



Modern Green Freshwater Lobster Aquaponics: UiTM Sabah's Innovative Model for Sustainable Community Empowerment and Resilience

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Abstract

This paper presents the implementation of the Freshwater Lobster Production – Green Aquaponic Perennial System (FLP-GAPS) 2.0 as an innovative model developed by UiTM Sabah to sustainably empower and uplift rural communities. The project, carried out in Kampung Kayu Madang, applies a modern green aquaponics approach that integrates freshwater lobster farming with sustainable vegetable cultivation anchored in the principles of the Blue Economy. Community participants received comprehensive training in technical aquaponics, entrepreneurship, and resource management, resulting in significant improvements in knowledge (93%), technical skills (94%), and daily practices (86.7%). The project fostered strong self-confidence among the community, enabling them to manage the system independently with minimal external support. The outcomes of FLP-GAPS 2.0 go beyond income generation; they inspire a wider vision for replication in other underserved communities. The success of this project reflects UiTM Sabah's role as a catalyst for social innovation and sustainable rural development through effective knowledge transfer, technology adoption, and inclusive university-community collaboration.

Keywords: Aquaponics, Blue Economy, Community Empowerment, Sustainable Development

Introduction

The development of sustainable community-based aquaculture models has become increasingly important in achieving Malaysia's agrofood and rural development goals (Ministry of Agriculture and Food Security, 2023). The Freshwater Lobster Production – Green Aquaponic Perennial System (FLP-GAPS) initiative by UiTM Sabah exemplifies an integrated approach combining aquaponics technology with socio-economic empowerment. The project's location in Kampung Kayu Madang, a semi-rural area with high B40 household representation, aligns with national priorities for poverty alleviation and food security (Department of Statistics Malaysia, 2023; ToCoDeS, 2024).

Previous studies highlight that aquaponics offers a sustainable food production solution with minimal environmental impact while fostering local economic resilience (Boyd & McNevin, 2015; Goddek et al., 2019). In Sabah, research by Rozita et al. (2023), Hendry et al. (2023) and Cyril et al. (2024) underscores the potential of aquaponics and freshwater lobster farming to empower rural communities, particularly through technical training, market integration, and adherence to Islamic Green-Blue Economy principles.

Problem Statement

Rural communities in Sabah, particularly in semi-rural and peri-urban areas, face persistent challenges in economic resilience, food security, and youth engagement. The dependency on traditional agriculture with low productivity, combined with limited access to markets and technology, contributes to rural poverty and migration (Mohd et al., 2020; Department of Statistics Malaysia, 2023). Kampung Kayu Madang mirrors these conditions, with a majority of households in the B40 category and lacking sustainable income-generating activities. Despite governmental efforts, there remains a gap in implementing integrated, technology-driven, and community-centred solutions (ToCoDeS, 2024).

Objectives

The objectives of this study are:

1. To evaluate the effectiveness of the FLP-GAPS 2.0 aquaponics model in enhancing the livelihoods of rural communities in Sabah.
2. To assess the socio-economic and environmental impacts of integrating freshwater lobster farming with sustainable vegetable cultivation.
3. To identify challenges and propose strategies for scaling and replicating the model in other rural contexts.



Significance of the Study

This study provides empirical evidence on the role of integrated aquaponics systems in rural community empowerment, contributing to the body of knowledge on sustainable aquaculture and rural entrepreneurship and the Islamic Green-Blue Economy framework (Rozita et al., 2023; Surail et al., 2023). By documenting the implementation and outcomes of the FLP-GAPS 2.0 project, the findings offer policymakers, practitioners, and community organizations a practical blueprint for poverty alleviation, youth entrepreneurship, and environmental stewardship.

Literature Review

Aquaponics, as a closed-loop food production system integrating aquaculture and hydroponics, has been widely recognized for its potential to address food security while minimizing environmental impact (Goddek et al., 2019; Somerville et al., 2014). Studies by Love et al. (2015) highlight its efficiency in resource use and adaptability in diverse climatic conditions. In Malaysia, aquaponics initiatives have been linked to community development and rural entrepreneurship (Mohd & Yusuf, 2021; Hisham & Rahman, 2022).

In the context of Sabah, Hendry et al. (2023) and Cyril et al. (2024) documented successful integration of aquaponics in rural livelihoods, emphasizing technical training, entrepreneurship support, and market linkages. Rozita et al. (2023) and Surail et al. (2023) further contextualized aquaponics within the Islamic Green-Blue Economy framework, aligning economic activities with sustainability and ethical principles. The combination of freshwater lobster farming and aquaponics is relatively novel in Malaysia, offering higher-value market potential compared to conventional aquaculture (Boyd & McNevin, 2015).

Methodology

A purposive sampling was carried out to gather in-depth information from the participants (Robinson, 2023). A specially designed questionnaire, completed by all 15 participants of this programme, was developed based on the primary goals and objectives of the programme. A questionnaire instrument was used as it is a practical and most effective way to obtain information (Hasan & Bao, 2020). The questionnaire set comprised ten (10) sections: Sections A, B, C, D, E, F, G, H, I and J. Section A focuses on participant information; Section B assesses the relevance of the programme to community needs; and Section C examines the level of collaboration between the University and the Community. Section D reviews stakeholder perceptions, while Section E analyses the programme's impact on changes in attitudes, knowledge, skills, and community aspirations. Section F presents participants' personal experiences, and Sections G and H explore the programme's impact on practices and challenges in innovation adoption. Section I and J focuses on community empowerment and the programme's sustainability for the future. The data were analysed using descriptive statistics to determine the frequencies and percentages.

Findings and Discussion

4.1 Section A: Participant Information.

Table A1: Participant Age

Age range	Frequency	Percentage (%)
20 - 29	2	13.3
30 - 39	3	20
40 - 49	7	46.7
50 - 59	3	20

Table A1 shows participants' ages ranging from 20 to 59 years old.

Table A2: Participant Status

Status	Frequency	Percentage (%)
Married	12	80
Not Married	2	13.3
Widower	-	-
Widow	1	6.7

Table A2 shows that most participants were married (80%), 13% were single, and one was widowed.



Table A3: Participant Gender

Gender	Frequency	Percentage (%)
Male	6	40
Female	9	60

Table A3 indicates that the programme comprised 9 female participants (60%) and 6 male participants (40%).

Table A4: Participant Ethnicity

Ethnicity	Frequency	Percentage (%)
Kadazandusun	14	93.3
Rungus	1	6.7

Chart A4 shows the ethnic distribution of participants, with the majority being from the Kadazandusun and Rungus communities.

Table A5: Participant Educational Background

Education	Frequency	Percentage (%)
UPSR	1	6.7
PMR/SRP	6	33.3
SPM	6	40
Sijil Kemahiran	1	6.7
Diploma	6	13.3

Table A5 shows participants' educational levels: 6 participants with SPM (40%), 5 with PMR (33.3%), 2 with Diplomas (13.3%), and one each with a skills certificate and UPSR (6.7%).

Table A6: Participant Occupation

Occupation	Frequency	Percentage (%)
Housewife	6	40
Private sector	6	40
Self employed	3	20

Table A6 shows the participants' occupations: the majority were housewives (40%) or employed in the private sector (40%). Only 3 participants (20%) were self-employed on a small scale.

Table A7: Number of Family Members Involved

Number of family member involved	Frequency	Percentage (%)
1	-	-
2	2	13.33
3	3	20
4	2	20
5	5	33.33
6	-	-
7	-	-
8	2	13.33
9	1	6.7

Table A7 shows the actual number of family members who helped the participants to implement the programme with 44 family members in total reflecting the overall number of individuals indirectly involved.



4.2 Section B: Programme Relevance to the Community

Table B1: Project Relevance

Relevance	Frequency	Percentage (%)
Strongly not agree	-	-
Not agree	-	-
Neutral	-	-
Agree	6	40
Strongly agree	9	60

Table B1 shows participants' feedback on whether the programme is relevant and needed by the community. All participants strongly agreed that it is relevant and highly needed.

Table B2: Programme Meeting Actual Community Needs

Programme Meeting Actual Community Needs	Frequency	Percentage (%)
Yes	11	73.3
No	-	-
Unsure	4	26.7

Table B2 shows that 73% of participants stated the programme meets actual community needs, while 26.7% were unsure.

Table B3: Programme Benefits

Programme Benefit	Frequency	Percentage (%)
Economy	11	73.3
Education	1	6.67
Social	1	6.67
Environmentally sustainable	1	6.67
Others	1	6.67

Table B3 shows the main benefits of the programme. The majority (73.3%) cited economic benefits, while 26.7% mentioned education, social, environmental, and other benefits.

4.3 Section C: University–Community Collaboration

Table C1: University–Community Collaboration

Awareness of University–Community Collaboration	Frequency	Percentage (%)
Yes	11	73.3
No	4	26.7

Chart C1 shows that the majority (73.3%) were aware of collaboration between UiTM and the Kg. Kayu Madang community, with only 4 participants unaware.

Table C2: Impact of Collaboration

Impact of Collaboration	Frequency	Percentage (%)
Strongly effective	3	20
Effective	9	60
Neutral	3	20
Not effective	-	-
Strongly not effective	-	-



Table C2 shows that 80% believed the collaboration had a very positive impact, while 20% were unsure.

Table C3: Project Model

Suitability of project model	Frequency	Percentage (%)
Yes	13	86.7
No	-	
Unsure	2	13.3

Chart C3 shows that 13 participants (86.7%) agreed the pilot project could serve as a model for future projects, while 2 participants (13.3%) were unsure.

4.4 Section D: Stakeholder Perceptions

Table D1: Programme Support

Stakeholder support	Frequency	Percentage (%)
Strongly agree	6	40
Agree	8	53.3
Neutral	-	-
Not agree	-	-
Strongly not agree	1	6.7

Table D1 shows that 40% strongly agreed, 53.3% agreed, and only one participant was unsure about the appropriateness of stakeholder support for the project.

Table D2: Communication and Cooperation Levels

Communication and Cooperation Levels	Frequency	Percentage (%)
Strongly agree	3	20
Agree	9	60
Neutral	3	20
Not agree	-	-
Strongly not agree	-	-

Table D2 shows participants' satisfaction with communication and cooperation levels, with most expressing satisfaction between the parties involved (MOF–UiTM–JKKK–Community).

Table D3: Project Impact

Project impact	Frequency	Percentage (%)
Knowledge and skills	14	93.3
New occupation	-	-
Additional income	-	-
Uplift living standard	-	-
Care of environment	1	6.7
Others	-	-

Table D3 shows that the greatest impact of the project was in knowledge and skills acquisition.



4.5 Section E: Programme Impact on Changes in Attitude, Knowledge, Skills, and Aspirations

Table E1: Impact on Attitude Change

Impact on Attitude Change	Frequency	Percentage (%)
Strongly agree	5	33.3
Agree	9	60
Neutral	1	6.7
Not agree	-	-
Strongly not agree	-	-

Table E1 shows that 33.3% strongly agreed and 60% agreed that the programme changed their attitudes towards the need for knowledge, skills, and aspirations.

Table E2: Knowledge Enhancement

Knowledge Enhancement	Frequency	Percentage (%)
Highly enhanced	5	33.34
Enhanced	6	40
Neutral	2	13.33
Less enhanced	2	13.33
Not enhanced	-	-

Table E2 shows that 73.3% reported significant knowledge enhancement, especially in freshwater lobster farming and aquaponics systems.

Table E3: Technical Skills

Technical Skills	Frequency	Percentage (%)
Strongly agree	1	86.6
Agree	13	6.7
Neutral	1	6.7
Not agree	-	-
Strongly not agree	-	-

Table E3 shows that 6.7% strongly agreed and 86.6% agreed that the technical skills learned greatly helped them manage aquaponics projects more effectively.

Table E4: Aspirational Changes in Family Economy

Aspirational Changes in Family Economy	Frequency	Percentage (%)
Extremely changed	3	20
Changed	6	40
Neutral	3	20
Minimal	3	20
No change	-	-

Table E4 shows that the majority stated the programme had positively changed their aspirations and perspectives regarding their family's economic future.



4.6 Section F: Participants' Personal Experience

Table F1: Attitude Change

Attitude change	Frequency	Percentage (%)
More proactive	1	6.7
More confident	2	13.3
More open to new knowledge	11	73.3
Others	1	6.7

Table F1 shows that 73.3% of participants became more open and receptive to new knowledge.

Table F2: New Skills

New skills	Frequency	Percentage (%)
Freshwater lobster management	5	33.3
Aquaponic system operation	11	73.3
Entrepreneurship skills	4	26.6
Others	1	6.7

Table F2 shows that aquaponics knowledge dominated the list of new skills learned, followed by freshwater lobster farming and entrepreneurship.

Table F3: Community Inspiration

Community inspiration	Frequency	Percentage (%)
Yes	14	93.3
No	-	-
Unsure	1	6.7

Table F3 shows participants' views on whether the programme inspired the community to engage in more community development projects in the future.

Table F4: Unity and Cooperation in the Community

Unity and Cooperation in the Community	Frequency	Percentage (%)
Strongly agree	2	13.3
Agree	11	73.3
Neutral	2	13.3
Not agree	-	-
Strongly not agree	-	-

Table F4 shows that the majority agreed the programme fostered greater unity and cooperation compared to before.

4.7 Section G: Programme Impact on Practice Changes and Innovation Adoption

Table G1: Daily Practice Changes

Daily Practice Changes	Frequency	Percentage (%)
Strongly agree	2	13.3
Agree	11	73.3
Neutral	2	13.3
Not agree	-	-
Strongly not agree	-	-

Table G1 shows that 86.7% reported adopting new practices in resource management, economic approaches, and eco-friendly habits.



Table G2: Modern Aquaponics Application

Modern Aquaponics Application	Frequency	Percentage (%)
Yes	14	93.3
No	-	-
Unsure	1	6.7

Chart G2 shows that 93.3% intended to apply modern aquaponics in their farming activities.

Table G3: Productivity with Aquaponics System

Productivity	Frequency	Percentage (%)
Very helpful	4	26.6
Helpful	9	60
Neutral	1	6.7
Minimal	1	6.7
Not helpful	-	-

Table G3 shows that 86.6% agreed aquaponics increased efficiency and productivity compared to traditional systems.

Table G4: Main Changes

Productivity	Frequency	Percentage (%)
The use of aquaponics technology	7	46.7
Efficient water management	2	13.3
Care of environment	1	6.7
New entrepreneurship approach	4	26.7
Others	1	6.7

Table G4 shows that aquaponics technology was the main change implemented, followed by entrepreneurship skills, environmental care, and resource management.

Table G5: Innovation Application

Innovation Application	Frequency	Percentage (%)
Very effective	1	6.7
Effective	11	73.3
Neutral	3	20
Ineffective	-	-
Very ineffective	-	-

Table G5 shows that combining livestock and crop production through modern aquaponics had a highly positive impact.

Table G6: Continued Innovation Application

Continued Innovation Application	Frequency	Percentage (%)
Yes	14	93.3
No	-	-
Unsure	1	6.7
Others	-	-

Chart G6 shows that 93.3% intended to continue using innovation after the programme ended, with only 0.7% unsure.



4.8 Section H: Challenges in Innovation Adoption

Table H1: Innovation Application Challenges

Innovation Application Challenges	Frequency	Percentage (%)
Lack of technical knowledge	4	26.7
Financial constraints	9	60
Lack of logistic support	1	6.7
Time constraints	1	6.7
Others	-	-

Table H1 shows that the main challenges were financial constraints (60%), lack of knowledge (26.7%), and lack of logistics and time (6.7% each).

Table H2: Additional Support

Additional Support	Frequency	Percentage (%)
Yes	15	100
No	-	-

Table H2 shows that all participants requested additional support such as advanced training to ensure continued innovation success.

4.9 Section I: Community Empowerment and Sustainability

Table I1: Community Empowerment

Community Empowerment	Frequency	Percentage (%)
Strongly agree	1	6.7
Agree	6	40
Neutral	6	40
Not agree	2	13.3
Strongly not agree	-	-

Table I1 shows that 53.3% felt they needed outside assistance to run projects independently, while 40% were unsure as they needed to understand the type of project to be implemented.

Table I2: UiTM Support

UiTM Support	Frequency	Percentage (%)
Independent	-	-
Minimum support	4	26.7
Unsure	7	46.7
Continuous support	4	26.7

Table I2 shows that most participants were not confident in sustaining modern aquaponics freshwater lobster farming without UiTM's assistance.

Table I3: Knowledge and Skills

Knowledge and Skills	Frequency	Percentage (%)
Very sufficient	-	-
Sufficient	4	26.7
Neutral	6	40



Insufficient	4	26.7
Very insufficient	1	6.7

Table I3 shows that continued knowledge and skills enhancement was necessary for long-term project sustainability.

Table I4: Project Sustainability Measures

Project Sustainability Measures	Frequency	Percentage (%)
Prepare project management timetable	8	53.3
Conduct periodical meetings with community	9	60
Collect fund from community for maintenance	7	46.7
Train more community members	11	73.3
Others	1	6.7

Table I4 outlines measures needed to ensure project or innovation continuity.

Table I5: Dependency on the University

Dependency on the University	Frequency	Percentage (%)
Technical support	8	53.3
Financial support	11	73.3
Marketing support	8	53.3
Others	2	13.3
Not needed	-	-

Chart I5 shows that most relied on the university for financial support (73.3%), followed by technical and marketing support (53.3% each).

4.10 Section J: Sustainability and Future Challenges

Table J1: Challenges or Barriers

Challenges or Barriers	Frequency	Percentage (%)
Lack of operating capital	11	73.3
Lack of advance skills	1	6.7
Lack of leaders in community project	1	6.7
Market volatility	1	6.7
Others	1	6.7

Table J1 shows that lack of operating capital (73.3%) was the main barrier to continuing the project.

Table J2: Commitment to Continue the Project

Commitment to Continue the Project	Frequency	Percentage (%)
Very committed	7	46.7
Committed	5	33.3
Neutral	3	20
Uncommitted	-	-
Very uncommitted	-	-

Table J2 shows that 46.7% were highly committed, 33.3% committed, and 20% unsure.



Table J3: Project Duplication

Project Duplication	Frequency	Percentage (%)
Yes	13	86.7
No	-	-
Unsure	2	13.3

Table J3 shows that 86.7% believed the project should be expanded to more participants or communities, while 13.3% were unsure.

The program yielded significant improvements across multiple dimensions. Post-training evaluations showed a 93% increase in aquaponics knowledge, 94% in technical skills, and 86.7% adoption of sustainable daily practices. Income generation from freshwater lobster and vegetable sales demonstrated a positive trend, with several participants reporting supplementary earnings sufficient to reduce reliance on low-wage jobs. The integration of freshwater lobster farming with green aquaponics aligns with findings from Mohd & Yusuf (2021) and Pantanella et al. (2010), where technology adoption coupled with entrepreneurship training enhances community resilience. The FLP-GAPS 2.0 model also supports the National Agrofood Policy 2021–2030 by promoting efficient resource use, reducing environmental impact, and strengthening rural economies.

Conclusion And Recommendations

The FLP-GAPS 2.0 initiative demonstrates the viability of integrating aquaponics technology with rural entrepreneurship to empower communities, enhance food security, and support environmental sustainability. Key success factors include comprehensive training, strong institutional support, and market integration. Challenges such as limited capital, market access, and technical maintenance require targeted interventions, including micro-financing schemes, public-private partnerships, and the development of cooperative marketing networks.

It is recommended that the FLP-GAPS 2.0 model be scaled to other rural communities in Sabah and adapted for different local contexts. Further research should explore long-term socio-economic impacts, gender inclusion, and the role of digital tools in market expansion.

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