill development and greater readiness to apply aquaculture practices in real community settings (Begho et al., 2026).

University-Community Collaboration

University-community collaboration can support rural development by transferring knowledge, providing technical guidance and strengthening community capacity. In community-based programmes, universities play an important role as knowledge providers, facilitators and development partners (Hințea et al., 2022). Through academic expertise and research-based practice, universities can help communities identify local potential, understand technical requirements and develop suitable intervention strategies. This form of collaboration is important because rural communities may have local resources and interest, but they often require structured support to transform these resources into sustainable livelihood activities.

Universities can act as facilitators by designing training modules, conducting demonstrations, monitoring project progress and evaluating programme outcomes. In the context of aquaculture training, university facilitators may provide guidance on cage construction, fish husbandry, feeding management, water monitoring, maintenance and basic business planning (Biswal et al., 2024). They can also support the community through continuous mentoring and evaluation to ensure that the knowledge gained during training is applied correctly. Such collaboration allows communities to benefit from both theoretical knowledge and practical technical support, especially during the early stage of project implementation.

In the context of AquaCage Semerak, university-community collaboration is important because the community requires technical support in cage fish farming. However, collaboration should aim to build local capacity rather than create long-term dependency. The role of the university should gradually shift from direct guidance to supportive monitoring as the community develops the confidence and skills to manage the project independently. The ultimate goal is for the Semerak community to take ownership of the cage fish farming initiative and sustain it

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as a community-based enterprise that contributes to rural livelihood development and local economic empowerment (Yang et al., 2026).

Sustainability of Aquaculture-Based Community Projects

The sustainability of aquaculture-based community projects depends on the integration of technical, economic, social and environmental factors. Technical sustainability refers to the ability of the community to manage fish husbandry, cage maintenance, water quality and disease prevention effectively. These aspects are important because poor technical management can affect fish growth, increase mortality and reduce production outcomes. In cage fish farming, participants must be able to monitor feeding routines, observe water conditions, maintain cage structures and respond to fish health problems. Therefore, technical skills and continuous guidance are essential to ensure that the project can operate beyond the initial training phase (Iliyasu et al., 2016).

Economic sustainability is also a key factor in determining the success of aquaculture-based community projects. This includes the ability to manage feed costs, identify market access, set appropriate prices, generate income and reinvest profits into future production cycles (Tacon & Metian, 2015; Béné et al., 2016). Feed cost is particularly important because it forms a major part of aquaculture production expenses. Without proper financial planning, record keeping and market linkage, cage fish farming may become difficult to sustain. Therefore, communities need exposure not only to technical aquaculture skills but also to basic entrepreneurship, cost calculation, sales planning and profit management.

Social and environmental sustainability are equally important in community-based aquaculture projects. Social sustainability involves community cooperation, leadership, shared responsibility and collective decision-making. Since cage fish farming may be managed as a group activity, clear task distribution and strong community commitment are needed to avoid unequal workload or weak participation. Environmental sustainability involves the responsible use of water resources, proper waste management and awareness of ecological impacts (Kurniawan et al., 2022). Therefore, cage fish farming projects should not only focus on training but also include continuous monitoring, evaluation, financial planning, market linkage and environmental responsibility to ensure long-term project sustainability

Methodology

Research Design

This study employed a qualitative case study design. A qualitative approach was selected because the study aimed to explore the implementation process, participants' experiences, perceived benefits and sustainability challenges of the AquaCage Semerak initiative. The case study design was appropriate because the research focused on a specific community-based aquaculture training programme implemented in Semerak, Pasir Puteh.

Study Location

The study was conducted in Semerak, Pasir Puteh, Kelantan. This location was selected because it has potential for fisheries and cage fish farming activities. The local aquatic

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environment and community interest provided a relevant context for examining aquaculture-based rural livelihood development.

Participants and Sampling

Participants were selected using purposive sampling because they had direct experience of or involvement in AquaCage Semerak. The study involved 25 participants, comprising 8 local residents, 15 community representatives, 5 project facilitators or trainers and 2 aquaculture stakeholders. The confirmed participant distribution must replace the planning ranges previously reported in Table 1 before submission.

Table 1. Participant Categories and Confirmed Sample

Participant Category	Confirmed Number	Rationale
Local residents	8	To explore direct experiences, learning outcomes, skills gained and challenges in cage fish farming.
Community representative	15	To understand local coordination, community participation and project relevance.
Project facilitators	5	To examine training delivery, monitoring process, technical guidance and programme evaluation.
Aquaculture stakeholder	2	To understand market potential, sales opportunities and sustainability issues.

Source: Authors' fieldwork (2026).

Data Collection

Data were collected using semi-structured interviews, programme observation, document analysis and evaluation records. Semi-structured interviews were conducted with participants to obtain detailed information on their experiences, knowledge gained, perceived benefits and challenges in cage fish farming (Yang et al., 2021).

Programme observation was conducted during training and monitoring activities. Observation focused on participant engagement, cage construction demonstration, fish husbandry practice, feeding techniques, monitoring activities and interaction between facilitators and participants. Document analysis was conducted on relevant programme materials, including training notes, attendance records, monitoring reports, photographs, evaluation forms and project documentation. These documents helped provide background information and supported the interview findings.

Evaluation records were reviewed to examine training delivery, attendance, engagement and reported learning. Because the available manuscript does not report a validated pre- and post-test or longitudinal economic measurement, these records were used as supporting qualitative evidence and not as proof of causal improvement or impact.

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Interview Protocol

The interview questions were developed based on the research objectives. The following questions were used as a guide:

1. Can you explain your involvement in the AquaCage Semerak programme?
2. What motivated you to participate in cage fish farming training?
3. What knowledge did you gain from the programme?
4. What practical skills did you learn during the training?
5. How useful were the cage construction and fish husbandry demonstrations?
6. What challenges do you face in managing cage fish farming?
7. How can cage fish farming help generate income for the community?
8. What kind of technical support or monitoring is needed?
9. How does community cooperation influence the success of the project?
10. What suggestions do you have to improve the AquaCage Semerak initiative?

Data Analysis

The data were analysed using thematic analysis. The analysis began with repeated reading of interview transcripts, observation notes, programme documents and evaluation records. Important statements were coded according to the research objectives. Similar codes were grouped into categories and later developed into major themes (Nzaligo et al., 2026).

The analysis focused on identifying themes related to training implementation, knowledge improvement, practical skills, income potential, community participation, monitoring, challenges and sustainability strategies. The findings were presented through thematic descriptions.

Trustworthiness of the Study

Several strategies were used to strengthen trustworthiness. First, data triangulation was applied by combining interviews, observation, document analysis and evaluation records. Second, participant triangulation was used by involving local residents, community representatives, project facilitators and aquaculture stakeholders. Third, member checking was conducted by confirming key points with selected participants. Fourth, peer review was conducted with the research team to refine the themes. Fifth, thick description was used to explain the programme context, training process and participants' experiences (Saini et al., 2023).

Ethical Considerations

The study was conducted according to ethical research principles. Participants were informed about the purpose of the study and their participation was voluntary. Consent was obtained before interviews were conducted. Participants' identities were protected using codes such as P1, P2 and P3. The study respected the privacy, dignity and local knowledge of the Semerak community. The data were used only for academic and research purposes.

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Findings

The analysis generated five themes: technical knowledge development in cage fish farming, experiential learning through hands-on training, follow-up monitoring as a capacity-building mechanism, cage fish farming as a perceived alternative-income opportunity and sustainability challenges. The findings reflect participants' accounts, supported by programme observations, documents and evaluation records; they do not constitute measured pre- and post-intervention effects.

Theme 1: Strengthening Technical Knowledge in Cage Fish Farming

The first theme concerns participants' reported development of technical knowledge. Interview accounts identified learning related to cage-farming concepts, fish species suitability, cage construction, feeding practices, fish-growth monitoring and water conditions. Programme observations and training records supported participants' exposure to these topics. As no pre- and post-test results were reported, the evidence is interpreted as perceived learning rather than a quantified improvement.

The theoretical briefing helped participants understand the basic principles of cage fish farming. Participants were introduced to the importance of proper cage structure, suitable water flow, fish stocking, feeding frequency and routine monitoring. This knowledge was important because cage fish farming requires systematic management rather than informal practice.

The findings suggest that technical knowledge is a foundation for community-based aquaculture. Without basic understanding, participants may not be able to manage cages effectively or respond to farming problems (Nzaligo et al., 2025).

Theme 2: Experiential Learning through Hands-On Training

The second theme concerns hands-on training. Participants valued practical sessions because they were able to observe and practise cage construction, fish handling and husbandry techniques. Demonstrations helped participants understand the actual process more clearly than theoretical explanations alone.

Participants associated direct involvement in cage construction and fish-management activities with greater confidence in attempting cage-farming tasks. This evidence reflects participants' perceptions and observes engagement during practical activities; confidence was not measured using a pre- and post-intervention scale.

This finding shows that experiential learning is important in rural community training. Practical demonstration allows participants to learn by doing and reduces fear of trying new activities. For cage fish farming, hands-on learning is especially important because the activity involves technical procedures.

Theme 3: Continuous Monitoring as a Mechanism for Capacity Building

The third theme concerns follow-up monitoring and guidance. During training and early implementation activities, project facilitators monitored feeding practices, water conditions, fish health, cage maintenance and participants' application of the procedures. Participants

indicated that this support helped them identify technical problems and apply the training more appropriately.

Project facilitators provided technical guidance when issues were identified, while participants and community representatives contributed local observations and routine information. The monitoring process therefore functioned as follow-up mentoring and capacity support. For future cycles, responsibilities should be gradually transferred to a community aquaculture committee, with technical officers or university facilitators providing periodic specialist advice.

This finding suggests that community-based aquaculture programmes should include follow-up support. A one-time training programme may increase awareness, but continuous monitoring is needed to build independent management capacity.

Theme 4: Cage Fish Farming as an Alternative Income Opportunity

The fourth theme concerns the perceived economic potential of cage fish farming. Participants viewed fish sales to local buyers, restaurants, markets or community networks as a possible source of supplementary income if production could be maintained. However, the study did not report actual sales, profit or household-income changes; the finding therefore represents perceived opportunity rather than demonstrated economic improvement.

Cage fish farming was also perceived as a possible way to diversify rural livelihoods. Instead of depending only on existing income sources, the community could explore aquaculture as an additional economic activity, subject to production viability, cost management and market demand (Gurung et al., 2010).

However, the findings also indicate that income generation depends on production success, market access, cost management and community commitment. Therefore, entrepreneurship training should be integrated into aquaculture training to ensure that participants understand both farming and business aspects.

Theme 5: Sustainability Challenges in Community-Based Aquaculture

The fifth theme focuses on sustainability challenges. Participants identified several issues that could affect long-term project success, including feed costs, maintenance of cages, fish disease, weather conditions, labour commitment, market uncertainty and need for technical support.

Feed cost was identified as a major concern because it affects production expenses. If feed costs increase, profit may decline. Cage maintenance was also important because damaged cages can affect fish safety and production. Participants also needed knowledge of fish disease prevention and proper handling.

Community cooperation was another important issue. Cage fish farming requires shared responsibility, especially if the project is managed as a group. Without clear roles, the workload may fall on a few participants. Therefore, task distribution and leadership are important for sustainability. The findings suggest that AquaCage Semerak must be supported by technical, economic and social planning. Sustainability depends not only on fish production but also on community organisation and business management.

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Discussion

The findings suggest that AquaCage Semerak has potential as a community-based cage-farming initiative. Participants reported exposure to cage construction, fish husbandry, feeding practices and routine monitoring, while programme observations and records indicated engagement in hands-on activities. These sources support perceived learning and confidence development, but they do not establish causal improvement because no validated pre- and post-assessment was reported.

The second contribution is experiential learning. Hands-on demonstrations enabled participants to observe and practise technical procedures in a real setting (Piščalkienė & Lottrup, 2019). The third contribution is structured follow-up monitoring: project facilitators monitored technical application during training and early implementation, while future monitoring should assign routine responsibilities to community leaders or a local aquaculture committee and reserve specialist guidance for technical officers or university facilitators.

The fourth contribution is the economic potential of cage fish farming. The programme introduced aquaculture as an alternative livelihood activity. However, the findings show that income generation depends on effective cost management, market access and production consistency. Therefore, cage fish farming should be linked with entrepreneurship training.

The fifth issue concerns the conditions required for sustainability. Weak cooperation, unclear responsibilities, high feed costs, production risks and insufficient technical support may prevent continuity. AquaCage Semerak should therefore be regarded as a promising model rather than an already sustainable model. Its longer-term viability depends on clear community roles, financial planning, market access, technical support and evidence from subsequent production cycles.

Implications of the Study

This study provides several implications for community development, aquaculture training and rural entrepreneurship. First, cage fish farming programmes should begin with a community readiness assessment to ensure that the project is suitable for the local context. This assessment should include water suitability, participant interest, labour availability, existing community resources and market potential. By understanding these factors at the early stage, programme facilitators can design aquaculture initiatives that are more relevant, practical and responsive to community needs.

Second, aquaculture training should combine theoretical knowledge with hands-on practical experience. Participants need conceptual understanding of cage fish farming, including fish husbandry, cage maintenance, feeding management and water quality monitoring. At the same time, practical exposure is necessary to help participants apply what they have learned through cage construction, feeding demonstrations, fish handling and maintenance activities (Gonzalez Parrao et al., 2021). This combination can improve participants' confidence, technical skills and readiness to manage cage fish farming activities independently.

Third, follow-up monitoring, entrepreneurship training and university-community collaboration should be integrated into programme design. During the early production cycle, project facilitators or technical officers should review fish health, water conditions, feeding,

cage maintenance and production records. Routine monitoring should gradually be led by designated community members or a community aquaculture committee, supported by periodic technical consultation. This division of responsibility can build local capacity while reducing long-term dependence on external facilitators.

Recommendations

Based on the findings, several recommendations are proposed to strengthen the implementation and sustainability of the AquaCage Semerak initiative. First, a structured AquaCage training module should be developed to guide participants systematically in cage fish farming. The module should cover important components such as cage construction, fish husbandry, feeding management, water monitoring, cage maintenance and harvesting techniques. A structured module is important because it provides clear learning content and ensures that all participants receive consistent technical knowledge. Before the project is expanded, a community readiness assessment should also be conducted to identify suitable water resources, participant interest, labour availability, local leadership and market potential (Norzeri et al., 2025).

Second, the programme should continue to emphasise hands-on training using real cage construction and fish management demonstrations. Practical exposure is important because participants can observe, practise and understand the actual process of cage fish farming more clearly. In addition, a community aquaculture committee should be established to coordinate tasks, make decisions and ensure shared responsibility among participants (Ahmad Faiz et al., 2010). The committee can help organise feeding schedules, cage maintenance, monitoring activities and communication with facilitators. A cage management checklist should also be prepared to guide participants in daily and weekly tasks related to feeding, maintenance, fish health and water conditions.

Third, project facilitators, supported where appropriate by aquaculture technical officers, should conduct structured monitoring during the first production cycle. Monitoring should cover fish health, feeding, water conditions, cage maintenance, mortality, participant task completion and production records. A community aquaculture committee should progressively assume routine monitoring, while external specialists provide scheduled technical review. The programme should also introduce cost calculation, sales records, pricing, profit planning and reinvestment, alongside market linkages with local buyers, restaurants, fish traders and community markets.

Finally, periodic evaluation should distinguish process, outcome and longer-term impact indicators. Process evaluation may assess training delivery, attendance and engagement; outcome evaluation may assess demonstrated technical competencies and self-reported confidence; and impact evaluation should examine verified production, sales, income, community cooperation and continuation across subsequent farming cycles. Until such evidence is available, AquaCage Semerak should be described as a potential community-based entrepreneurship model.

Proposed AquaCage Semerak Community Empowerment Model

Based on the findings, this study proposes the AquaCage Semerak Community Empowerment Model. The model consists of five components:

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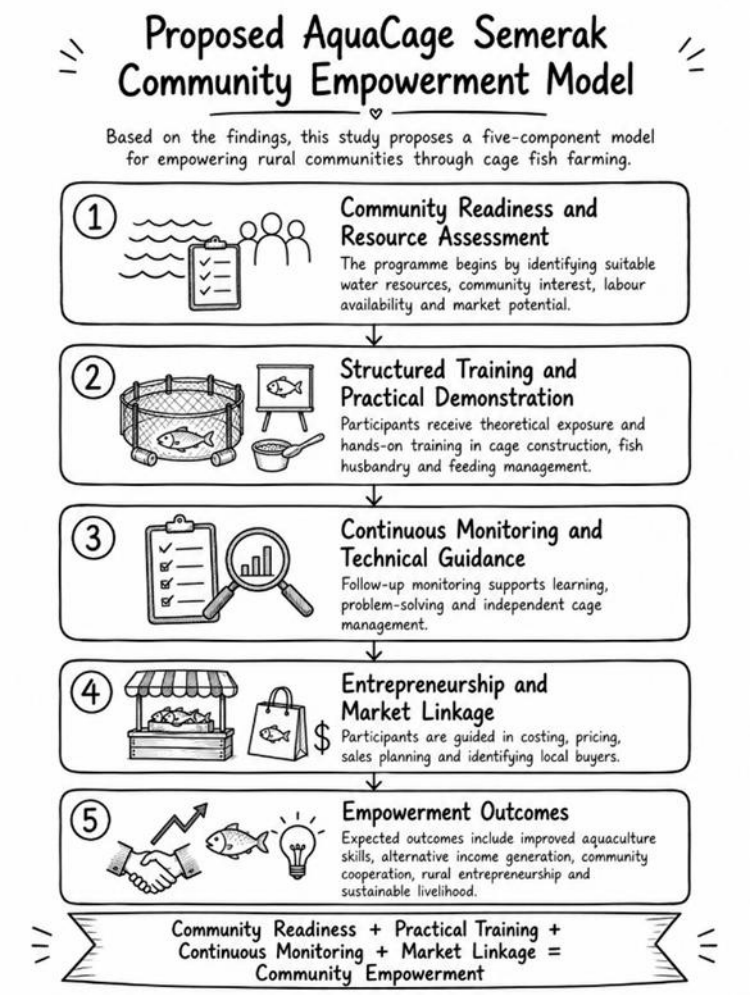


Figure 1. Proposed AquaCage Semerak Community Empowerment Model

The proposed model integrates community readiness and resource assessment, structured cage-farming training, hands-on demonstrations, follow-up monitoring, entrepreneurship preparation and market linkage. Project facilitators and technical officers support early technical monitoring, while routine responsibility is progressively transferred to community leaders or a community aquaculture committee. The model presents improved knowledge, skills, confidence and income generation as intended or emerging outcomes that require verification through competency assessment, production records, sales data and longitudinal follow-up.

Conclusion

This study explored AquaCage Semerak as a community-based aquaculture training programme in Semerak, Pasir Puteh. Participants reported gaining knowledge of cage construction, fish husbandry, feeding practices and routine monitoring, and they associated hands-on activities and facilitator guidance with greater confidence. These findings represent perceived learning supported by programme observations and records, not measured causal improvement.

Participants also perceived cage fish farming as a possible supplementary income activity. Its viability remains dependent on feed-cost management, cage maintenance, disease prevention, market access, community cooperation and continuing technical support. Actual income generation and project continuity should be assessed across future production cycles.

Overall, AquaCage Semerak may be considered a promising model for community-based entrepreneurship and rural livelihood development rather than an already sustainable model. The study is limited by its context-specific qualitative design, the absence of confirmed participant counts in the current manuscript, and the lack of validated pre- and post-assessment or longitudinal economic measures. Future evaluation should report the exact sample, participant-level evidence, demonstrated competencies, production outcomes, sales and income changes over time.

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Ethics Statement:	The study was conducted in accordance with ethical research principles. Participants were informed about the purpose of the study and their participation was voluntary. Consent was obtained before interviews were conducted. Participants' identities were protected using participant codes. The study respected the dignity, privacy and religious-cultural context of the pondok community. The data were used only for academic and research purposes.
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