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The importance of good aquaculture practices in improving fish farmer's income: A case of Malaysia

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The importance of good aquaculture practices in improving fish farmer's income

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Abstract

Purpose – The purpose of this paper is to identify the level of good aquaculture practice (GAqP) among aquaculture farmers; and to analyse the factors influence the level of practice and the importance of GAqP in increasing farmer's income.

Design/methodology/approach – Primary data were obtained through a survey conducted on 216 aquaculture pond fish farmers. The descriptive study was employed to identify the profile of respondents and their level of GAqP practices. The structural equation modelling (SEM) method was applied to analyse the factors influence the level of GAqP practice, and the influence of GAqP on the total income of aquaculture farmers.

Findings – The results showed that the pond management by brackish water fish farmers is better than freshwater fish farmer, indicated by 77 per cent of them adopt GAqP at a level of 60 per cent and above, as compared to only 20 per cent by freshwater farmers. Physical and human assets were revealed to be most significant factors influence the practice of GAqP. The results also proved that GAqP was among the significant factor contributes to increasing in farmers' household income; in addition to their other livelihood assets.

Originality/value – To the best of the author's knowledge, this is the very first study that employs SEM method to analyse the relationship between GAqP with livelihood asset and farmer's income simultaneously in Malaysia. Furthermore, since the empirical studies related to GAqP is very few, the study will contribute to development of knowledge in the field of aquaculture.

Keywords Sustainability, Income, Fish farmer, Good aquaculture practices, Level of practice, Livelihood assets

Paper type Research paper

1. Introduction

Aquaculture is the business of producing aquatic animals and plants in managed, unnatural aquatic ecosystems for profit (Boyd and Schmittou, 1999). In Malaysian, aquaculture production increased markedly in the country over the last five years with an annual growth rate of 10 per cent (FAO, 2012). In 2010, the total aquaculture production of 581,048 tonnes had a value of US$875 million (DOF, 2011). The industry was able to create job opportunities for 2,445 local entrepreneurs in 2010. Though this number is comparatively small as compared to other Asian producing countries such as Thailand, Indonesia, Philippines, and Vietnam, the increasing trend recorded has promise for continued growth.

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In Malaysia, aquaculture activities have been identified by government as one of the suitable alternatives to improve the living standards of the rural population who are trapped in poverty. Moreover the current Malaysian Economic Transformation Programme (ETP) recognises aquaculture as key economic area for growth particularly in the rural area (PEMANDU, 2010). Its positive social and environmental attributes make it an attractive entry point to improve the livelihoods of the poor in rural development programmes (Edwards, 2000). Efforts to eradicate poverty were spearheaded by a special programme known as the Development Programme for the Poorest. Among others, aquaculture is one of the activities under the programme. Aquaculture was introduced to low-income farmers in rural as secondary activity to upgrade their household income. The participants of this programme were given various types of assistances such as financial capital, culture equipment, and advisory services at the initial stage of the project. Even, the introduction of aquaculture has been warmly welcomed by the rural population who want to increase their income. However, due to the lack of livelihood asset, either physical or human assets particularly in terms of knowledge, access to information, and experience, most of these farmers ignore particular aspects of sustainability in terms of environmental conservation (Roslina, 2009).

Moreover, due to lack of financial resources and coupled with an excessive price of formulated feeds, farmers rely heavily on low quality agricultural by-products and waste as feeds. These low-quality feeds are moist and unstable in water, and the faecal matter and uneaten feeds can cause major deterioration of water quality in the ponds. These effluents are often drained into general water bodies such as rivers and canals giving rise to other pollution-related problems. The waste and uneaten feed become ideal grounds for the proliferation of many aquatic weeds including the blue-green algae which when consumed by fish, would give the muscle the characteristic muddy taste of freshwater (Guan and Hashim, 2005). Hence, The use of chemical and organic substances, as well as having improperly managed nutritional systems that cause pollution in the surrounding area, not only affect the livestock itself, but also have an impact on the environment and nearby communities (Delgado *et al.*, 2003; Pillay, 1992; Asean Development Bank/Network of Aquaculture Centres (ADB/NACA), 1998; Barg and Philips, 2004).

From this issue arises the question of whether action taken by these farmers in ignoring the quality of the product and environmental conservation would be profitable in terms of production cost savings? The ensuing question is, would it be a loss because of the effect on the environment, specifically water quality, which in turn will influence the growth and taste of the fish cultured? Consequently their production systems are not environmental friendly and outputs from these farms do not conform to safety, hygiene, and environmental standards, making their products unsuitable for export.

In light of the increasing concern about environmental, economic, and social impact of aquaculture development, the government of Malaysia had introduced Code of Conduct for Aquaculture called Good Aquaculture Practices (GAqP) for the various aquaculture systems as guidelines to advocate sustainable and best aquaculture practices. GAqP are a series of considerations, procedures, and protocols designed to foster efficient and responsible aquaculture production and expansion, and to ensure final product quality, safety, and environmental sustainability. Unfortunately GAqP is not a compulsory practice that must be implemented by all farmers, but rather it is adopted on a voluntary basis to qualify an aquaculture farmer to get the Malaysian Aquaculture Farming Certification Scheme (Skim Pensijilan Ladang Akuakultur

Malaysia – SPLAM) that emphasises more on the implementation of Hazard Analysis Critical Control Point (HACCP) at the source (HACCP at source).

Adoption of the practices by producers might be poses a problem because it will require an investment in time, effort, and money, so some producers may refuse (Boyd, 1999). Other producers may adopt the practices that are inexpensive or easy to implement and ignore the others. In order to improve and sustain the living standards of fish farmers in rural areas through adoption of farming system that meets all sustainable criteria, hence the research questions for this paper are:

RQ1. To what extent the GAqP was practiced among fish farmers?

RQ2. What are the factors influence the level of GAqP practice?

RQ3. Is GAqP practice capable to increase fish farmers' household income?

Thus, this paper will discuss the level of practice of GAqP among aquaculture farmers, analyse the factors that influence the level of practice, and the importance of practising the GAqP for improving farmer's income. The rest of this paper is divided into the following sections. Section 2 outlines the review of GAqP and factors influences GAqP practices. Section 3 discusses the methodology. Section 4 presents the empirical results while Section 5 provides conclusions and policy implications from the paper.

2. Literature review

In the last three decades (1980-2010), world food fish production of aquaculture has expanded by almost 12 times, at an average annual rate of 8.8 per cent. World aquaculture production in 2010 was 79 million tonnes, worth US$125 billion included farmed aquatic plants and non-food products. About 600 aquatic species are raised in captivity in about 190 countries for production in farming systems of varying input intensities and technological sophistication (FAO, 2012). Aquaculture contributes significantly to the world food supply, providing around 40.1 per cent of fisheries production (FAO, 2013). Moreover, capture fisheries are being exploited to their sustainable limit and beyond, aquaculture is expected to continue to have an important role (Boyd, 2003).

In spite of the importance of aquaculture to world food supplies, its future will be diminished unless it improves its environmental and social image (Boyd and Tucker, 1998). Aquaculture has become large enough to have significant impacts on the environment and natural resources, and a number of concerns have been expressed by both environmental activists and scientists (Dierberg and Kiattisimukul, 1996; Goldburg and Triplett, 1997; Naylor *et al.*, 1998, 2000). To ensure the sustainable development in aquaculture, the Food and Agriculture Organization (FAO) of the United Nations (1997) had developed a Code of Conduct for Responsible Fisheries and Aquaculture. This Code of Conduct consists of a series of general statements on how aquaculture should be conducted and the statements are addressed to the governments of the world.

An aquaculture association or an individual aquaculturist can adopt a modified version of the FAO Code of Conduct for Aquaculture (Boyd, 1999). The general principles in Codes of Conduct usually are expressed in more detailed Codes of Practice. The statements in Codes of Practice usually are called Best Management Practices (BMPs). The term BMPs often refers to Good Management Practices, GAqP and other terms. In fact, private standards and related certification are becoming significant features of international fish trade and marketing (FAO, 2011). Recent commitments by

major buyers in developed countries to buy only certified seafood, indicate that significant portions of global industrial aquaculture production may soon come under the certification umbrella (Vandergeest, 2007).

However, most developing countries have so far had relatively little exposure to the pressure to comply with quality standards, due to their proportionately smaller volumes of supply into markets where private standards are most prevalent; and most of producers typically supply non-processed or minimally processed fish, while private standards apply mainly to processed value-added products for brands or private labels (FAO, 2011). Currently, the majority of the world's aquaculture fish are produced in Asian countries which represent about half of world exports of fish and fishery products by value and about 60 per cent in terms of quantity (FAO, 2012), and where aquaculture facilities are characterised by the heavy use of many chemical and biological agents, including antibiotics, metal-based compounds, pesticides, other agrochemicals, and animal and human excreta (Sapkota *et al.*, 2008).

Malaysia, being one of significant country in Asia in term of aquaculture production, fully supports the initiatives taken by UN bodies such as FAO (1997) to introduce a Code of Conduct for Responsible Fisheries. The government has already initiated steps to zone specific areas for aquaculture and develop standard for sustainable aquaculture practice that do not lead to ecological imbalances. As a mean to mitigate environmental impacts of aquaculture development, Department of Fisheries (DOF) in Malaysia comes out with a guide line on GAqP for every aquaculture systems. This guide line upholds the standard requires by international body such as FAO and Global Aquaculture Alliance.

At the moment, the practice of GAqP is on voluntary basis (Roslina, 2009). Along this line, DOF Malaysia introduced Farm Certification Scheme or SPLAM (Skim Pensijilan Ladang Akuakultur Malaysia). The objective of SPLAM is to provide official recognition to aquaculture entrepreneurs who have practiced GAqP and environmental friendly concepts to ensure the safety, quality, consistency, and competitiveness of the products based on the criteria, guidelines, and standard determined by the DOF Malaysia. Farmers can obtain quality certification for their products after some period of quality assessment by authorities (DOF, 2004).

The benefits derived from participating in the SPLAM programme among others are to ensure the aquaculture products from the farm meet the food safety standards require by domestic and international market. Second is to assist and expedite the issuance of Health Certificate and Sanitary and Phytosanitary Certificates, so that it does not solely depend on the final product testing. The third benefit is to encourage consumer acceptance of aquaculture product from local farms. Not the least is to assist the development of the aquaculture industry in a sustainable and environmentally friendly manner (DOF, 2004).

However up to now, quantity and quality of the produce was far yet from satisfactory. The issue of production sustainability, employment of improve technology, concept of eco-friendly, and food safety regulations are still challenges facing the industries. Among the constraints were education and knowledge, human greed, irresponsible, short-sighted activities, small farm size and investment, uprising cost of production and weak legislation and enforcement (Mohd Fariduddin Othman, 2010). Hence, because of its potential, aquaculture has been recognised as one the key economic area to be focused in Malaysia ETP 2010-2020, with an objectives to transform a traditionally small-scale, production-based sector into a large-scale agribusiness industry that contributes to economic growth and sustainability based on an integrated and market, and centric model that focuses on economies of scale and value chain integration (PEMANDU, 2010).

There are three key factors that contribute to the low compliance with the quality standard by most aquaculture farmers in developing countries. First, they supply proportionately smaller volumes into markets where private standards are most prevalent, second, they supply non-processed, or minimally processed, fish and seafood, while private standards apply mainly to processed value-added products for brands or private labels, and third, they tend to operate in supply chains with low levels of integration and, therefore, a limited direct interface with retailers and private standards schemes (FAO, 2011). On other aspect, a key criticism concerns the way that certification institutions and procedures do not allow for participation by all stakeholders, especially small-scale fish farmers (Vandergeest, 2007).

For instance, Nowak (1992) found that when a strong attachment to traditional farming methods exists, farmers are unlikely to implement BMPs, which are considered innovations, even if economic incentives were offered to cost-share the initial costs of implementation. This was due to many farmers did not have the managerial skills, additional capital, or the knowledge required to implement and then sustain the new practices.

Even in the case of China, rapid development of shrimp farming industry draws investments from many other industries, but due to the education background and technical skills of shrimp farmers that may not always meet the demands, they are lacking in needed technology, poor understanding of the water quality and feeding method, and poor management render the farmers helpless in case of accidents (Biao and Kaijin, 2007). Co-management arrangement might be one of possible way to increase the participation of rural communities in resource management. The argument is that rural communities have more intimate knowledge of their localities than the state resource agencies, and they also have a greater stake in managing resources sustainably because their livelihoods depend on it (Vandergeest, 2007). Some governments, such as Thailand, may succeed in enticing small-scale shrimp and fish farmers to produce certified aquaculture products for export (Boyd, 2003).

According to Boyd (2003) factors such as farm size, market and operating cost were the main contribution to the adoption of BMPs in aquaculture. It is likely that many large fish and shrimp farms producing export products will adopt BMPs and some of these businesses also will seek environmental certification from one or more certifying bodies in order to protect their image among environmentally aware consumers. Even in Malaysia, big-scale operators however on their own initiative implement GAqP as to comply with the product quality requirement for export market (Mohd Fariduddin Othman, 2010).

Market was identified as one factor influencing the compliance of quality standard. Most of the world's aquaculture is in Asia and most of them sell their products to domestic markets. Consumers in these markets have much less interest in the environmental record of a product than in its cost (FAO, 2011). That is why, farmers tend to be reluctant to change management practices, and they do not respond well to coercion. Fear of failing to comply with regulations (breaking the law) or threats of market losses because of consumer rejection of products produced by practices harmful to the environment have not resulted in willing and widespread adoption of BMPs. Even inducements based on subsidies to offset the cost of implementing BMPS often do not result in satisfactory implementation of BMPs. The best inducement is when adoption of BMPs clearly increases profit (Boyd, 2003). Perceived fixed costs and production uncertainties are real obstacles to BMPs adoption (Stanley, 2000). Nyaupane and Gillespie (2011) found that land tenancy, whether a crop rotation was used, whether

double cropping of crawfish with rice was practiced, farm size, portion of income from farming, and farmer age, education, risk preference, and technology adoption tendencies influenced best management practice adoption among aquaculture farmers.

Thus, there is a need to conduct a study of private standards and certification in fisheries and aquaculture and their implications for fish trade from developing countries (FAO, 2011). Even though, some aquaculture associations are concerned about the possible effects of environmental criticisms on the markets for their products. There is a growing trend of environmental awareness by aquaculture associations, and they are promoting environmentally responsible production methods. There also is widespread interest in the economic advantages of products certified to be "environmentally friendly" (Boyd, 2003). Voluntary compliance with sustainable practices could be enhanced by complementary policy tools and role of governments in aquaculture zone management (Stanley, 2000; Roslina, 2009).

3. Methodology

The research designed to be both descriptive and analytical. The descriptive study was undertaken to describe the level of practice of GAqP among aquaculture farmers. The analytical study was conducted to identify the factors that influence the level of GAqP practice, and to analyse the importance of level of GAqP practice on the income of farmers involved in aquaculture.

The study was conducted in the state of Kedah, Malaysia. In the study the sample were drawn through application of basic mixed method of purposive and stratified random sampling strategy. Based on the list of aquaculture farmers provided by DOF, the total number of aquaculture farmers in Kedah was 894 from different aquaculture systems. There are many aquaculture systems in Kedah such as pen, marine, cage, and pond either in freshwater or brackish water environment. However freshwater and brackish water pond system were selected purposively because these system are very popular adopted among aquaculture farmer and produce higher production as compared to other system. After this procedure, total aquaculture farmers for these two systems were 760, which were 600 farmers from freshwater pond system and 160 farmers from brackish water pond system.

From the list of 760 farmers for both freshwater and brackish water pond system were then stratified by district. There are eight districts in the state of Kedah. However, for brackish water pond system only three districts were involved. The researcher would then independently select a random sample from each district that focus only to farmers involved in freshwater and brackish water pond system. Thus, sampling procedure now consist of one random sample of freshwater pond farmers in eight districts and one random sample of brackish water pond farmers in three districts. Finally an equal number of farmers were selected through random sampling method to make the total sample size of 216 (171 from freshwater farmers and 45 from brackish water farmers) for investigation which represent 30 per cent of total population.

A set of coded structured questionnaires was developed that consist of information on various livelihood assets possession, GAqP criteria, the economics of aquaculture activity and household's income. The questionnaire was developed in the national language of Malaysia (Malay) and the survey was conducted with the help of local research assistants under the supervision of the researchers. A face to face interview with 216 aquaculture farmers was conducted in November to December 2011. Coded data then were key-in in SPSS version 20 Software. In order to aggregate the data, descriptive analysis such as frequency analysis was employed to identify the profile of

respondents and the level of GAqP practice. The structural equation modelling method was used to analyse factors influence the level of GAqP practices, and the importance of level of GAqP practices on farmer's income that involved in aquaculture, using AMOS version 4 software published by SPSS Inc. The hypothesised model was shown in Figure 1, which assumes that all asset categories, namely human asset, financial asset, physical asset, social asset, and natural asset will influence the level of GAqP practices among fish farmers in positive way.

The list of indicators for each category of asset is presented in Table I. Then, the GAqP was hypothesised to have influence over Aquaculture Income Total (AIT) of farmers positively. Besides GAqP, all livelihood assets group were also hypothesised to influence AIT either directly or indirectly. The list and details of the variables used in the model as shown in Table I.

4. Results and discussion

4.1 Profile of respondents

Table II presents the profile of respondents. The result showed the majority of fish farmers (63 per cent) especially for freshwater aquaculture aged more than 50 years old.

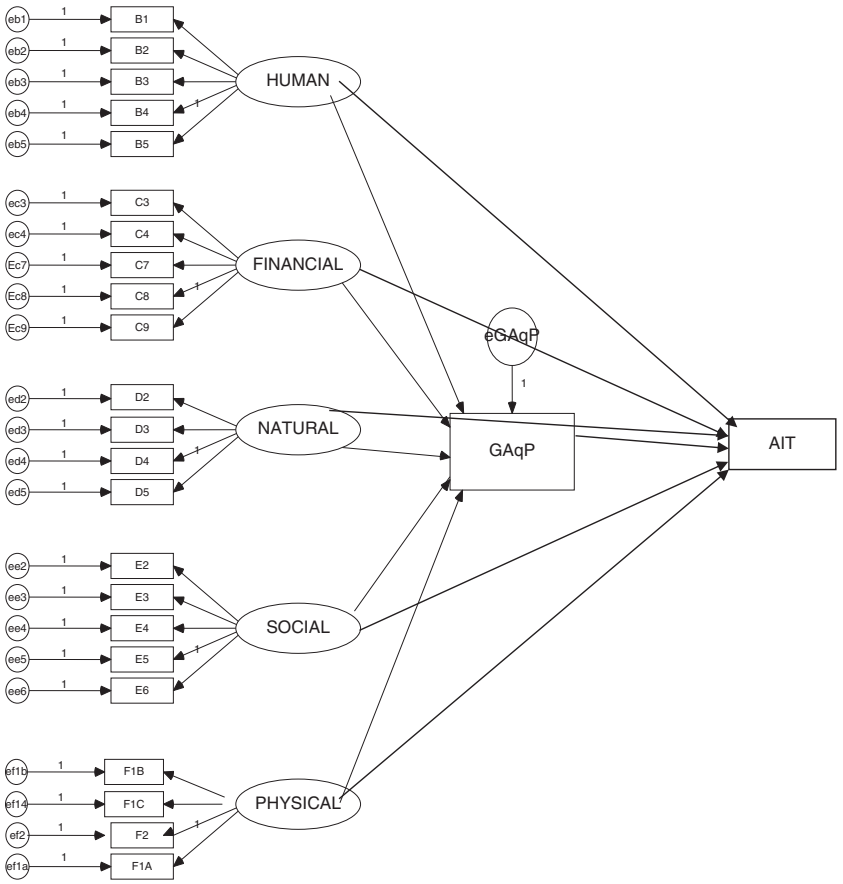


Figure 1.
Hypothesis model related to the factors influence GAqP and AIT

Variable	Description of determining variables	Symbol
Human asset	*Farmer age*	B1
	Level of education of farmer (ranking 1-6)	B2
	1. Unschooled	
	2. Completed primary school	
	3. Completed high school (lower)	
	4. Completed high school (higher)	
	5. STPM/certificate/diploma	
	6. Bachelor degree and above	
	Farmer experience in aquaculture (years)	B3
	Percentage of knowledge level about the basic aspects of aquaculture	B4
	Attendance in courses and training related to aquaculture	B5
Physical asset	Distance of project site with the following facilities:	
	Road	F1A
	Main city	F1B
	Market	F1C
	Sufficient level of pond equipment (R) such as such as nets, paddle wheel, harvest collector container, boats, generators, and other equipment that is a requirement in aquaculture activities	F2
Financial asset	Early investment total (RM)	C3
	Operational cost total used in aquaculture referring to the production costs covering fixed cost and variable cost (RM)	C4
	Financial problems faced by farmer for the duration of the aquaculture operations?	C7
	How much difficulty in getting financial assistance from any parties	C8
	Funding	C9
Natural asset	Overall total of owned land (hectare)	D1
	Total area of aquaculture ponds (hectare)	D2
	Status of ownership of aquaculture land	D3
	Water source of breeding ponds	D4
	Distance between ponds and water source (metre)	D5
Social asset	Level of political party involvement by farmer	E1
	Holding posts/positions in the community	E2
	Farmer involvement in aquaculture-related associations or other farming associations?	E3
	Visits by fishery department staff to your project site	E4
	Total number of contacts among stakeholders	E5
Level of good aquaculture practice (percentage)		GAqP
Total income from aquaculture activities in a month		AIT

Table I.
List of variables used in the model

For brackish water aquaculture, it was found that 63 per cent of fish farmers were less than 50 years of age. The higher profit in brackish water aquaculture, especially for tiger shrimp farming was attracted young people to get involved in this activity. Age factor has an important implication to the modernisation of the aquaculture sub sector, since the elderly are quite difficult to accept the changes and they are more comfortable to conduct their activities in a traditional way (Malaysian Institute of Economic Research (MIER), 1999). However, to ensure the efficiency, productivity and competitiveness of the sector, the introduction of modern technology is a must.

Education level of fish farmers can also accelerate the adoption process of latest technology in aquaculture. The majority of the freshwater fish farmers were made up of those with primary and lower secondary school (74.54 per cent). The education level of brackish water fish farmers however, were quite high with the majority (78 per cent)

Items	Freshwater farmer (%)	Brackish water farmer (%)
Age of fish farmer		
29 years old and below	2.48	6.67
30-39	8.07	22.22
40-49	26.71	35.56
50-59	37.27	24.44
60 years old and above	25.47	11.11
Education achievement		
Never been to school	12.42	11.11
Primary school	49.07	8.89
Lower secondary school (PMR/SRP/LCE)	25.47	35.56
Upper secondary school (SPM/SPMV/MCE)	9.94	26.67
STPM/diploma/skill certificate	1.24	13.33
Degree/master/PhD	1.86	4.44
Experience in aquaculture		
Less than 5 years	62.73	24.44
Between 6 and 10 years	14.29	40.00
Between 11 and 15 years	8.70	17.78
Between 16 and 20 years	4.97	13.33
20 years and above	9.32	4.44
Income per month		
RM999 and less	32.9	2.2
Between RM1,000 and RM1,499	29.8	6.7
Between RM1,500 and RM1,999	16.1	13.3
RM2,000 and above	21.2	77.8
Status of involvement in aquaculture		
Full time	16.00	87.00
Part time	84.00	13.00
Species cultured		
Polyculture	54.04	
Catfish	17.39	
Carp	5.59	
Tilapia	22.98	
Tiger Shrimp		68.89
White Shrimp		20.00
Seabass		8.89

Source: Analysed from survey data

Table II.
Profile of respondents

of them attained at least PMR/SRP/LCE certificates. This is coinciding with shrimp aquaculture system in particular, which requires the farmers who are capable in absorbing highly technical knowledge. Another aspect of human capital is experience in the aquaculture activity, which measured by their involvement in aquaculture activity. Result found that most of the freshwater fish farmers (62.73 per cent) only have less than five years' experience. While, most of the brackish water fish farmers (40 per cent) having experience of six to ten years. In fact, there are 35 per cent of brackish water fish farmers having more than ten years' experience.

Most of brackish water fish farmers (87 per cent) involved in aquaculture activity for full time. While a large portion of freshwater fish farmers (84 per cent) making

aquaculture activity as their part time job to improve their household income. The monthly income of freshwater and brackish water fish farmers also quite different, whereas the majority (62.7 per cent) of the freshwater fish farmers has a monthly income less than RM1,500, while most of the brackish water fish farmers (77.8 per cent) having a monthly income of more than RM2,000. The species cultured for freshwater aquaculture includes carp, catfish, and tilapia. Even, there are freshwater fish farmers (54.04 per cent) that practice polyculture system, which is their culture various species of carps with tilapia in the same pond. While, tiger shrimp is the popular species cultured mostly (68.89 per cent) by brackish water fish farmers.

4.2 Level of practice of GAqP among aquaculture farmers

To determine the level of practice of GAqP, the respondents were asked whether they practise every item listed in the questionnaire, which includes 42 variables of GAqP. The respondents only needed to answer "yes" if they do practise GAqP and "no" if otherwise. For every item that is practised, the respondent will be given a single mark. Then, the total marks obtained were transformed into a percentage. Table III shows the percentage of freshwater and brackish water aquaculture farmers in accordance with the level of practice of GAqP, based on a survey conducted on 216 aquaculture farmers in Kedah. The results revealed that the management of brackish water ponds by operators is better than freshwater operators where 77 per cent of them adopt GAqP at a level of 60 per cent and above, as compared to 20 per cent of freshwater operators. The low level of GAqP practice among freshwater famers especially for catfish is due to the usage of low quality and unhygienic feed and mismanagement of water quality. Although freshwater species such as catfish and tilapia are quite hardy, this is not an advantage for freshwater operators in ignoring the environmental aspects of aquaculture project. On the other hand, findings showed that the level of pond management is quite good among farmers of brackish water ponds. This is due to the biological aspect of the brackish water species such as tiger prawn, white shrimp, and sea bass that require a great deal of care in terms of seeding rate, nutrition, and the environment to ensure quality results at a sufficiently high survival rate.

Environmental condition particularly water quality is an importance aspect in assuring the quality of farmed fish. Fish quality is essential to maintaining product value. Poor quality cannot only reduce value, but could build a poor reputation for a particular farm or an entire industry. As for product safety, certain controls must be used to maintain quality. Food safety problems are rare, but certain problems can result in significant illnesses and costly damage to the industry and product reputation.

Farmers, DOF and buyers share responsibility for the quality and safety of farmed fish. The areas of responsibility begin during fish growth, post-harvest, and continue

Practice level (%)	Freshwater	Brackish water
1-20	0	0
21-40	34.3%	0
41-60	45.7%	22.2%
61-80	11.4%	51.1%
81-100	8.6%	26.7%
Total	100	100

Source: Analysis of survey data

Table III. Percentage of farmers according to the level of practice of GAqP

until product distribution. Likewise, regulatory authorities such as DOF are expected to serve as a "competent authority" or third party providing surveillance and assurances that the fish are produced to provide safe products for domestic and foreign consumption. Farmers and fisheries officers must work in cooperation to assure the safety of the product produced and the sustainability of the project. They should take into account the quality of the resulting product and the quality of the surrounding area to ensure the continuity and longevity of the project.

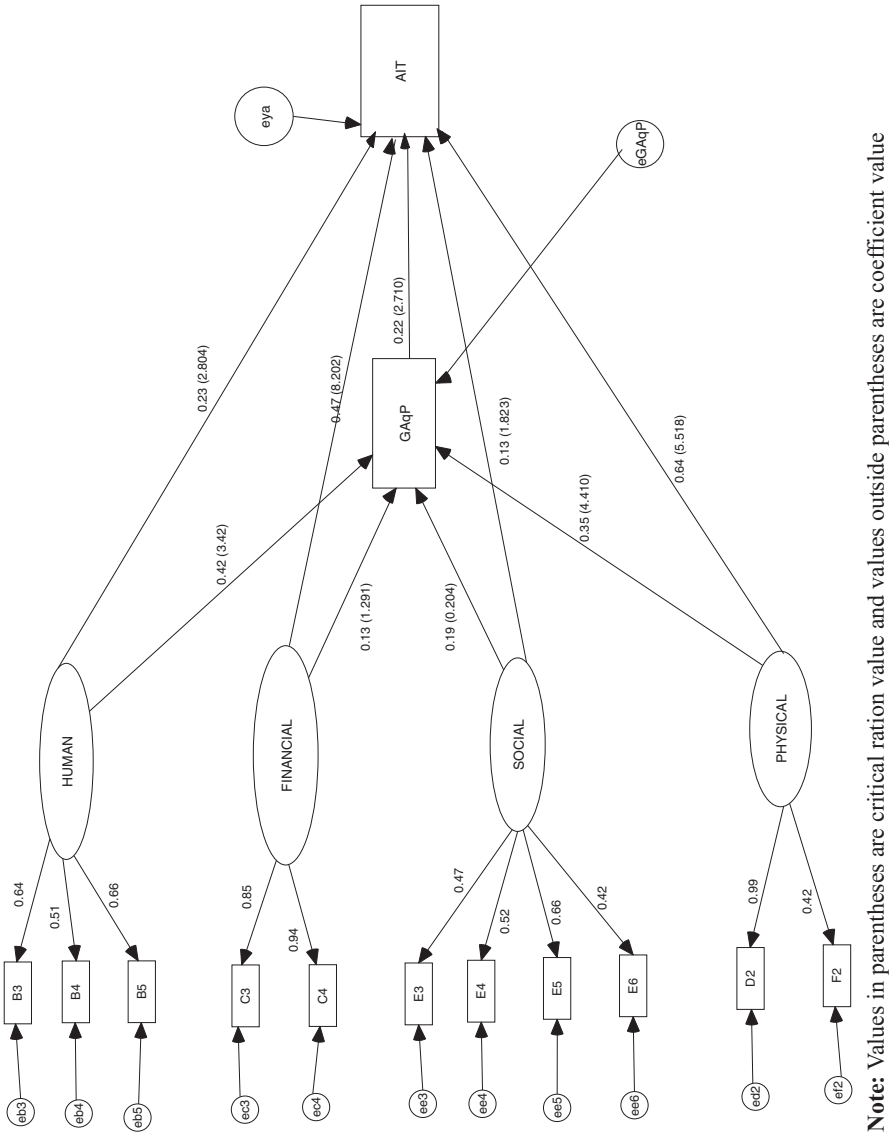
4.3 Relationship between livelihood asset, GAqP, and income

Based on the hypothetical model (Figure 1) in the methodology section, there are five types of assets which are human, financial, physical, natural, and social that affects the level of GAqP practices among fish farmers and their total income. Despite this, the results of the final analysis, as shown in Figure 2 witnessed the absence of natural asset variables in the model. This variable was dropped during the analysis process due to the insignificant of factor loading. Figure 2 shows the results of the analysis model that highlights the relationship between livelihood assets, the level of practice of GAqP, and total income earned by the farmers with the related standardised estimated coefficient value and the critical ratio.

The results showed that the level of GAqP practice significantly affects the amount of income by aquaculture farmers positively, with the coefficient value of 0.22. This finding implies that the higher the percentage of GAqP level by operators, the farmers will get the higher revenue. These findings emphasised on the importance of the level of practice of GAqP by farmers in increasing revenue, while additionally ensuring a better quality of production and the products are safe for consumption by the user.

However, there are other more important factors contributing to the increase in aquaculture farmer income, in particular farmer livelihood assets. The analysis of the physical asset variable, as represented by the total area of ponds and farm equipment owned by the farmer, showed that this particular asset is an important factor affecting the income of aquaculture farmers, with a coefficient value of 0.64. Additionally, the physical asset is the most important factor that contributes to the level of practice of GAqP among aquaculture farmers. This finding support the study by Ohajianya *et al.* (2013), Abbas and Ukoje (2009), and Anyanwu and Ezedinma (2006) states that size of farm is the major factors influencing aquaculture production. Ownership or the right to access land and water has a positive relationship with the variable size of the pond, which is one of the key elements for guaranteed high yield production (Ahmed *et al.*, 1993). A study by Veerina *et al.* (1993) also showed that 85 per cent of farmers in Andra Pradesh, India, who have their own lands, are capable of producing higher fish production quantities than those who carry out aquaculture activities on temporarily owned land.

The same applies when relating to financial assets and human assets. The coefficient values in Figure 2 shows both these assets as having significant effects on the level of practice of GAqP and the total income of aquaculture farmers. For example, for financial assets, the increase in the cost of the investment and operating costs will influence the level of practice of GAqP, and thus increase the amount of income of farmers directly involved in aquaculture. Operating cost in aquaculture is associated with input used. Inputs such as seed, feed, fertiliser, and rearing equipment, is the main requirement in the development of successful aquaculture. According to Drewis (1987), lack of input such as seeds will lead to a price increase for that input, which will be an obstacle to the development of aquaculture, especially rural aquaculture that is dominated by small-scale farmers who lack the financial resources. Normally in order



Note: Values in parentheses are critical ration value and values outside parentheses are coefficient value

Figure 2.
Final model shows the relationship between livelihood assets, GAqP and AIT

to assist these groups, the government would provide incentives for production through subsidies on inputs, such as mentioned above. Access to these inputs should be ensured for continual supply in order to guarantee the survival of aquaculture activities. Even so, it is important to avoid from causing farmers to be too dependent on government subsidies, because these subsidies may not be sustained forever (FAO, 1987).

In term of human assets, finding implies that farmer who has vast experience in the field of aquaculture, has a high level of technical knowledge, and has attended training related to aquaculture, would have the potential to increase the level of practice of GAqP and thus ultimately increase their total income. According to Olawumi (2012), many fish farmers start their enterprises only to abandon them because of their inability to make decisions on the level of intensity to adopt, what capital to invest and how the available capital can be utilised. Due to lack of information, many farmers depend on trial and error, which often lead to failure. Many management techniques relating to feeding, fertilisation, stocking, liming, and monitoring of parameters are not known to them.

In this context, the ability of farmers to gain access to technical knowledge and management skills are essential in the development of aquaculture, which includes matters pertaining to training centres, training concepts, and ability of the teaching staff. In this matter, extension was important in continuing basis, because farmers face different production problems at different stages of development. As in China, Technical Extension Stations were set up at county and township levels respectively with technical personnel had mostly attended local aquaculture training courses and had obtained certification from an aquaculture school. Their offices are located in villages near the fish ponds. Hence, they coordinate directly with farmers on technical matters, such as the prevention and treating of fish disease. They are also responsible for disseminating information among farmers about training courses (Sun and Collins, 2013).

Finally, social assets do not significantly affect the level of GAqP and total income of the aquaculture farmers. Although social assets do not significantly affect the level of GAqP and total income of aquaculture, these assets are still related to financial assets, human assets, and physical assets in reality.

5. Conclusion

There is no doubt that the introduction of GAqP and provision SPLAM can give many benefits to farmers, but the survey data showed that the practice of GAqP among operators is low, especially for freshwater systems due to lack of human assets specifically related to the knowledge and access to information on the practice of GAqP. The positive influence of this asset on the level of practice of GAqP, and total household income, imply that the measures related to increasing knowledge of the farmers should be emphasised. As such, measures that encourage these farmers to attend courses related to aquaculture and increase the number of aquaculture training centres should be taken into consideration.

Besides enhancing knowledge to producers, knowledge of GAqP also could be extended to consumers, to attract them to buy aquaculture products that produced by those who practice GAqP. In spite of that lack of knowledge, those consumers hold a rather negative view of aquaculture. It is hoped that with the knowledge about aquaculture production process, the consumers will have some preference for certified aquaculture products.

Additionally, results of the analysis also revealed that GAqP is one of the important factors that can increase the income of aquaculture farmers. Therefore, a detailed description of GAqP, covering the method of practice, the benefits that can be gained if farmers adopt GAqP, and the effects if they not in comply with GAqP, should be extended to all farmers. All responsible parties, in particular the DOF under the Malaysian Agricultural Ministry, may want to emphasise the adoption of GAqP by making it mandatory for all operators in order to ensure the sustainable development of aquaculture and the safety of aquaculture products.

Of course, in order to prove that sustainable aquaculture development is achieving its goal, a monitoring effort is necessary to show that sustainable aquaculture development variables remain with acceptable ranges. Finally, if monitoring reveals that those variables are outside the acceptable range of food safety or environmental impacts are occurring, only then GAqP enforcement can be implemented by imposing fines or penalties on the defaulting farmers who do not practise GAqP.

To encourage more fish farmers to adopt GAqP, the government may take such initiatives such as giving incentives, subsidies or set a higher price for fish that are produced by those who practice GAqP. This is because production costs for farmers who fully adopt GAqP were higher than those who do not practice GaqP. GAqP emphasis on the use of good quality feed and seed and the use of modern culture equipment to ensure high quality fish produced and competitive at the international market.

The study recognised that the production of safe product from aquaculture was the shared responsibility of governments, industry and consumers, each having an important role to play in the protection of human health. Action at all levels is required for the development of regulations and the provision of resources for enforcement of, education and training in, and research on, responsible practices of aquaculture. There is an urgent need to raise the awareness of fish farmers, especially small-scale rural subsistence farmers, of food safety issues associated with farmed fish and of the impact of the consumption of contaminated food on human health.

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