CHALLENGES AHEAD IN MEETING AQUACULTURE PRODUCTION IN MALAYSIA UNDER THE THIRD NATIONAL AGRICULTURAL POLICY, NAP3 (1998-2010)

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ABSTRACT

Following the impact of the 1997 Asian financial crisis, Malaysia fast made a revision on its agricultural food production policy to ensure the sector's contribution to the national economy, and for its global competitiveness to continuously remain strong. As a testimony of the government's commitment, the Third National Agricultural Policy (NAP3) and its action plans was formulated and endorsed in the year 1998. Within the potential and importance of fisheries as food security, commodity, potential foreign exchange earning was highlighted and given a significant task—to balance out food import bill (BOT) which has indicated a deficit for a long time. The increase in production and contribution was set to come from the aquaculture sector, which is currently not fully utilized. Government will capitalize the vast production area which is still available, and not the least to employ advanced technology, which enables high productivity yet with environment-friendly approach. The target was set at 662,000 metric tons to be achieved by and beyond 2010. The main commodity singled out from aquaculture food production are marine shrimp (180,000 mt), marine fish (122,000 mt), fresh water fish (230,000 mt), cockle (130,000 mt) and sea weed (125,000). In a move to get closer to the production target and to boost the country's image as a producer of quality aquaculture products, the government introduced best aquaculture practices management and food safety programs. However, it will need a few years more before the policy year-end quantity and quality of the produce to become satisfactory. The issue of production, sustainability, employment of improved technology, concept of eco-friendly, food safety regulations and the likes are still the challenges currently 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. While the relevant authorities continuously take initiatives to improve the approach, there is an emerging need to improve, adopt health management through stock improvement by means of domestication, selective breeding program and bio-security measures. The government is keen in attracting foreign capital and appropriate know-how to develop and assist in this program.

Key words: Malaysian NAP3, aquaculture production, challenges

INTRODUCTION

Similar to other nations in the region, fish and fish-based products are important to the daily diet of Malaysians. Majority still depend on this type of food as the main source of animal protein. Most of Malaysians put more preference on marine fish than the fresh water fish, because it is tastier despite a much lower market price of the latter fish. The particular demand may be justified by the fact that Malaysia is surrounded by sea. Apparently, there is also very little natural productive area in the country for fresh water fish production. Note that fish, being a cheap source of animal protein makes an average Malaysian consume more of it than any other animal protein. Though there is no statistical data to show

the passed consumption rate, the record for the year 2000 indicated an average per capita consumption of 49 kg per capita. An increase to 53 kg per capita in the 2005 was further recorded. The trends are expected to rise further to 56 kg per capita in the year 2010. For such high consumption rate, Malaysia will definitely be ranked as among the country with the highest fish consumption in the world.

The important of fish as food is further reflected in the expenditure of the household. On the average, this comprises about 20 percent of their food budget (8th Malaysian plan). With the increase in number of population of the country and increase in health consciousness among people, apparently current local production will not be able to meet the goal of the country being self-sufficient in fish within the coming years. Basically, the self-sufficiency was only 89 percent in 2000. This was slightly increased to about 90 percent in 2005 and is expected to slightly increase to 94.3 percent in 2010.

Despite serving to meet national food requirements, sometimes the sector is being overlooked in any of the national development program as contrast to other agricultural products. It is probably because of the belief that natural catch is still sufficient to support local needs; and not the least, it is considered as a non-economical and traditional investment . Another salient point to note is that all this while the nation is being supported at significant amounts by industrial crops such as oil palm and rubber. The turning point, however took place after the 1997 financial crisis when the nation started to feel the impact of global economic downturn. As a result of negligence and poor awareness on requirements to look on sustaining food production, the agricultural sector had caused the nation a huge financial debt and as a result, it continuously records a huge food import deficit. In the year 2004, this was about US$1.75 billion (Arbi Musa, 2005).

Following the impact, the agricultural sector and fisheries as a whole were given a facelift. The government had foreseen a need to ensure that the sector's contribution to the national economy and its global competitiveness remain strong in the future. As a testimony of the government's commitment, the Third National Agricultural Policy (NAP3) and its action plans were formulated and endorsed in the year 1998, as a revised version of the NAP2. Several new strategies were incorporated in the NAP2 to deal with expected challenges and changes to the international economy (Anon, 1998; Musa, 2005). The latter policy was first formulated in 1992 and targeted to end by the year 2010. The first NAP (NAP1) on the other hand was endorsed in 1984. In particular, the formulation of the policy is to adopt a development framework in order to sustain and direct the development of the agricultural sector. Among the issues, which demand the need to formulate the policy were increasing liberalization in agricultural products and the rapid process of industrialization within the country during the period (Anon, 1984). In response to the crisis, the NAP2 was revised.

THE THIRD NATIONAL AGRICULTURAL POLICY, NAP3

The Third National Agricultural Policy (NAP3), covers the period 1998-2010. Overall, the NAP3 is set to provide the policy framework for the future growth of the agricultural sector into the next millennium. Overriding the objective of NAP3 is maximizing of income through optimal utilization of resources in the sector. Beyond that, the policy has underlined five specific objectives to be achieved. These are: (1) To enhance food security, (2) To increase productivity and competitiveness of the sector (3), To deepen linkages with other sectors (4) To create new sources of growth for the sector, and (5) To conserve and utilize natural resources on a sustainable basis.

It is in the NAP3 that the potential and importance of fisheries was first highlighted and was given a significant task. Its contribution as important food source and significant income contributor will be capitalized. Effort will be undertaken to increase its production by means of deep sea fishing and aquaculture on a commercial and integrated basis.

THE ROLE OF FISH FOOD SECTOR UNDER NAP3

Beside its traditional role as food supply for the country, the fish food sector is trusted to enhance food security, which means it needs to increase its production and contribution. Second, the sector is to become an engine that has to contribute to national income and export earnings. Third, is to maximize income of the producers and for poverty alleviation. The expectations and high hopes placed on the fisheries sector were practically based on the basis that the aquaculture sector in particular can produce

Table 1. Food export and import bills in year 2004

Commodity	Exports (RM million)	Imports (RM million)	Trade balance (RM million)
Livestock	1005.2	2696.3	-1691.0
Fish products	2073.0	1935.0	137.9
Agricultural	4337.5	7778.4	-3440.9
Others	2513.8	4144.8	-1631.0
Total	9930.0	16554.5	-6625.0

Source: Ministry of Agricultural Malaysia, 2004

Table 2. Fish production from marine landings and marine aquaculture in the year 2000-2004

Year	landing		aquaculture		total	
	Volume (mt)	Value (RM mill)	Volume (mt)	Value (RM mill)	Volume (mt)	Value (RM mill)
2000	1,285,696	4399.23	117,205.56	665.34	1,402,901.56	5,064.57
2001	1,231,289	4166.11	133,562.79	958.01	1,364,851.79	5,124.12
2002	1,272,078	4206.81	145,439.81	843.49	1,417,517.81	5,050.30
2003	1,283256	4013.62	146,926.82	931.09	1430182.82	4,944.71
2004	1,331645	4241.45	146,668.04	903.38	1478,313.04	5,144.83

food at competitive costs. Aside from that, the country still has a vast suitable area for the industry development. Last, but not least was from an economic standpoint. Previous records of earnings indicated that the fisheries sector was a clear contributor to national economy (Table 1).

RECENT FISH PRODUCTION AND REQUIREMENTS

Annual production of fish from marine sector in Malaysia from 2002 to 2004 was about 1.4 million metric tons which valued slightly more than RM 5 billion. The bulk of the production or close to 90 percent of the contribution came from captured fisheries sector. An average 10 percent of the share of the product is from aquaculture. This amounted to about 1,200 to 1,400 metric tons, which was valued between to RM 700-900 million annually during the last five-year period (Table 2). Overall, brackish water aquaculture contributed an average of 70 to 75 percent of the total aquaculture production. In terms of quantity, a big chunk or about 30 to 40 percent and 10 to 20 percent of marine aquaculture production were from cockle rearing and seaweed cultivation, respectively. Pond-based production, which is typically for shrimp aquaculture and cage system contributed at about 5 and 15 percent respectively, in terms of fish volume in marine aquaculture sector. Despite the low volume, products from this sector earned the highest trading value in fishery product.

Generally, marine fish contributed to more than 70 percent of local demand. Despite the volume, this constituted mainly lower grade species such as mackerel, sardines, scad and tuna. Besides economic reasons, it is worth noting that eating habits and dining style of Malaysians, especially the Malay ethnic group, which is the majority, is inclined towards small-fish servings. The big or high-value fish such as crustacean is normally served in restaurants and is of high demand during festive season and ceremonies especially among the Chinese community. Except cockle and mussel, fish from marine aquaculture sector generally do not really supply the needs of ordinary people.

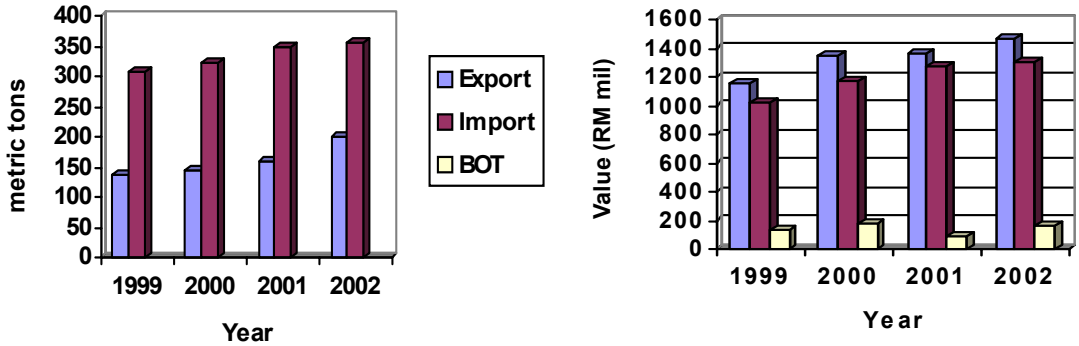

Fig. 1. Quantity, value and effect to BOT in import and export of fishery commodities

As a result of the continuously high demand of small-and-lower grade fish species, Malaysia needs to import fish as a means to ensure enough supply for its people. On average, this was between 300,000-350,000 metric tons of fish and its products during the year 1999–2002. The import bills that came with the expenditures were between RM 1000-1300 million (Fig. 1). The increase in volume arrived at 406,000 mt in 2004 (Table 3) with import bill of RM1,935 million. Majority of the imported fisheries commodities were from neighboring and traditional countries such as Thailand, Indonesia, Singapore, as well as China (Table 4).

As a source of income, Malaysia exports most of its high-value fish to foreign market. Among the commodities are shrimp, high-grade fish and mollusk (Table 3). The bulk of these commodities were sent to United States followed by Singapore, Japan, Europe Union (EU) countries and China. During the period 1999-2002, the amount of the products was between 130,000–190,000 mt. The earnings that the country gained from export of these high value fishes during the same period were between RM 1.1–1.4 million. Subsequently, this was more than 238,000 met and valued at RM 2.072 million in 2004. Apparently, the trading brought in positive gains to the country by as much as RM 90-182 million during the year 1999-2004 (Table 3, 4).

AQUACULTURE DEVELOPMENT UNDER NAP3

The fact that there is very little landings from inland fisheries and the typical Malaysian which puts preference to marine fish has prompted the need to put on much weight to increase production from the marine sector. Apparently, however, landings from the coastal water which supplies more than 80 percent of the fish sources was already fully utilized and practically will not contribute extra. Reliance on deep sea resources however, was not taken seriously by locals. Till the end of 2004, the deep-sea fishing fleet stands at only 761 units. Still a small fleet, it practically will not bring any significant changes to marine landing to the country within these coming years. Hence, the only area left is aquaculture.

Thus, the government came up with strategies to develop marine aquaculture and it was clearly defined under the Third National Agricultural Policy (NAP3) 1998-2010. The sector is trusted with the task of enhancing food security and creating income to balance out food import bills (BOT) which had shown deficit for a long time.

As it looks forward to the status of becoming a developed country, Malaysia recognizes the significance of sustainable aquaculture as an integral part of efforts to develop its natural resources. Malaysia is on its way of putting up efforts to increase its aquaculture production. An area that is given attention is the shrimp and marine finfish aquaculture industry. Various institutions and government agencies had been given the task to commercialize this sector, get involved in research, training and development. On the other hand, mindful of the rising labor shortage in Malaysia, the government policy is to promote capital-intensive large-scale commercial shrimp aquaculture farms. We promote mechanization and automation whenever feasible. Farms are encouraged to operate on an integrated and self-sustaining basis. Fry and feed production, processing and packaging, as well as marketing, are built into these vertically integrated systems.

In achieving these, Malaysia as well encouraged partnership. The government is also

Table 3. Main export and import of fisheries commodity, Malaysia, 2004

Commodity	Exports		Imports	
	Volume (mt)	Value (RM 10^6)	Volume (mt)	Value (RM 10^6)
Live fish	8332	74,941	4502	24,792
Fish-fresh, chilled or frozen	79,836	188,526	317,892	980,719
Fish–dried, salted or in brine, smoked	1,495	9,351	1,834	9,254
Crustacean & mollusk-fresh, chilled, frozen, salted dried	116,992	1,446,864	60,259	772.792
Crustacean & mollusk– prepared or preserved	31573	353,267	21,709	147,484
Total	238,229	2,072,229	406,190	1,935,041

Source: DoF Malaysia, Annual Statistic

Table 4. Malaysia's major trading countries, 2004

Export			Import		
Country	RM (million)	value (%)	Country	RM (million)	value (%)
USA	527,808	25.46	Thailand	465,146	24.04
Singapore	226,836	10.94	China	272,275	14.07
Japan	210,056	10.13	Indonesia	245,234	12.67
Italy	157,971	7.62	Singapore	161,722	8.36
China	112,297	5.42	Vietnam	161,093	8.33
Others	837,982	40.42	Others	629,571	32.54
Total	2,072,950	100		1,935,04	100

interested in attracting foreign capital and appropriate know-how whenever it is available to develop this sector through environment-friendly technologies.

While recognizing aquaculture as one of the thrust areas for development, the government of Malaysia is fully aware of the growing concerns over sustainability and environmental impact of shrimp aquaculture. Human greed, coupled with profit-driven, irresponsible, shortsighted activities, are prohibited to tarnish the image of aquaculture. In the step towards realizing this, the impacts of aquaculture on coastal eco-systems including mangroves, water and soil quality, as well as socio-economic linkages in rural communities, are being carefully studied.

Malaysia fully supports the initiatives taken by UN bodies, such as FAO (FAO, 1997), to introduce a Code of Conduct for Responsible Fisheries. The government has already initiated steps to zone specific areas for aquaculture and developed standards for sustainable aquaculture practice that do not lead to ecological imbalances. Legislative measures on code of practice for shrimp aquaculture and establishment of fish health management programs of international standards are under active consideration (FAO, 2004).

CURRENT SITUATION OF AQUACULTURE IN THE NATIONAL ECONOMY

Recently, aquaculture from marine sector contributed about 133,000 to 146,000 metric tons annually. This represented about 8 to 33 percent of total fish production in the country (Fig.2) (Table 5). There are six major sectors which contributed to the production. The most and traditional contributor is from cockle cultivation. In 2004, this was 44 percent. Pond and mainly shrimp production added to about

22 percent. The next major contributor was from seaweed cultivation with a share of about 21 percent. Production from cages, mainly finfish and raft, mainly mussel, each contributed to about 6 and 7 percent, respectively.

According to a recent Malaysian Fisheries Annual Report (DoF, 2004a), fisheries production as a whole contributed between 1.37 to 1.73 percent to the national GDP during the year 2002 -2004 (Table 6). More than 85 percent of the contributions were from marine fisheries landing and the contribution from aquaculture sector as a whole was about 15 percent for the past four years or so. Majority or slightly more than 70 percent of the share were marine aquaculture origin.

Breaking down the marine aquaculture production yielded an estimated 0.11 to 0.14 percent on GDP . These monetary gains were mainly generated from the trading of 145,000 to 147,000 metric tons of fish and its products, which were worth at a wholesale value of RM 843.5 million to 931.1 million. Further generating income, this sector, at that time, provided job opportunities to about 4,000 to 4,200 people (Table 6). The number represented about 20 percent of the workforce in aquaculture-related activities during the last four-year period.

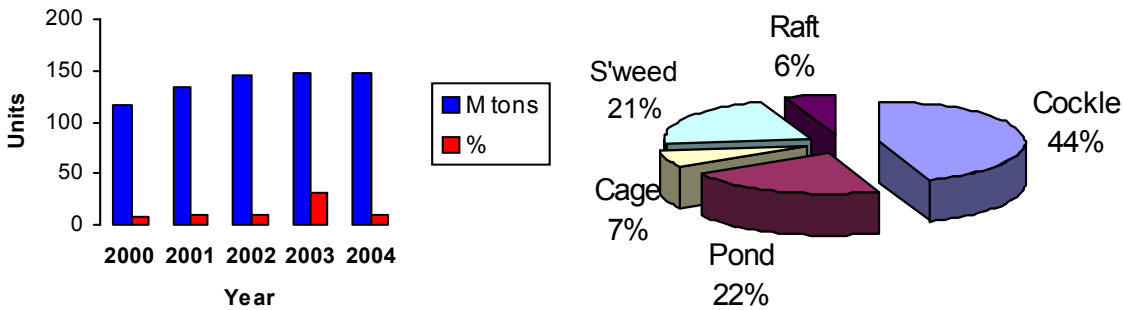

Fig. 2. Annual production and contribution according to system from brackish water culture sector, 2004

Table 5. Production, Income and labor involve in respective aquaculture activities during the year 2002-2004

	2002			2003			2004		
	Mt '000	RM mill.	men	Mt	RM mill.	men	Mt	RM mill.	men
Inland	46.40	237.7	17074	49.95	241.2	16679	55.57	255.1	17298
Marine	145.44	843.5	4090	146.93	931.1	4435	146.79	903.4	4209
Total	191.84	1081.3	211644	196.87	1,172.3	211144	202.24	1,158.5	21507

wholesale value

Table 6. Contribution of marine aquaculture (in percentage-%) to fisheries and national economy during the year 2002-2004

Parameters	2002	2003	2004
GDP	0.13	0.11	0.14
Employed in aquaculture	19.3	21.0	19.5
Fisheries	20.0	13.3	13.2
Volume (mt)	75.8	74.6	72.5
Value (RM)	78.0	79.4	78.0

Note: Fisheries to GDP - 1.5% (2002); 1.37% (2003); 1.73% (2004)

AQUACULTURE STRUCTURE AND PRODUCTION

Marine Shrimp

Marine shrimp culture operation is considered finished after 120 days of culture period. For shrimp, harvesting is usually done by draining the pond and attaching a net around the outlet pipe to trap the shrimp. The harvested shrimp is then washed using the waste-water from the pond. The shrimp left in the pond is then collected manually. Before harvesting, the buyers take a random sampling to determine the average size and its price. Ex-farm price of black tiger shrimp of 40 pieces/kg ranges from RM 20-25. White shrimp (*P. vanamei)* of standard size (70 pcs/ kg) deserved an ex-farm price between RM12-15. Buyers provide ice, boxes and also transportation for the shrimp to be sent to processing plants. The distribution channel for cultured shrimp is straightforward. Buyers are also processors or exporters.

Most of the products are for export markets and only a significant quantity goes to local markets such as restaurants, hotels or other retail chains. Despite the vast market, like elsewhere in Asian countries, the industry is vulnerable to threat from disease and impact of fluctuating prices in the world market. It is also set to the subject of market regulation and traceability issues, which may slow down production from small-scale farmers. In terms of new area, not much can be developed if there is a boycott of shrimp from mangrove area. This is further hindered by competition in terms of production costs between major producing countries. Labor wise, Malaysia is on the disadvantage side. Presently, most of the farms employ foreigners to run their operations. As the government is tightening the procedure for entry however, if Malaysia could make use of fuel as its strong point to reduce cost of production, probably the industry can have more space to remain competitive.

Marine Finfish

Marine finfish is considered marketable at about 500 grams. However, different markets may take different sizes. Consumers in Hong Kong prefer 600g to 1.2 kg sizes for live grouper. There are two modes of marketing channels. One is to local markets and the other is to overseas, mainly Hong Kong. Species cultured for local market are mostly seabass, various species of snapper and black grouper. The ex-farm price for seabass is between RM12-14 per kg, black grouper and snapper is between RM18-25 per kg. Despite that, local market for live marine finfish is very .limited to festivals and the peak season for consumption is around January-March, coinciding with the Chinese New Year.

On ordinary days, the main outlet is Chinese seafood restaurant. The price of fish in restaurant is at least double than that of the farm. Export markets are fish of high-value such as tiger grouper and mouse grouper. The price is reflected in international market.

For live finfish, handling and packaging are given a serious attention to ensure the best price. Shipment of fish from cages to local market or to holding tanks or nets is done by using truck equipped with an aerated seawater tank. Shipment of live fish is done in two ways. One is actual packing in plastic bag and the other, usually in large quantity is by Live Fish Transport Vessel (LFTVs), usually owned by a Hong Kong importer. Fish in plastic bags are commonly for airfreight transportation. They are placed at about 4-5 kg per bag in a four- layer plastic bag followed by a final packing into styrofoam boxes or simply into cardboard boxes.

Typically the practice of production for live fish market will not see drastic scale increase of the production in the near future as expected by government, which was stipulated in NAP3. First, it is constrained by seasonal demands and second, there is a dilemma to suit the changing demands of market which needs multi-species of production. In addition, the industry is vulnerable to the supply of seed and space to expand the operations. Disregarding the result of ever-changing species and seasonal demands, seed is still a major constraint in the development of traditional fish such as seabass. While practically the number of suppliers is enough, most of them, however are practicing pond-based production system which are adversely vulnerable to infection and poor survival, hence the quality delivered to farmers. Due to seasonal demand and multi-species fish, culture operation in nature also affects seed supply. Seed producer is in dilemma on upgrading its system. On space of culture, there seems little to be done as the area is restricted, and is further vulnerable to carrying capacity and increasing coastal water pollution problem. Unless deep sea cage or land-based system is employed, the future direction of this industry is limited.

Mollusk

By large, production from cockle cultivation, green mussel and oyster are sold at a local market through middlemen. The retail price of a kilogram of cockle is RM1.50-2. Raw mussel usually has a retail price of about RM5. The dried form may fetch a retail price of about RM12-15. In volume, fresh oyster is still small and mostly sent directly to seafood restaurants or hotels. A piece of fresh mussel may fetch an ex-farm price of RM 1-3. Typically a nature-given commodity, harvest from cockle cultivation depends largely on availability of suitable mudflat area and environmental free-pollution zone. Future plans to expand the cockle, mussel and oyster culture may look into consideration the aspect of seed supply, effect of harmful algal bloom and food safety issues. The food safety issues need to be addressed with rigorous environmental monitoring and quality controls.

Seaweed

Singularly a Sabah product, main commercial species culture is *Eucheuma. cottonii*. Environmental conditions around the Sabah coastline are generally favorable for the culture of the species. Many of the operators there are of Filipino ancestry. Seaweed is sold as a dried item. It takes approximately 9 kg of seaweed to produce a kg of its dried form. Seaweed culture is a low capital investment and has a fast turnover. According to a report by DoF recent record of seaweed production showed that in general, it is still profitable from steady production volume (DoF, 2004a). Seaweed from Sabah is mainly for export market mainly to Denmark. Its dried form is sold directly to exporter without using any middlemen. Usually the latter assists farmers by providing its aquaculture facilities, hence an obligation to sell the product back. The price for a kg of dried form is about RM1.50.

Of late, however, not many people wanted to get involved in the culture of seaweed because of better opportunities in other sectors. Beside price incentive, commercial production of it is quite risky as the price generally fluctuates and harvest largely depends on good sun-drying condition. In addition, future expansions need to take into consideration conflict with trespassing of fishing boats and promotion of tourism industry.

GOVERNMENT ORGANIZATION AND SUPPORT SERVICES FOR AQUACULTURE

Training Centers

Presently DoF has two training centers to cater to marine aquaculture related activities (DoF, 2006). Another center will be built within the next two years with specialization in brackish water grow out. Besides catering for local requirement, both the centers also train overseas participants, mainly those under Malaysia Technical Cooperation Programme (MTCP) which was established for aquaculture since 1989. One of the center situated north of peninsular Malaysia is Institute of Marine Aquaculture (IAM), Pulau Sayak, Kedah, which was established in 1987. Among the courses offered at the center are marine finfish seed production, finfish aquaculture in cages, marine shrimp seed and grow out program, seed and grow out production of oyster and as mussel and feed formulation for farm practice (DoF, 2006). The second training center for marine aquaculture in Malaysia is Marine Finfish Production and Research Centre (MFPRC) Tanjung Demong, Besut, Terangganu, located at the east coast of peninsular. At MFPRC, courses offered are marine finfish fry production and cage culture operation.

Existing and Proposed Alternative for Technology Transfer Mechanism

In making a concerted bid to develop the aquaculture into a major industry by 2010, the government of Malaysia through DoF had put emphasis on the acquisition of technology through research and development (R&D) and by means of training mechanism to acquire and transferring of technologies.

Technology Acquisition through R&D

Realizing that private sectors play a critical role in spurring development in this sector, but may not be keen in investing in research yet due to long-term results, the government practiced a joint project. The area that needs utmost attention is in quality seed production, an example is in production of SPF broodstock. Aside from that, the government, too, will provide high-grade broodstock to farmers as a means to initiate them to produce high-quality seed. To facilitate research in such areas, the government

will develop staff capabilities and skill in areas such as biotechnology, genetic engineering, breeding and disease. At the same time outsourcing mechanism may be adapted to bring in external knowledge.

Training as Mechanism of TOT

It is an obligation also on the part of DoF to provide knowledge and technology to both present and future aquaculturists. With an increasing demand from the industry and to fulfill manpower requirement for development available, facilities are being upgraded and newly built ones will increase the number of participants to enable more enrollment and access to facilities. On side to that syllabus is improved and personnel upgrade. As a latest development in this aspect, the DoF, alongside with the National Vocational Training Authority (MLVK) launched a training school to produce qualified skilled manpower in various fields of aquaculture.

Present Training Activities and Future Requirements

Currently DoF is officially conducting eight training programs in brackish water/marine aquaculture as listed in Table 7 in two of their training stations specializing in brackish water/marine sector. Included in the syllabus of these training programs are subjects such as disease diagnosis and water quality management. In the near future, no doubt additional programs are needed to be included. Areas that are most likely to be included are finfish broodstock management and spawning, and management and application of recirculating system.

Table 7. Training program in marine aquaculture conducted by DoF in 2005

Title of the training program	Duration (days)	Intake per year (head)
1. Fundamental aquaculture practice	7	20
2. Seed production and management of marine finfish	30	15
3. Cage culture of brackish water finfish	5	15
4. Seed production and management of marine shrimp	20	20
5. Culture and management of marine shrimp in pond	12	20
6. Feed formulation and preparation at farm scale	3	20
7. Seed production and culture of oyster	30	20
8. Seed production and culture of mussel	14	20
9. Giant fresh water prawn seed production	30	20

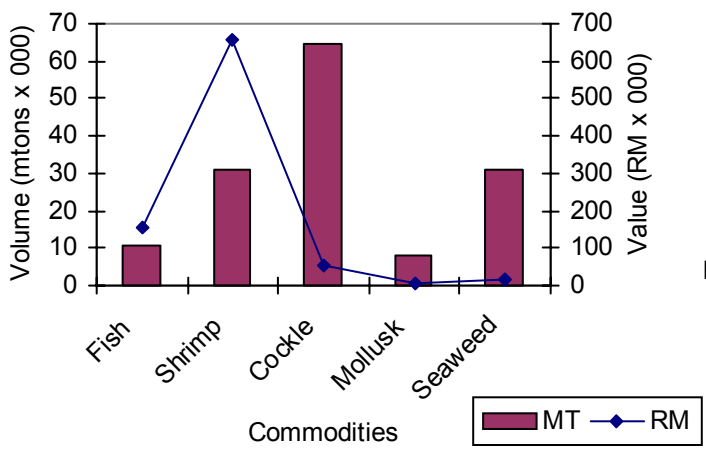

Fig 3. Quantity and value from mariculture production based on commodities in 2004

Existing Major Aquaculture Species

Mariculture activities in Malaysia constitute of products from five major commodities. The commodities are finfish, shrimp, cockle, mollusk and seaweed. In terms of volume, cockle stayed put as the highest quantity of aquaculture product. In the year 2004, its production was close to 64.56 million metric tons. The next highest production was from seaweed cultivation which produced 30.96 metric tons. This was followed by shrimp production which contributed 30.84 million mt.

During the same period, finfish culture brought in about 10.51 million mt of fish; and harvest from mollusk culture was 8.17 million mt. Despite the volume, income generated from the sale of cockle production ranked third or equivalent to RM54.2 million. In general, shrimp production continues to dominate the income earning in aquaculture. In 2004, this was recorded at RM 656.5 million. The second income-generating production was from finfish culture trading. During the same year, this was recorded at RM157.48 million. Each of the seaweed and mollusk generated an income of RM15.48 and RM4.60 million respectively in 2004.

Recent Achievements in Aquaculture Development

Following a decision by government to increase fish production through aquaculture under NAP3 thrust plan, various strategies were put forward and implemented since 1998. Marine shrimp in particular was given priority as a commodity to generate income and hence contributed to foreign currency earning.

However, the planned development was not expected due to the following reasons: diseases, land matters, market regulations and price fluctuation as well as competition with those from labor extensive countries. For these reasons, production from marine aquaculture from 2000 to 2004 as a whole did not indicate much development. Obviously, annual growth rate of about 20 percent is expected under NAP3. In the early years of its implementation there seemed to be a jump albeit temporary. After a slight jump of about 13 percent from about 117,000 mt in 2000, production from marine aquaculture almost did not indicate any development even until 2004. The contributions were maintained in the range of 133,000 to 146,000 mt annually. From an increase of about 8 percent in the year 2002, the three consecutive years after that showed only an annual increase of one percent.

STATUS OF TECHNOLOGICAL DEVELOPMENT IN AQUACULTURE FARMING

Marine Shrimp

The sea around Malaysia has a habitat of more than 15 species that are classified as commercial marine species. Of these, five are of very high export value and form the backbone of seafood trading in the country. These are the black tiger shrimp (*Penaeus monodon)*, the banana shrimp (*P. merguiensis/ indicus)*, the flower shrimp (*P. semisulcatus)* and the greasy back shrimp, (*Metapenaeus ensis).* Despite having different varieties, only the black tiger shrimp is cultured at commercial scale ever since. However the popularity of the black tiger shrimp is slowly taken over by the Hawaiian white shrimp (*Penaeus vanamei)*. The illegal introduction of the species was recorded since 2000. Despite being prohibited species, illegal production during the year 2003 to 2005 was estimated between 5,000 to 7,000 metric tons. Considering the yet unsolved disease problem in black tiger shrimp, the government finally took a stand to legalize its culture effective April 2004. Nevertheless, in a step to contain disease transmission, there is still a control on fry and brood stock entry into the country.

Many traditional black tiger shrimp producing countries will see a transitional period in the coming years. Hawaiian white shrimp is expected to take over the leading role in shrimp aquaculture industry if there is nothing is yet to come out towards revitalizing the black tiger shrimp's species culture operation. While hoping for something better, the DoF is always encouraging farmers to put interest in culturing local white shrimp (*P. merguiensis)*. Rather not a new entrant, this local shrimp species was already being cultured at some scale prior to a shift to Hawaiian white shrimp. The product as a live shrimp market was mainly shipped to Singapore. Besides the Hawaiian white shrimp factor, poor interest was shown toward accepting local white shrimp as an aquaculture organism for sometime due to a fact that it shows poor-growth-performance under high-culture density. In the long run, however, the problem could be solved through selective breeding program. Such practice was proven effective in shrimps like *P. vanamei*, *P. stylistoris* and *P. chinensis* alike.

Being a great income-generating species, the government looks forward to increase shrimp from aquaculture production. Under NAP3 the target was set to achieve a production of 150,000 mt (Table 8) on or before 2010. Concurrent to that, various contingency measures were undertaken, of which the utmost attention is given to increase culture area.

With the scale of production to achieve, an estimated total of 30,000 ha pond area is needed. This means a four-fold increase in area compared to the present one (Table 8). Though the set target needs to take a longer time due to reasons such as land matters, diseases, market issues and regulation plus the ever increasing production from labor-extensive countries. The set target will partly be achieved if a very drastic and holistic action is to be implemented.

Fry Production

Presently there are about 50-60 number of fry production centers which supply the seed to growout farmers. Though these production centers were built for the production of the black tiger shrimp, lately, majority of these centers shift to the production of Hawaiian white shrimp. Sometime in 2005, three hatcheries facilities were granted permit to import SPF Hawaiian white shrimp broodstock.

On the government side, there is the National Prawn Fry Research and Production Centre (NAPFRE), a training and research facilities for marine shrimp. There is also one fully bio-secured hatchery system that is capable of producing clean/ SPF *P. monodon* fries. Also included are two to three others with 'partially' bio-secure system belonging to well-established aquaculture companies such as CP and Grobest that adhere to the production of black tiger shrimp.

Overall, there was a rather static development in this sector at a small-scale level. Among other things, this is attributed to inconsistent demand, strict quality requirement of fry and the demand for warranty after some period in pond. System wise, most of the hatcheries are indoor types and capable of producing 20-30 million seeds per year. Beside chlorination as a mean to treat water, it is also a common thing to see local hatcheries system equipped with extra gadget such as UV or ozone facilities. There is also a trend towards application of biotechnology products such as probotic bacteria, bioremediation and enzyme. Due to space and limitation, most hatcheries apply a single-tank system to complete the fry production cycle. Only those few established ones have a separate larval and nursery tanks for that purpose.

With regard to black tiger shrimp (*P. monodon*), currently local supply of the brood stock are still sufficient. In fact, following the interest on Hawaiian white shrimp (*P. vanamei)* saw the demand on black tiger shrimp dropped drastically from time to time. In terms of volume and quality, stock from east of Malaysia mainly from Sabah waters is sorted after. Once, those from the strait of Malacca was good enough. But lately, majority of the stock are found to be carriers of harmful pathogens. As a biosecurity approach, it is already become a practice for spawners to be screened for MBV, WSSV and TSV pathogens. Except small scale operators, which do direct spawning or purchase only *nauplii* larval stage, the procedure may not be adhered so strictly. There are a few wild spawners- collecting centers

Table 8. Shrimp culture status in Malaysia, 1995-2004

Year	Acreage (ha)	farmers (number)	Shrimp production (metric tons)	
			black	white
1995	2,623	1,010	6,779	NA
1996	2,958	971	7,748	NA
1997	5,910	931	10,385	NA
2000	7151		17,231	NA
2002	7813	1150	23,987	845
2003	7011	1239	25,375	804
2004	7555	1252	25,721	5,118
2010*	30,000		150,000	

* Projected figure based on NAP3 (1998-2010)

that deliver such products to small scale operators. The price for a million *nauplii* of black tiger shrimp is around RM400-600 whereas gravid broodstock is priced at RM200-250 apiece with a body weight size range of 130-160 g.

Pond Operation

Once, shrimp pond in Malaysia is synonymous with mangrove swamp area. However, it is slowly making way to less critical and better areas such as coastal land, abandoned coconut estates or paddy field which is close to infrastructure and facilities. Water source is supplied by means of pump or connected by canals. Commercial farms integrate reservoir and sediment ponds to cater for their operation in ensuring good quality water supply. Aside from that, separate inlet and outlet drain is installed. Be it a small-scale or commercial operations, by large, rectangular ponds of 0.5-1.0 ha dominate the present system of operation. The depth is usually 1.2- 1.5 m. Water exchange made is less frequent or reservoir is made as one of the accessory and facility in the farm. Pond sizes are in the range of 0.5-1.0 ha. Ponds structure and design are of several types. The most common ones are earthen pond. Ponds with plastic lining represent a small portion of the system. Though available, ponds with concrete wall structure is slightly rare.

In a belief to sustain water quality and increase productivity, of late farmers put aside investments on various biotechnology products. Some of these are bacteria domination compound, enzyme, yeast, inert feed, simple sugar and vitamins. A common practice for tiger shrimp culture is to stock fry at PL stage 15-20, however for Hawaiian white shrimp (*P. vanamei),* this is done at PL 7-10.

Under present system, stocking are applied at 30-40 for black tiger shrimp (*P. monodon)* and up to 120 for Hawaiian white shrimp. Prior to stock in, responsible farmers will do the acclimatization and selection as a final step to guarantee that only quality and healthy fries are stock in. Fries are delivered through a plastic bag.In a standard plastic bag of 5-8 liters, fries are packed between 500-1,000 per liter. As criteria for fry quality, farmers insist on disease test and certification aside from adhering to physical, microscopic observation and stress test implementation. In ensuring sufficient oxygen supply, paddle wheel of single or double blades are installed between four to six pieces per pond. Aside from that, long-arm paddle wheels of six or more blades are also installed at some corners to sweep and accumulate left over feed from the feeding area. In feed adjustment process, feeding trays of 1 sq m usually will be hanged between four to six in number per pond. Feeding commences with a rate of twice per day and is increased to four and up to six to eight times daily upon reaching the harvesting size. During the process, various types of lime are applied to stabilise the water pH. Harvest usually commences upon the shrimp attaining size of 30-50 pieces per kg for black tiger shrimp and about 70 pieces for Hawaiian white shrimp

Marine finfish

Despite having a known activity existing at about the same time as that of marine shrimp aquaculture practice, the development of marine fish in Malaysia was however slow and less dominant. One of the prominent reasons are, it is overshadowed by the black tiger shrimp (*P. monodon)* farming activity that once attracted people from all levels as it was a fast and lucrative source of income at that moment. Another single factor is: it is not a land-based activity, hence it is restricted to certain small areas. Being still at the infancy stage, the industry thus still holds the concept of traditional farming. Almost all of the produce come from open floating net-cages and is basically of small-to-medium-sized cage farms. As a commodity that contributes to national economic and food security, the government has put a target production of 120,000 mt to be achieved by year 2010 through aquaculture venture. Presently this amounted to about 10, 500 mt (Table 9). In terms of value, the sale brought in about RM158 million as an income to the country, an increase of about 24 percent to that of year 2002. Hence, with the target to achieve and having the demand for fish increasing, there is a need to change the concept of subsistence farming to commercial scale by all means.

a. Species of interest

In Malaysia, sea bass (*Lates calcarifer)* culture started aquaculture proper during the '70s. Like other Asian countries, this sector as well is characterized by the culture of a range of fish species regarded as high value. The choice of which is related to availability of seed stock and the ever-changing preferences of consumers in Hong Kong to Singapore. The species are also being switched when current stocks are affected by disease problems. Since the last five years, the number of species coming into play increased drastically

Table 9. Production in metric tons and wholesale value in RM million of main fish species during 2002- 2004

Fish species	2002	2003	2004
Asian sea bass	4003.73	4210.93	4000.54
Mangrove snapper	591.44	706.56	572.97
Yellow snapper	1556.15	2351.55	2,263.33
Red snapper	989.68	1402.09	1,162.85
Grouper	1210.43	1977.33	2,283.59
Tilapia	283.97	222.07	264.42
Total (metric.tons)	8635.4	10,870.53	10,547.7
Fish species	2002	2003	2004
Asian sea bass	46220.13	49,260.86	46,241.57
Mangrove snapper	6157.05	8415.69	7,742.36
Yellow snapper	20,188.00	32,491.55	32,771.81
Red snapper	12,951.31	18,513.27	14,687.02
Grouper	30,385.26	49,954.09	54,628.69
Tilapia	1683.98	1049.09	1,387.08
Totalx000	117,585.73	159,684.55	157,458.53

following the success of breeding either locally, or fries that were brought in from outside the country. Presently, at least 10 species of fish are being cultured throughout the country. Still leading in the culture practice is the traditional species, sea bass (*Lates calacarifer)*. Next to it is the *Lutjanidae*, which comprise of yellow streak snapper (*Lutjanus lemniscatus)*, mangrove snapper (*L. argentimaculatus)* , John's snapper (*L. johni)* and red snapper (*L. erythropterus)* (Table 10). The interest in grouper has led to at least six species already being introduced. Among the common ones are tiger grouper (*Epinephelus fuscoguttatus*), orange spotted *(E. coiodes)* and Malabar (*E. malabricus*.) Other minor species are fourfinger threadfin (*Eleutheronema tetradactylum)*, cobia (*Rachycentron canadum)*, pompano (*Trachinotus blochii*) and not the least is the red tilapia.

b. Seed production

Seed supply still poses a constraint in the development of marine fish culture in Malaysia. Quiet a significant amount is still being imported from neighboring countries such as Indonesia, Thailand and Singapore and as far as Taiwan. Beside seeds, eggs are also brought in. At present, local seed production centers are still too small to supply the demand especially when dealing with multi-species way of fish production. Moreover, most are still crude in approach, hence it does not always meet the requirements to supply good quality seed for a sustainable grow out farms. To supplement the demand, there are two typical seed production system employed. These are the tank or hatchery system and the pond-based system. Unofficial record indicated that there are currently12 land-based fish hatcheries on operation. Two of them are government research and training centers, which on occasions distribute their produce to farmers. Each of the private hatcheries has a capacity to produce about 0.5-2 million fries per year. As a complete setup, some of these hatcheries maintain broodstock whereas the other still needs to acquire eggs from outside.

To supplement further seed requirement, there are more than 50 fry production unit that adopt earthen or partially concrete ponds as their production system. Each of the unit employs three to10 ponds of 0.1-0.5 ha on average. The operation starts with hatching of eggs in hapar installed in pond or in separate tanks put closed to the pond. A few days after hatching, when the larvae are ready to consume outside food, they are released. Prior to that, ponds are enriched with live food that consists of organic or inorganic fertilizers. Being low capital and food-chain based, survival from this production system is between 1-5 percent on the average. In fact, on occasions when natural food availability is insufficient, nothing is produced. However, production from this sector is quiet significant. Often, each farm can produce between 0.2-1.0 million fingerlings per year.

Table 10. Species of interest in mariculture in Malaysian waters

Commodities	Common name
Sea Bass	
Lates calcarifer	Barrahmudi, giant sea perch
Snapper	
Lutjanus lemniscatus	Yellow streaked snapper
L. argentimaculatus	Mangrove red snapper
L. johni	John's snapper
L.erythropterus	Crimpson snapper
Grouper	
Epinephelus coiodes	Orange spotted grouper
E. malabricus	Malabar grouper
E. sexfasciatus	Sixbar grouper
E. fuscoguttatus	Tiger/marble grouper
E. leopardus	Coral trout
Cromileptes altivelis	Humpback hind
Threadfin	
Eleutheronema tetradactylum	Fourfinger threadfin
Cobia	
Rachycentron canadum	Cobia
Tilapia	Red tilapia
Pompano	
Trachinotus blochii	Golden pompano

Broodstock and egg production is another part of job which is being scrutinized and getting improved. Currently, eggs are distributed by broodstock breeders, which keep the stock in floating cages. Egg production normally comes out from the process of natural spawning. Indirectly, the operator needs to keep large number of spawners so that when a need arises, there are already few eggs ready to be released . Upon spawning, eggs are collected by net. Though wild caught spawners are preferred for egg production, due to some problem, others collected are those fish stock from normal cage production system. The price of a million eggs varies from RM 500-3,000, depending on fish species.

c. Farm operation and production

The main production system for marine fish is still floating net-cages. Pond production until this moment is yet to be given due consideration. Despite the volume that it can produce, pond production may yet be suitable for high-value fish species that demand water of higher salinity than inland ponds .

Pond culture is also susceptible to off-flavor effect and may not be convenient as a system for live fish market. Seeing the potential, venturing into mass production using deep sea cage was initiated by the government through DoF a decade ago., However there was not much development since then. The main reason seemed to be the fish fry supply. The demand in terms of number and quality is yet to be matched. Apparently, this is due to the result of being a multi-species style of production. As of end-2005, there were 100 units of the square-type cages measuring 6m by 6m each and a total of 21 units of round-type with a diameter of 15m each. All of these cages were harbored at Langkawi island, north of peninsular Malaysia. Pond culture is still being faced with technical problems since most of the time, the cages were operated under capacity.

Until a new system of fish production or cage culture technology could be introduced effectively, traditional floating cages will continue to be the core marine fish production system. As of 2003 and 2004, there were a total of one million sq m of cage areas, an increase of about 14 percent from year 2002 (Table 11). These cages were run by about 1,400 and 1,600 operators respectively, during the production year 2002 and 2003-2004 (Table 11). Majority of the operators are small scale farmers who run a small (3m by 3m) to medium-size cages (6m by 6m) farms. Stocking in cages varies from 300-1,000 fingerlings per cage. The culture extends from six to 12 months depending on species. As for

Table 11. Facilities and operators involved in marine fish operation during 2002-04

Facilities	2002	2003	2004
Hatcheries (unit)	12	59	56
Cages (m^2)	940,948.28	1,034,664.10	1,110,221.04
Cage operator (head)	1374	1651	1623

Table 12. Production, areas and number of operators in mollusk aquaculture during year the 2002-04

Commodities	2002	2003	2004
Cockle	78,706.64	71,067.29	64,564.75
Mussel	5919.85	7,701.73	7,904.76
Oyster	285.66	256.43	260.68
Total	84,912.15	79,025.45	72,730.19

Commodities	2002		2003		2004	
	Area (ha/m^2)	Men	Area (ha/m^2)	Men	Area (ha/m^2)	Men
Cockle	6891.17	297	7447.06	311	6662.70	276
Mussel	82,186.09	288	109,816.75	347	156,798.71	357
Oyster	103,145.25	264	103,212.25	282	104,008.05	309
Total	192,222.51	849	220,476.06	940	267,469.46	942

feeding, trash feed remains the major feed type and only on some occasions, a commercial feed is being supplemented. It is still difficult for farmers to change to pellet for the sake of disease and environmental factor. The main reason is the cheap price of trash fish and the supply is readily available. Moreover, many farmers still believe that trash fish still produce market preference fish in quality and texture.

In recent years, increasing intensification in production, and area in cage farming usage led to many disease problems. As a result, there are regular records of mass mortality which were related to water quality and oxygen depletion. The farmers seemed to take this into account and are willing to invest in new operation for the sake of fish production.

Mollusk

Malaysia has a long tradition of mollusk culture. In terms of quantity of mollusks, particularly cockle, it contributed the most or about 40-percent harvest from aquaculture sector. Annual production of cockle since the past three years, ranges to 70,000 mt (Table 5.5). The value from sale of cockle in 2004 was about RM54 million. The total area covered for the cultivation of cockle is about 7,000 ha presently, and record indicated that there are about 300 operators that operate the cultivation of the said commodity. Mussels, which come next were harvested in the range of 6,000-7000 mt, whereas oyster were produced in the range of 250-285 mt annually during 2002-04. Both mussel and oyster are cultured in raft. Lately there are about 100-150,000 sq m and 100,000 sq m of areas respectively, for the production of the two commodities. The number of operators involved in the culture activities during the last three years was about 300-350 and 260-300, respectively for each mussel and oyster production (Table 12). In terms of revenue, both produce created an income of about RM 5 million in 2004 (Fig. 3).

Seaweed

Compared with other marine aquaculture products, seaweed culture is localized in only one state which

Table 13. Statistic on seaweed aquaculture 2002-04

Sp	2002	2003	2004
Volume (mt)	25,624.92	27,607.90	30,956.90
Acrage (ha)	1908.32	1206.25	986.02
Operator (no.)	712	605	392

is Sabah and in one area only (Anon, 2004), Semporna. Culture of the commodity has a long tradition. Since 2002, its annual production has increased to around 3 million mt, from 26 to about 31 million mt in 2004 despite a record of decrease in culture area, i.e. from 1,900 ha to an area of about 1,000 ha (Table 13). Apparently, there was a drop in operator involved in the cultivation from about 712 to about 392 in 2004. In terms of quantity, seaweed cultivation contributed about 21-percent share in the marine aquaculture sector. The annual production from this sector since the past three years ranged from 26,000-31,000 mt (Table 5.6). The value from the sale of the product during 2004 was about RM 15.48 million.

EMERGING NEEDS AND FUTURE DIRECTIONS

As a sector that traditionally supplies food and continuously contributes to the national economic, aquaculture potential was lately given a special attention by Malaysian government . The strategy and action plan to develop the sector was clearly spelled out in the Third National Agricultural Policy (NAP3 1998-2010), a long-term plan for agricultural development. A volume of 600,000 mt was set aside for aquaculture sector to be delivered by 2010. Based on the record in the Annual Fisheries Report, current achievement is around 202, 225 metric tons. Hence, a difference of about 400,000 mt is yet to be achieved. With another five years to go, an annual production growth of about 22 percent is necessary to achieve the target. In the marine sector, two top income-generating commodities, shrimp and finfish was each set with a production of 120,000 and 150,000 mt respectively. Presently, each of the commodity attained a production of only about 10,500 and 32,000 mt, still less than the target to be achieved.

While the massive increment in production will no doubt come from increase in area under culture, most of it will probably from intensification of existing culture practice.

Marine Shrimp

The major constraint in the development of traditional black tiger shrimp is disease problem. Hence, research priorities in scope as listed below need to be considered:

a. Production of SPF broodstock and disease-free post larvae
b. Application of best management practices
c. Automation toward reducing production cost
d. Development of sustainable production system

While the long traditional shrimp species need to be scrutinized and its problem solved the importance of indigenous shrimp species, such as the banana shrimp (*Penaeus merguinsis),* it should be given a due consideration to create interest for commercial production. In a way, this will create diversity of choice to wean away with exotic species (*P. vanamei)*. To attract commercial culture of the species extensive research has to go all-out to solve the problem of poor growth performance under high-density culture; and to realize a culture period of 120 days, a stereotype benchmark to many shrimp farmers in Malaysia. As an action plan, research in the aspect listed below should be given due consideration.

a. Domestication and selective breeding program
b. Development of feed for its aquaculture program
c. Develop culture technology

Marine Finfish

Being at a pioneer stage in the marine finfish industry, we can learn a lot from success and failure stories in shrimp industry. Foremost, seed should be of high quality and if possible a SPF standard. To pursue it, domestication and selective breeding program

should be in the list. A biosecurity system is also essential in the set. On the development aspect, to turn it into a food industry, focus should be given to a specific species to be developed. It indirectly means one cannot rely much on live fish market. Frozen fish market should be the main agenda and market should diversify through value-added varieties to increase intake by local consumers. Land-based production system, be it in pond or tank should be a means of production in the future as environmental issues may no longer permit waterways to used for cage operation. Foreseeing the upcoming problem, priority in research and development should be given to the list as underlined below:

a. Research and Development on selected fish species
b. Development of broodstock bank
c. Research and development in domestication and selective breeding program.
d. Development of biosecurity fish fry production centre
e. Research and development in live food production.
f. Research and development in growout production facilities.
g. Research and development in nutrition and feed formulation.

IDENTIFICATION OF BETTER MANAGEMENT PRACTICES TO MITIGATE ENVIRONMENTAL IMPACTS

As a means to mitigate environmental impact, DoF in Malaysia comes out with a guideline on Good Aquaculture Practices (GAqP). Mainly for shrimp industry at this moment (FAO, 2003), this guideline upholds the standard required by international body such as FAO. The same guideline will soon be developed for marine finfish aquaculture activities and others. Currently, a major task of the government is to ensure that the guideline is practiced by culturists, particularly the downstream farmers. At this stage for that level, it is still difficult to implement because a free-for-all situation already existed for a long time. Lack of institutional and legal support may jeopardize the action plan. Otherwise, local government has to impose rules on domestic food safety standards from aquaculture, as requirements of many importing countries. Big-scale operators, however, on their own initiative should implement good aquaculture practice to comply with the requirements for quality fish/shrimp products for export market. To be part of a food producer, one has to have standards and environment-friendly production protocol.

Along this line, the Department of Fisheries Malaysia for the past few years introduced Farm Certification Scheme or SPLAM. The objective of SPLAM is to provide official recognition to aquaculture entrepreneurs who have practiced Good Aquaculture Practices (GAqP) and environment-friendly concepts to ensure the safety, quality, consistency and competitiveness of the products based on the criteria, guidelines and standard determined by the Department of Fisheries Malaysia. Farmers can obtain quality certification for their products after some period of quality assessment by authorities. The benefits derived from participating in the SPLAM program among others are to ensure the aquaculture products from the farm meet the food safety standards required by domestic and international market. Second, is to assist and expedite the issuance of Health Certificate and Sanitary and Phytosanitary (SPS) 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 in the development of the aquaculture industry in a sustainable and environment-friendly manner.

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