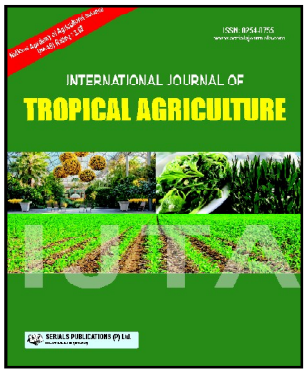

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The Reality and Challenges in Farming the Malaysian Giant Prawn, *Macrobrachium rosenbergii*: investigations in Leveraging the Malaysian Industry of the Malaysian Giant Prawn in Nurturing an Indigenous Niche

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Abstract: Aquaculture of the Malaysian giant prawn, *Macrobrachium rosenbergii*, is expanding worldwide. This study was conducted in order to explore pond management-related reasons for recent fluctuations in Malaysian giant prawn production in Malaysia. The study used in-depth interviews with entrepreneurial pond system producers of the species in the state of Negeri Sembilan, Malaysia, augmented by unpublished data from the site of the Malaysian Department of Fisheries. The study showed that the major causes of production instabilities are lack of good quality seed stock and high juvenile mortality; both of which are in turn likely to be caused by detrimental inbreeding. Better seeds could be obtained by keeping the whole production cycle in captivity and paying better attention to the genetic diversity of broodstock. Furthermore, juvenile grading throughout the production cycle could substantially shorten the production cycle and result in more homogeneous production. Adherence to the recommended stocking density is also important. Utilizing renewable energy could help both to alleviate the problem of water scarcity and to increase stocking rates affected by lack of aeration. A further factor is high feed prices, caused primarily by monopolism rather than supply and demand. This could be eliminated if the Malaysian government could guarantee fairer competition and transparency in this area. Finally, it is vital to attract more large-scale investors if production of the species is to reach its full potential.

Keywords: Not in title.

INTRODUCTION

The enhancement of agricultural sectors, including aquaculture, has been shown to have a strong and positive association with poverty alleviation and economic development in developing countries (Christiaensen *et al.*, 2011; Muhanji, *et al.*, 2011; Ndanga, *et al.*, 2013). Aquaculture, which is the fastest growing agricultural sector in the world (FAO, 2012; WWF, 2015) is expected to boost the existing supply chain of fish in some countries and create new job opportunities that may contribute to economic momentum (Cai *et al.*, 2009; Mapfumo, 2011) such as small food stalls in pasar malam (literally night markets) in Malaysia or bukas (a type of local restaurants) in Nigeria (Cai, *et al.*, 2009; Miller and Atanda, 2011; FAO, 2014,), and thus contribute to reduction of unemployment by providing continuous employment for youth (Chopin, 2015) and reduction of food import bills.

Worldwide, aquaculture provides close to half (47%) of all fish supplies destined for direct human food consumption, (FAO, 2012). In Malaysia, 10% of the total fish produced is provided by aquaculture and currently the fisheries sector as a whole provides direct jobs for more than 111 000 citizens (Department of Fisheries, 2014). Of this proportion, cultivation of the Malaysian giant prawn (MGP), *Macrobrachium rosenbergii*, is gaining popularity because shrimps (including GMP) represented 50% of exported fishery products. All Malaysia, being part of Southeast Asia, a major part of species range (Wowor and Ng, 2007), is virtually suitable for it farming excluding only areas prone to flooding, landslips or storms. The Malaysian prawn is preferred by farmers for its large size, pleasant taste and omnivorous eating habits, and better returns compared to many other agricultural activities.

For all the above reasons, farming of *Macrobrachium rosenbergii* is already important, and is anticipated to have a high future potential, for it is already listed within the exported commodities of Malaysia (Department of Fisheries 2013). With its near-ideal natural environment, well-trained fish biology experts and excellent infrastructure, Malaysia should be capable of developing an even more flourishing industry of this omnivore. Water, the vital input, is very cheap if not free, while land prices and rental are reasonable. Moreover, there is significant governmental aid available in the sector, through the provision of assets such as paddle wheels, seeds and free extension services.

Despite all this, agribusiness companies still seem hesitant to invest in the sector, even though it is highly profitable and does not involve much risk. Results showed that the only event of loss when a viral plaque-white spot syndrome virus or (WSSV) hit the country (NACA-FAO, 2011). Nevertheless, worries about disease and other constraints have led to production being lower than might be expected, resulting in fluctuations in the amount of total crop of Malaysia within the recent fourteen years (Figure 1).

Fluctuations of the Produce of *Macrobrachium rosenbergii* (metric tons) in Malaysia (2000-2013).

The current study was conducted through in-depth interviews with investors in the entrepreneurial pond culture system of the GMP in Negeri Sembilan, in order to investigate the reasons behind these declines and fluctuations in production.

METHODOLOGY

The data and information used in this paper were collected from available literature, unpublished data on the website of the Department of Fisheries (DOF), and from in-depth interviews with main stakeholders in the entrepreneurial pond culture-based GMP industry in the Malaysian state of Negeri Sembilan. The goal of the interviews was to explore in depth the respondents' views, feelings and perspectives concerning all aspects of their GMP farming agribusiness. For this purpose, intermediary persons were contacted in order to select suitable interviewees, as the address sheet available on the

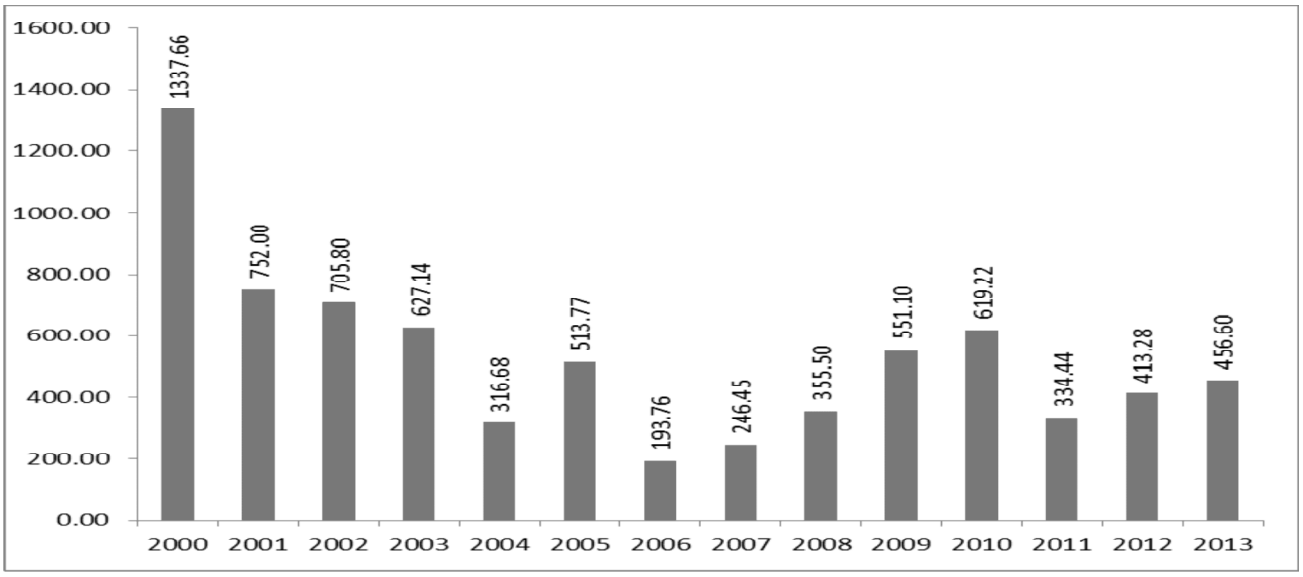

Figure 1

website of the DOF was not up to date. The interviewees were selected through different intermediaries based on purposive sampling. None of the informants was previously known to any of the research group or the interviewers. Earthen ponds method, used by prawn farmer in the study area, is the main method used in freshwater aquaculture in Malaysia, practiced in 55% of freshwater aquaculture enclosures (DOF, 2013).

The interviewees were concentrated in the district of Kuala Pilah, because aquaculture itself is unevenly distributed within the state and, additionally, the major water source of springs are also uneven in their geographical distribution.

Interviewers made appointments with respondents at least a week before conducting actual interviews with them. All discussions were held on site, in order to allow the interviewers to conduct a transect walk to see at first hand the relevant farming conditions as well as to minimize the disturbance to the respondents' work. The questionnaire consisted of three parts: first, the personal data of the GMP farmers in the state; second, their occupations and the organization of their businesses; and third, their current pond management data, including any problems facing them. Negeri Sembilan was chosen for this study because it is a major production area of GMP as well as for its relative geographical proximity to Singapore, to where especially significant quantities of live prawns are exported (DOF, 2013). Moreover, Negri Sembilan is also quite close to Kuala Lumpur, in which the bulk of Malaysian middle class income earners live. This class, as well as the rich, spends substantial amounts on recreational fishing, especially during weekends. These sport fishing ponds allow more people to fish while sustaining wild stocks.

The results presented in the sections that follow are first-wave (initial) results. The intention is that further waves will follow in due course, based on an updated and revised questionnaire and with wider coverage of all the major producing states in the country in order to produce a comprehensive survey.

RESULTS AND DISCUSSION

Farmers and Land Tenure

The data in this study are based on a small sample size due to the unwillingness of some farmers to share cost and profit information for commercial proprietary reasons, as well as to the inherent constraints of using in-depth questionnaires to study

a single or small number of units such as giant Malaysian prawn under entrepreneurial pond culture system in Negeri Sembilan, Malaysia. A similar unwillingness to share information for the same reasons was observed in a value chain analysis of aquaculture in Kenya, reported by Ndanga, *et al.*, (2013). In the case of the present study, we were also constrained by our concern on research ethics.

The group of GMP producers who agreed to participate in the study were generally of middle age when they got into the business, and had a reasonable level of education (secondary school or above) which may have been a factor in their decisions to become pioneers by adopting a relatively new technology such as GMP farming in spite that they had no direct background in fish breeding. This dovetails with what was reported in Mozambique (Uaiene, *et al.*, 2009) on farmers' adopting new technologies. Earthen ponds method is the main method used by prawn farmers, hence a summary of key data on the earthen ponds used by respondents together with a flowchart of the activities carried out by their relevant entrepreneurial pond management stakeholders are presented below in the table given below.

Table 1
Criteria of Entrepreneurial pond culture system of GMP, *Macrobrachium rosenbergii*, in Negeri Sembilan

Feature	*Criterion*
Number of ponds	4-25, with most having less than 20
Pond length (m)	1500-2100 m
Pond width (m)	12-45 m, with most between 20-30 m
Pond depth (m)	0.9-1.8 m, with most around 1.5 m
Pond construction cost (USD)	3000
Water depth (m)	1.2-1.5 m
Electricity and fuel consumption (USD)/ month	50-420
Water maintenance	Pump and ventilation
Stock population (PL_{45}) m^{-2}	Mostly more than 20 pieces.
Feed	Starter feed (38% protein), grower feed (30% protein).
Length of cycle (months)	Mostly more than 5 months.
No of prawns per Kg	30-50 pieces
Type of harvesting	Continuous, beginning at 4 months of stocking up to 8 months (every two to three weeks) without replacement.
Survival rate (%)	60-70%
Production kg^{-1} $pond^{-1}$ $cycle^{-1}$	2500-3000
Pond repair interval (years)	Mostly every 3 years.
Time required to empty pond (hours)	4-48 hours, with most less than 6.
Facilities (offices, residential stores, vehicles etc).	Most possess these. A residential area, fridge, area is provided when workers do not live in a nearby village.
Nursery operation	Seldom practice
Nursery period (days)	Seldom, 45-60 days
Record keeping	Seldom
Source of fry	Hatcheries in Perak and Kedah states

Contacted prawn farmers had voluntary registered their business with a view of getting bank loans and government assistance. A small proportion of them had registered their business names in order to be able to bring in foreign workers.

The majority cited better returns as the reason why they had opted for GMP production under the entrepreneurial pond culture system rather than other agricultural activities such as tilapia aquaculture or

coconut or banana farming. In fact this system of production adopted by these farmers and chosen for this study inevitably involves significant capital investment, as paid labour completely takes over from family labour in routine farm operations. But currently, that is after more than twenty years in business, most farmers are approaching senior citizenship stage, thus age–and the lack of succession are constraints confronting planning to expand, because, unfortunately, most of their sons and daughters desert the business in favour of a job in a big city for just having a different life style but not a better payment. But still, a few families with clear longer-term business plans send their sons to study animal agriculture-related sciences so that they can develop the business, expand it further, and keep the family name alive. On the other hand, younger medium-income entrepreneur farmers who do GMP farming as a part-time job have a desire to expand; but they are worried about the risks and uncertainties associated with the agribusiness, so they are not fully involved in the business.

In sum, what can be anticipated in the future is that while the individuals involved may change, GMP farming will continue to expand until it exhausts all available suitable land.

Interviewed farmers generally did not adhere to keeping records after the first few cycles of production, mainly because they run a family business in which detailed accounting is not really required. This is in contrast to cooperative farms, with their many and heterogeneous stakeholders, where good record-keeping and professional, transparent management are necessary.

The vast majority of the respondents did not adhere to recommended sustainable practices, simply because they felt that these practices had no tangible benefits for them and no direct effect on their sales.

Land tenure in the study area is a complicated issue, as most of the land is inherited and thus has multiple owners. Interestingly, those renting the land are mostly men, while the land owners are mostly women; this is because the area is dominated by the Minangkabau clan, which is a matrilineal society that passes communal land ownership entirely through the female lineage (Stark, 2013).

Water Sources

All the GMP farms included in this study depend solely on spring water from creeks on which small dykes are built. So, their ponds were largely free of agricultural residues such as fertilizers and pesticides.

Farmers use the continuous flow water system, mainly to dilute waste metabolites produced by their cultured species, to aerate their ponds and to replace water loss by evaporation and percolation. This system is water intensive, thus, there is no guarantee that such huge quantities of water will be continually and reliably available for the rest of this century, given the prevalence of extreme weather events such as a decrease in the number of rainy days in South-East Asia within the last twenty years (Trenberth and Hoar, 1997; Manton, *et al.*, (2001); which were reported to negatively affect groundwater levels (Bosma and Verdegem, 2009). In Malaysia, nobody will forget the dry spell of 2014 that even affected municipal water supplies in big cities such as Kuala Lumpur, forcing the authorities to introduce water rationing affecting about 90% of the residents (Tan, 2014). By the same token, many of our respondents confirmed that the dry spells of 2014 had drastically affected their business. A number of farmers were forced to keep lower quality pond water, as their ponds might otherwise have dried up and they would then have lost their whole GMP crop.

Most of our respondents feel that there is no problems with water quality, thus they only look at water colour when monitoring its quality. Virtually none of them consider buying water quality measuring devices as a priority even though these instruments, while expensive, are crucial tools that every pond-based commercial fish farmer should possess. So, some faced pH or salinity problems that

rendered their ponds unsuitable for GMP culture. Moreover, some farmers disclosed that they had even observed their prawns trying to jump out of the water when it rained after a long dry spell due to the sudden change in the chemical properties of the water (when it rains, run-off water can carry eroded soils with different chemical properties in sufficient quantities to affect pond water characteristics.

Ultimately, tackling major environmental problems such as soil erosion and climate change impacts will require a strategic approach at a national and international level. However, the farmers themselves could take actions to mitigate potential water scarcity problems during dry spells. For example, they could invest in increasing the capacity of their dykes and harvest rainwater. This harvested water could be pumped into elevated emergency tanks during times of abundance using solar cells or wind mills in order to guarantee a smooth flow when water is in short supply. In addition, this energy could be harnessed to provide increased aeration in ponds, providing scope for vertical expansion. Encouragement of renewable energy sources would better be by installing a hybrid renewable energy source on the premises of the Farmers' Association with the Department of Fisheries organizing visits for farmers to see the example.

Pond Stocking

Quality and quantity of seed are further vital elements for the GMP business to flourish. As the vast majority of respondents revealed that they faced problems in getting PL to stock their ponds, sometimes having to wait as long as three months. This has resulted in fluctuations of production through recent years.

One of the reasons for this low productivity is high PL mortality rates, which may in part be caused by the practice of selecting small numbers of broods on the basis of their readiness to spawn rather than their genetic merits (Mather and De Bruyn, 2003; New *et al.* (2009); Kitcharoen, *et al.*, 2010; Nair and Salin, 2012), leading to cumulative inbreeding effects. In accordance with reported results in India (Nair and Salin, 2012) Malaysian hatchery operators were found to collect broodstock from the same farms they previously supplied with seeds.

To compensate for this mortality, farmers tend to deliberately stock more than recommended. Farmers when asked tell that they stock PL45 – PL60, but counting the larval period, which not appropriate for the term. Consequently they actually stock newly transformed PL, which face high predation as a result of a large majority of farmers not using nets to protect their newly stocked ponds from predators' entering. In addition, the feed offered is not suitable for PL at this age joined with the ponds being not conducive for zoo plankton growth resulting in PL to die of hunger. High PL mortality may in turn have affected PL prices, which are generally expensive in Malaysia at around 20 USD for 1 000 PL (this study), compared to other countries in the region. For instance, PL prices in Thailand were estimated to range between 1.9-2.2 USD for 1 000 PL (Na-Nakorn and Jintasataporn, 2012). However, although the Thai GMP industry faces similar problems to Malaysia and India, loss of genetic diversity and inbreeding effects have had a much smaller impact on their production levels (FAO, 2010). This may be because, according to Charoentawee *et al.*, 2007, Thai hatchery operators (unlike their Indian and Malaysian counterparts) tend to pool broodstock during the collection process without regard to their source or origin, which may have the unintended effect of broadening their genetic variation resulting in heterozygosity ranges comparable to those of wild populations (0.69-0.70). Information on the heterozygosity of GMP populations in Malaysia is available only for wild stocks, with the range being 0.53-0.83 (Abdul Razak 2011). Regarding foreign sources of GMP seeds, the Malaysian Ministry of Agriculture and Agro-based Industry informed us that, as of December 2014, no company had applied to import seeds of the GMP species from anywhere abroad.

On another hand, neglecting nursery period, which is stocking newly produced postlarvae (PL) in smaller ponds for eight weeks and grade them before stocking them in the main pond may have increased the cost of production (the table). As a few farmers who practice it were able to significantly reduce the production cycle and get five cycles in two years instead of four cycles without such a nursery period. Moreover, nursing results in homogeneity of the produce.

Some interviewees also claimed that PL brought from neighbour countries were all males, larger in size as a result; on the other hand, others mentioned that, although foreign-sourced PL are cheap, they are also delicate and so more likely to suffer illness, injury or death.

Actually, seed production in the study area is limited, making bringing seeds from distant states the only choice. Investors may have been discouraged by pollution reported in the estuarine of Malaysia (Law, 1995).

A permanent strategic solution for this seed problem would be to keep the whole production chain under complete captivity, keeping in mind that the genetic diversity of broodstock is of paramount importance in the breeding and management of this species. Broodstock should be collected from a variety of different ponds to prevent an accumulation of detrimental inbreeding effects and to guarantee genetic diversity. Furthermore, this would completely eliminate the risk of bringing disease in from the wild. Using molecular biology for regular checks of genetic diversity could also be practical and affordable; as such tests are becoming cheaper.

Feeds and Feeding

The giant Malaysian prawn growers generally buy feed, fertilizers and other chemicals through company venues. But they are sometimes forced to buy from local stores, at higher prices. All the producers complained about increases in the price of feed. As a result, feed availability and quality is a major obstacle for the aquaculture industry as a whole (FAO, 2005). Regarding this issue, the dilemma is that good quality imported feed is expensive, while some locally produced pellets are of low quality. Actually, all feed suppliers are venues for one company resulting in an outright monopolism of the commodity. Consequently, farmers have no choice over where to buy from. It is high time for the government of Malaysia to protect these small farmers.

Farmers provide two additional types of concentrated feed

Starter (mash form) and grower feed (pelleted), with crude protein contents of 38% and 30% respectively (the table) with prawns being rationed according to their age and body mass. Regarding information on the feed composition, the company just confirm that protein and fat ratios are satisfactory and ash and moisture are within permissible levels.

Moreover, this study showed that feed cost for one hectare pond under the improved method mentioned above is around 845 USD compared to 1030 USD under the conventional method.

Most of the respondents felt that there was no need to fertilize their ponds. This is true when a complete diet is offered. But with feed prices escalating, feeding complete diets may become increasingly expensive. So, it is far better to give only supplementary feeding and fertilize as reported by (Tidwell, *et al.*, 2013).

Pond Preparation, Chemical Manipulation and Predator Control

Pond repair is another problematic issue, as the overwhelming majority of respondents are renters, which makes it difficult for them in terms of cost benefit analysis to take decisions to repair enclosures that they might have to leave in due course. One possible solution to this problem might be to include in rental contracts a clause providing for compensation to be paid to renters for any repairs

they have carried out on ponds within a specific period (say a maximum of three years) prior to the termination of the lease. Respondents mentioned that they dry their ponds at the end of each cycle. However, some farmers stated that they rarely see the bottom of their ponds, indicating that drying is not complete which may lead to an increase in competitive unwanted fish populations and thus negatively affect the following season's production.

HARVESTING

As GMP is produced for commercial purposes, we should take a hard look at the market for the product. In 2009 shrimps collectively (including GMP) represented 50% of fishery sector exports in Malaysia. The Major local customers are recreational fishing ponds which are expected to expand more because of the growing the growing middle class and the rich as well.

The export market is also recreational ponds in Singapore. The mean selling price, for both local and export customers, depends on the grade (size) of prawn. Prawns weighing 30-35 pieces per kilogram sell for approximately 16 USD. However, prices as high as 23 USD/kg can be earned for a grade with 6 to 7 pieces per kg.

Finally, larger-scale investment is greatly needed to improve and expand the GMP sector in Malaysia. This task should be tackled by the Department of Fisheries, as well as by investment and commercial attachés in Malaysian embassies that could help to persuade larger companies to bring international capital to GMP aquaculture.

Weaknesses in information transfer resulting in farmers learning from their neighbours and friends. Farmers could not be blamed, even if educated, for not mining the internet to get knowllege.

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