

ANNEX 4

Report of the final regional stakeholders' workshop¹

EXECUTIVE SUMMARY

The project terminal workshop was held on 25-28 October 2010 at the Paradise Hill Hotel, Zhuhai, China. It was attended by all the country project coordinators, at least one member of the project monitoring team from each country, farmers selected from each country on the basis of the trial performances, international and regional consultants to the project, and representatives from FAO (Rome and Bangkok) and NACA. At the workshop, presentations were made by the consultants for the respective components, the country leaders, and NACA staff on farmer perceptions and a comparison of the country growth trials (four countries / five species). The workshop adopted four basic recommendations in the following broad areas: (i) pellet feeds for mariculture, (ii) trash fish/low-value fish, (iii) better management practices (BMP), and (iv) dissemination of findings.

1. PROJECT RATIONALE, OBJECTIVES AND DELIVERABLES

Over the past decade, marine finfish aquaculture in Asia has been developing rapidly at around 10 percent per annum, and in value terms, at 4 percent per annum of global finfish production. It is the fastest growing aquaculture sub-sector in Asia. Much of this increase in production is attributable to the expanding culture of high-value marine carnivorous species such as groupers. The countries that currently lead marine finfish aquaculture are China, Indonesia, Viet Nam and Thailand, with Korea and Japan not far behind. India is planning major expansion in the sector. The sector is largely dependent on trash fish/low-value fish as the food source of the cultured stocks. The use of trash fish/low-value fish is a contentious issue both from the resource and environmental integrity perspectives, the latter being reflected in the very high conversion rates which imply poor efficiency.

The long term economic viability and environmental integrity of marine finfish aquaculture practices in the region will essentially depend on a shift from the direct use of trash fish/low-value fish to formulated feeds. It is anticipated that this will improve the environmental integrity and economic viability of the farming operations. The problems outlined are common to all the nations involved in marine finfish farming in Asia, and therefore to generate synergies, it is logical to have a regional approach that incorporates farmers.

The project directly involved farmers, and was designed to reduce the perception that fish raised on trash fish/low-value fish perform better than those raised on pellet feeds, and thereby introduce a transition from the use of one feed form to the other. It is envisioned that the adoption of pellet feeds will contribute to the sustainability of the sector in Asia. The outcome of the project was anticipated to result in a reduced dependence on trash fish/low-value fish (and marine resources) for marine finfish farming in Asia. This would be achieved through a combination of improved feed management practices, and a shift in the sector towards better diets, and particularly the use of formulated diets. This outcome would increase the long term viability of

¹ This annex has been adapted from the Report of the Project Terminal Workshop, November 2010, prepared by NACA.

marine fish farm operations, improve the livelihoods of practitioners, and contribute to poverty alleviation.

The proposal was developed in close collaboration with NACA, FIRA, FIEP, RAPI, and subjected to consultations with stakeholders including the participating countries. The proposal received the letter of support from the Minister of Marine Affairs and Fisheries, Republic of Indonesia, and the Vice Minister of Ministry of Agriculture and Rural Development, Government of Viet Nam. The project was approved by FAO for funding in July 2008. NACA was responsible for the overall coordination.

Among the various components of the project were national and regional stakeholder workshops conducted at the start, during, and towards the end of the project. The proceedings and recommendations of the final regional stakeholders' workshop provide the basis of this report.

2. WORKSHOP PRESENTATIONS

At all times, the technical sessions were conducted in plenary. Each presentation was followed by a question-and-answer session and a general discussion on the presentation topic. The inferences derived from the discussions formed the basis of the recommendations. In the final session, the basic recommendations were presented, reviewed, and a consensus arrived at with respect to the major recommendations. The participants are listed in Annexure A.

3. MAJOR FINDINGS AND INFERENCES OF THE WORKSHOP

- a) It was generally agreed that the project has been successful - its major components were completed in time and within budget. All the country trials were completed, and the data collation carried out effectively.
- b) The consensus was that the farm trials generally demonstrated the technical feasibility of using pellet feeds to replace trash fish/low-value fish in marine finfish cage culture. Thus, in the long run, pellet feeds provide a viable alternative to trash fish/low-value fish as a feed for marine finfish cage culture.
- c) The farm trials showed that in comparison to the direct use of trash fish/low-value fish, the use of pellet feeds achieved similar performance (i.e. growth, survival, food conversion, production and economic benefit) in marine finfish cage culture. However, the results varied between countries. These variations were attributed to the different management practices and culture species that were applied/used in the different countries.
- d) The implementation of the project was seen as highly efficient, and that it helped to identify key improvements that need to be made to farming practices. It also brought about much needed cooperation among the farmers, and paved the way for the formation of farmer clusters or small scale farmer groups.
- e) It was agreed that the involvement of the private sector (fish farmers, farmer organizations, trash fish suppliers and traders, and feed companies) should be encouraged in future projects of this nature.
- f) The workshop agreed that for various technical reasons, the trials conducted in different countries were not strictly comparable. These reasons include species and feed types used, environmental differences between countries and sites, as well as aspects of management by individual farmers. Most of these differences were unquantifiable.
- g) The results of the farmer trials have generally changed the perception of farmers that pellet feeds may lead to poor growth and flesh quality. It has been reported that more farmers are shifting from trash fish/low-value fish to pellet feeds in China, and it is likely that farmers in other countries (Thailand, Indonesia and Viet Nam) would follow suit.

- h) From the results of the trials, it was concluded that:
- When fed to any of the culture species, there was no clear indication (statistically significant differences) in the performance of the two feed types.
 - Overall, the trials indicated that in all countries, and with the exception of China, the performance of the fish on the trash fish/low-value fish was slightly better than that attained using the pellet feeds, or in some instances, these differences in performance were hardly discernible (e.g. pompano trials in Viet Nam). All in all, the differences between the two feed types, for any one species, and in each of the countries, were not statistically significant.
 - There were clear indications that some of the traditional perceptions particularly those related to the weaning of wild caught seed onto pellet feeds, or changing from one feed type to the other, were not true. The farmer consultations and stakeholder meetings conducted in the course of the project have enabled the wider dissemination of these observations, which should in time be beneficial to the farming community.
- i) It was also observed that:
- Using pellet feeds was new to the trial farmers, and their inexperience in managing these feeds would have significantly impacted the trial results.
 - In general, management practices (stocking, cage design, feeding management, disease control and other practices) in marine cage fish farming are far from standardized. This often leads to poor results.
 - The uncertainty in production performance, and the many other risks to marine cage culture make cage farmers economically vulnerable. This is probably more so for the small-scale farmers.
- j) The environmental assessment component indicated that there were no significant local impacts associated with the use of pellet feeds and/or trash fish/low-value fish - as measured in terms dissolved nutrients (N and P, NH₃), and dissolved oxygen etc. This was attributed to the low stocking density of the cages where the farm trials were conducted. An increase in stocking densities and input levels may have led to different results. The assessment produced the following results:
- Over time, there were increases in the bacterial loading in trash fish/low-value fish that was stored on ice, as well as an increase in bacterial releases to the culture waters when feeding trash fish/low-value fish that had been stored for 2 or 3 days.
 - It was revealed that the estimated energy cost of producing a kilogram of farmed fish was much lower when trash fish/low-value fish was used.
 - In general, there was more nutrient leaching to the culture water when using pellet feeds as opposed to trash fish/low-value fish.
 - The need to estimate ‘fish in: fish out’ ratios for the production of a unit weight of the species under consideration was recommended. This was subsequently carried out, and reported (see Section VI and Annex 2).
- k) In general, the pellet feeds that were used in the farm trials were not species-specific and varied in quality. The feed analyses data revealed that some pellet feeds had high moisture and ash contents, which is not desirable. The workshop suggested that the feed analysis data needed to be compared with the specifications provided on the feed packaging.
- l) The modes of disseminating the large body of information that was generated from the project, and which is useful to the farmers as well as to other stakeholders (e.g. feed manufacturers, suppliers) were discussed. It was agreed that the modes and channels of information dissemination should be detailed in the recommendations.
- m) The workshop noted that there were a range of credit schemes available to the farmers. However, in general there is a lack of recognition of this sub-sector, and particularly the small-scale farmers as being sufficiently worthy of financial assistance. The workshop noted that there had been some recent developments in

micro-finance services in many of the countries in the region, and that they could possibly be used to assist the small-scale cage fish farmers. Some countries have introduced micro-credit for small-scale farmers while others, such as Thailand, bundle these loans into small-enterprise assistance programmes. Farmers were unable to obtain insurance. This was likely attributable to the perceived and indeed the actual high risks associated with marine cage farming. It was however noted that the organization of small-scale farmers into groups (clusters, collectives and associations), with legal advice and support, would be a way forward - as is the case for the Indian shrimp farmers. The governments of the participating countries have taken steps to promote the organization of small-scale farmers to improve their bargaining power in marketing, input purchases, and obtaining credit. The success of this exercise has proven that a step-wise evolutionary process to promote the recognition of farmer clusters by different authorities and institutions would lead to the provision of microcredit, cluster certification, and stronger leverage with governmental authorities in obtaining public services and amenities.

4. IDENTIFIED ISSUES AND WORKSHOP RECOMMENDATIONS

4.1 Pellet feeds for mariculture

Issue. Regionally, various finfish species are being farmed. Primarily, these include a number of grouper species (*Epinephelus*, *Cromileptes* and *Plectropomus* spp.), snapper (*Lutjanus* spp.), Asian seabass/barramundi (*Lates calcarifer*), pompano (*Trachinotus blochii*), and others. Of these, only the nutrient requirements of the barramundi are well understood. This, and the relatively high volume of barramundi production - when compared to any single species of grouper - has encouraged feed manufacturers to develop and market pellet feeds specifically for barramundi culture. In contrast, the nutrient requirements of the cultured grouper species and the other marine finfish are not well understood. As such, the pellet feeds that are available for these species are ‘generalized’, and there is uncertainty as to whether these feeds optimize performance. This uncertainty has tended to make farmers less inclined to use the pellet feeds that are currently available in the market.

Recommendation. The workshop recognized the need to develop species-specific diets for marine finfish species defining the nutritional quality, ingredients and formulation. The workshop therefore recommended that the public and private sectors should be encouraged to study the nutritional requirements of important cultured marine finfish species under different environmental conditions. Feed manufacturers should be encouraged to develop appropriate pellet feeds for marine species, and make them easily available and affordable to small-scale farmers.

4.2 Trash fish/low-value fish

Issue. In the foreseeable future, trash fish/low-value fish is likely to continue to be used in most countries in the region as a feed for cultured marine finfish. Currently, farmers either continue to feed trash fish/low-value fish, or use it in combination with pellet feeds. However, the farmers are beginning to be concerned about the growing scarcity of supply and the increasing prices of trash fish/low-value fish. At present, prices are still low (in most countries), and local supplies are still available. Furthermore, as the purchase of pellet feeds require large up-front cash payments, and the farmers usually find it easier to afford trash fish/low value fish which can be purchased on a daily basis. Many farmers also fish and either target low-value species or have access to bycatch to meet their trash fish/low-value fish needs. Other factors that affect their use of pellet feeds include the unavailability of pellet feeds that are designed for the target species, their irregularity of supply, and the relatively high price of these feeds in remote and relatively inaccessible areas.

The consensus was that low-value fish will continue to be used in marine finfish culture in most countries, albeit to varying degrees, and well into the foreseeable future. On the other hand, there is very limited knowledge of its seasonal availability, particularly the seasonality of the dominant species, quality changes, price changes along the value chain, and its other attributes as a commodity. Equally, there is no knowledge pertaining to the parasite loads, and the impact that these parasites may have on the health of the cultured stock. There is also little knowledge pertaining to the origins of the trash fish/low-value fish, such as whether it is derived from artisanal coastal fisheries, fisheries designed for this purpose only, or industrial fisheries.

Recommendation. The workshop recommended that further studies be undertaken on trash-fish/low-value fish to determine the quantities used, the quality of the product, and its impact on the environment.

4.3 Better management practices (BMP)

Issue. The workshop noted the benefits that the adoption of BMPs has brought to small-scale farming communities (e.g. shrimp farming in India; catfish farming in the Mekong Delta etc.), and especially when such communities are organised into clusters. The benefits that have been observed include increased productivity, market access, bargaining power (e.g. ability to purchase feed at a discounted rate, to demand seed of a standard quality, and to negotiate better deals with buyers), augmenting the certification of produce (the cluster as whole meeting the cost of the certification of all their farms rather than individual farmers paying for separate certification), and having a stronger voice in the formulation of policy. BMPs for marine finfish culture are however not available. The workshop recognised that some of the findings pertaining to feed types and their management can be used in the development of BMPs for marine cage culture, thereby facilitating the process of their development.

The BMPs could also be modified into technical guidelines for marine cage finfish farming in accordance with the FAO Code of Conduct for Responsible Fisheries².

Recommendation. The workshop recommended that BMPs be developed for marine finfish cage farming as a matter of urgency, and that to reap the maximum benefits from the activity, such a development should be linked to the formation of farmer clusters. The BMPs should emphasize resource use, in particular the biological resource use in feed of both types, the economic and environmental impacts of different feed management practices in small-scale marine cage culture in selected countries, and the development of suitable strategies and a set of best protocols for feed management.

The workshop also recognized the lack of technical guidelines for good feed management practices for small-scale farmers, and recommended that technical manuals/guidelines for better feed management practice should be developed and disseminated to farmers. This should be undertaken with the recognition of the need to develop better management practice (BMP) for the entire culture cycle of important marine finfish species.

4.4 Dissemination of findings

Issue. The workshop agreed that the project has generated information that will be useful to the marine cage finfish farming industry. It noted that the private sector in Thailand had taken the initiative to support the production and dissemination of extension materials prepared by NACA. The information from the growth trials, environmental study, farmers’ perception and livelihood analyses, could be disseminated through

² FAO. 1995. Code of Conduct for Responsible Fisheries. Rome, FAO. 41 pp. (also available at: <ftp://ftp.fao.org/docrep/fao/005/v9878e/v9878e00.pdf>)

semi-technical magazines such as *Aquaculture Asia* and *FAO Aquaculture Newsletter*, which have a wide readership and, in a way, specialized audiences. The results that are technically robust and can withstand rigorous statistical analyses can be disseminated through peer reviewed processes.

Recommendation. The workshop recommended that the findings of the project should be disseminated as widely as possible to the farmers and other stakeholders. This would include the FAO terminal report/technical paper covering the project findings, NACA publications, country project reports in local languages, extension materials and BMPs for farmers translated into local languages, and through scientific journals. FAO shall be acknowledged in all the materials published and its participation in the preparation of scientific and related publications is encouraged.

The workshop further recommended that FAO take up the initiative to enable relevant stakeholders that participated in the project to legally publish and disseminate the project findings as appropriate.

4.5 Other recommendations

Considering that the cage culture of marine finfish is likely to expand in the near future, there will be a need to move away from inner bay areas to offshore areas, and thus avoid the negative environmental impacts associated with developments in inshore areas. In this regard, the workshop recommended developing guidelines for offshore mariculture incorporating policy, technology and management aspects.

Currently, there are many small-scale farmer groups operating as clusters and organized as clubs making use of the advantages of clustering. This should be encouraged and promoted further using the models developed in Viet Nam and India. These models use the step by step approach to the formation of the clubs, and result in improved access to technical and financial services, marketing, and the promotion of good governance.

5. CONCLUDING REMARKS

In trials that involved four countries and different culture species, it was not possible to obtain directly comparable and uniform results that have statistical robustness. However, some common findings that are relevant to marine cage culture development in the region, and have possible application elsewhere, emerged from the on-farm trials and through the surveys carried out in the countries. These major findings included:

- grouper (as well as barramundi and snappers) can be weaned from one feed type to the other, within a few days, and without performance losses.
- the farm trials generally demonstrated the technical feasibility of substituting trash fish/low-value fish with pellet feeds, thus making pellet feeds a viable alternative to trash fish/low-value fish; and
- it was demonstrated that the quality of the fish is not impacted by the feed type. However, it would be useful to have flesh quality analysis carried out to consolidate this position.

The trials also brought together the project team and groups of farmers at many stakeholder meetings and consultations. These interactions were useful for both the project team and the farmers, and in many instances, the latter had the opportunity to learn from their counterparts' ideas and practices. These they eventually applied to their farms.

The major issue to determine the comparative efficacy of using trash fish/low-value fish or pellet feeds is not completely resolved as yet. The results of the trials in the different countries indicated that there was significant variability in the performance between both farms and species; however, the relative efficacies of the two feed types applied to the different species were not significant. Understandably, it was apparent

that the farmers rarely account for non-monetary variables and opportunity costs in their concept of profitability. Amongst others, these include the time spent for trash fish/low-value fish preparation prior to feeding, potential wastage, the lack of uniformity in the quality and quantity of the supplies of trash fish/low-value fish, storage problems associated with the trash fish/low-value fish, the overall convenience in feed management, and the depreciation of farm assets. An economic analysis that can reasonably take these issues into account would better indicate the real profitability of the enterprise. In this regard, there was consensus across all the countries, and the farmers endorsed the need to include these points in the dissemination of the information from the project.

There was also consensus among stakeholders in all four countries on how and in what forms the findings of the project should be disseminated. Other than the means suggested earlier, much of the scientific findings could be disseminated through FAO technical publications, scientific publications, with abbreviated forms published in semi-technical magazines, and extension materials in the national language.

One of the important features of the project was private sector involvement. Apart from providing pellets free of charges to the trial farmers in Thailand and Viet Nam, the two feed companies involved in the project came forward to take responsibility for the printing and distribution of a poster outlining the pros and cons of using the two feed types. Public awareness and interest in marine cage farming as a whole, and the project in particular can be promoted by enlisting the involvement of the mass media.

ANNEXURE A

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Discussion group leader (from Phang Nga) presenting the Phang Nga group's results during the stakeholders' workshop in Phuket, Thailand, June 2011. Eighteen cage farmers from Krabi, Phang Nga and Phuket, a third of them women, took part in the workshop

Courtesy of FAO/Mohammad Hasan



Discussion in the stakeholders' workshop in Bandar Lampung, Indonesia during the project follow-up mission in July 2011.

Courtesy of FAO/Budi Kurnia

ANNEX 5

Project uptake and future priorities¹

EXECUTIVE SUMMARY

A three country mission to Indonesia, Thailand and Viet Nam was undertaken sixteen months after the termination of the participatory on-farm trials to compare the efficacy of trash fish/low-value fish vs. compound pellet feed. The mission found that there were variations in the level of uptake of pellet feeds among the cage farmers and across the trial countries. With the strengthening of their aquaclubs, the Vietnamese farmers have begun trying or using pellet feeds. In contrast, Indonesian farmers were hesitant to adopt the trial results for their preferred species, the humpback grouper. The trails in Indonesia were undertaken with brown-marbled grouper (tiger grouper). In Thailand, the farmers indicated that they were experiencing difficulties accessing pellet feeds, and felt that these feeds were expensive. A common issue that was reported by the farmers was the lack of species or size specific pellet feeds. In Indonesia and Thailand, perceptions persist that the use of trash fish results in better growth performance than that achieved using pellet feeds. Nevertheless, there are encouraging developments, in that both trial and non-trial farmers expressed a desire to use pellet feeds, and would use them if they were available. The perception of a diminishing catch in low-value fish and the reality of increasing fish prices have led many farmers to seriously consider switching to pellet feeds - should suitable formulations be available on the market. This change in attitudes shifts the issue towards the commercial viability of producing and marketing pellet formulations for specific species and sizes of fish. The Indonesian findings suggest that there appears to be a business case for developing formulated feeds. Another issue shared by Viet Nam and Thailand was the availability of quality seed. Applying better management practice guidelines are a high priority among all the farmers in the three countries. The current mission has formulated project concepts to address these issues in the three countries.

1. INTRODUCTION

The three-country mission was undertaken 16 months after the termination of the participatory on-farm trials to determine the current status of the marine cage farming industry, the level of knowledge and the uptake of the project trial results, and to identify current issues and needs of the industry. It sought to confirm the recommendations that were made at the end of the project, and further assess the priorities for the sector in line with the objectives of the project². The mission activities comprised:

1. Conducted focus group discussions with the project partners in Lampung (Indonesia), Nha Trang (Viet Nam), and Krabi/Phuket (Thailand), to discuss the findings and conclusions that were derived from their respective case study reports. A particular focus was placed on the farmers' participatory trials.

¹ This annex has been prepared based on the mission reports of Dr Nigel Aberly and Mr Pedro Bueno and back to office travel reports of Dr Mohammad Hasan and Mr Jiangan Jia.

² The mission was made up of Dr Mohammad Hasan (FAO), Dr Nigel Aberly (FAO consultant), Ms Ruth Garcia Gomez (FAO) (Indonesia component), Mr Pedro Bueno (FAO consultant) (Thailand component), Dr Tipparat Pongthanapanich (Kasetsart University) (Thailand component), Mr Jiangan Jia (FAO) (Thailand component). The local project partners in the respective countries that facilitated the meeting with stakeholders are the Lead Centre for Mariculture Development, Indonesia; Research Institute for Aquaculture No. 3, Nha Trang, Viet Nam; Coastal fisheries Research and Development Centres, Phuket and Krabi, Thailand. The period covered was 7 to 23 July 2011.

2. Consulted the project partners to resolve the issues that required attention, and finalised the contents of the final project report.
3. Consulted and discussed the recommendations that were agreed at the terminal workshop with stakeholders. These included discussions with the marine fish cage farmers and trash fish/low-value fish fishers and suppliers in Indonesia, Viet Nam and Thailand.
4. Conducted a rapid survey of farmer management practices. The survey was designed to assess the relevance of the project recommendations.
5. Assessed the short term uptake by trial and non-trial farmers of the project findings and recommendations in the study areas.
6. In consultation with the relevant stakeholders, prepared project proposals that were designed to identify/develop better management practices for small-scale marine cage farming in the countries of the Asia-Pacific region. These proposals included the practicalities of their implementation.
7. Presented the overall findings and conclusions of the project during a focus group discussion in Phuket, Thailand.

2. METHODOLOGY

The mission visited Bandar Lampung, Indonesia (4 days), Nha Trang, Viet Nam (4 days), and Krabi, Phang Nga and Phuket, Thailand (5 days). The team met with national partners and farmers, and undertook field visits to interview cage culture farmers and hatchery operators (a mud carp farm that uses trash fish was also visited in Nha Trang, Viet Nam). A half-day workshop among the team members was held immediately after the Thailand stakeholders' workshop. The purpose of this team workshop was to synthesize the results and identify priority follow-up projects.

3. RESULTS

3.1 Issues requiring attention in the final report

1) Indonesia

Plankton blooms and water quality were monitored and had a major impact on the trials. However, water quality and phytoplankton protocols, materials or methods were not described in the country report. This was clarified with the project water quality monitoring and analysis team. During the workshop some farmers mentioned partitioning their trash fish (head and tail vs. body), and feeding head and tails to the brown-marbled grouper, and the body part to humpback grouper. The typical trash fish species, modes of feeding, and farmer procurement and preparation techniques were clarified with the project trial farmers.

2) Thailand

As many of the trash fish species have the same local names, the local names were clarified with the species names. Two trial farmers reported using fish processing waste, and more information was obtained about the species composition, source, and their use of this waste. The pellet feed that was used in the grouper trial was changed during the trial. It was established that the change in diet occurred two weeks prior to the termination of the trial, and that the new diet was in fact a sinking cobia pellet. The change in feed occurred in the Phang Nga trial farm.

3) Viet Nam

Modes of trial farmer trash fish procurement and processing were not described in the country report. These issues were clarified with the project trial farmers. In addition, the recommendations listed in the stakeholder report appear to be a repeat of the text from the Indonesian stakeholder's recommendations - this was clarified with the project partners.

4) Cross country information

Information pertaining to transport, processing and storage costs of trash fish/low-value fish was obtained from all three countries. This information, although variable for each individual farmer, can be used to develop an understanding the true cost of using trash fish as a feed.

3.2 Relevance of project recommendations

1) Indonesia

The Indonesian marine cage culture industry stakeholders prioritised their needs as follows:

- a. The top priority is for *better quality pellets for the final stages of rearing to be available in the market, and at a good price*. Farmers would switch to pellet feeds if the available feeds were able to match the growth attained using trash fish. Farmers placed a high priority on a pellet that produces high growth rates for large size (>250 g) humpback grouper. The farmers indicated that they would be willing to buy pellet for US\$ 2.70–3.80/kg (25 000–35 000 IDR³/kg) if the concomitant growth rates matched those attained using trash fish. The next priority was for a pellet that matched the high growth rate that they attain from using trash fish, for large brown-marbled grouper, and cost less than US\$ 2.00–2.50/kg. If such a feed could be developed, the farmers indicated that they would switch to the pellet feed. The Main Centre for Mariculture Development (MCMD) has a nutrition section and laboratory, but it does not have the equipment to undertake proximate analysis for protein, lipid, moisture, ash etc., or sufficient technical expertise in fish nutrition to undertake a project of this nature without assistance.
- b. The second priority is for *the development of better management practices (feed and health management)*. Farmers reported having issues with very high production costs, disease, and low survival rates. The farmers indicated that they wanted guidelines on advanced grouper production techniques that included disease identification and treatment, feeding and feed management, and stock management techniques. The cage mariculture sector is a relatively new industry and culture practice guidelines are yet to be developed. Although MCMD has a section that covers culture practices, the current activities do not include the development of better management practices for marine cage culture species. The responsible staff would require assistance in the development of such a program.
- c. The third priority is the provision of advice on *how to strengthen aquaclubs*. Farmers are having difficulty realising the potential of their aquaclubs, and are facing difficulties in dealing with the local authorities. In this regard, the farmers indicated that they want assistance to strengthen their aquaclubs such that they achieve the desired outcomes. The MCMD does not have sufficient expertise in aquaclub development or related activities to provide this support to the farmers.

2) Thailand

The Thai marine cage culture industry stakeholders prioritised their needs as follows:

- a. The top priority is *the development of guidelines on better management practices (BMP) for marine cage farming focusing on feed management*. Applied research to determine the optimal culture practices of grouper species and the development of guidelines for better management practices is required to provide the aquaculture extension staff with the knowledge that they need to instruct the farmers. BMPs are particularly important in Thailand as there have been large numbers of new entrants in to the marine cage culture industry in recent years, and this trend is likely to continue. These new entrants lack the knowledge and skills to culture

³ 1 US\$ = 9 100 Indonesian Rupiah.

groupers efficiently, and are thus operating in a high risk environment. The development and dissemination of better management practice guidelines for the key culture species would significantly reduce the business risk - particularly for new, small-scale entrants. As the highest cost associated with marine cage culture is feed, the development of better feeding and feed management guidelines should be prioritized.

- b. The next priority is *the market availability of a good quality feed suitable for grouper species*. Marine finfish cage farmers believe that trash fish is becoming scarcer, and that in future, will become more so, and more expensive. Apart from the increasing demand from aquaculture and other low-value fish users, farmers believe that in the future, environmental and social issues will likely result in further reductions in catches. To prepare for this situation, they believe that a good quality pellet feed suitable for grouper culture is required.
- c. An important priority is the *increased availability of fingerlings*. In Thailand, grouper fingerling production is undertaken by large-scale integrated producers, and the government hatcheries. Some fingerlings are imported by the larger operators who sell their excess seed, which the farmers claim are usually of low quality. Large-scale hatcheries produce fingerlings solely to supply their own needs. Small-scale farmers rely on the government produced fingerlings. Over the past two years, there has been an increase in the number of small-scale cage farmers entering the industry. This has increased the demand for grouper fingerlings and resulted in each farmer receiving fewer seed to stock than in previous years. The government hatcheries are aware of the increasing demand for fingerlings, and have planned to increase production. It is likely that the shortages in fingerling production will be resolved by the government hatcheries. However, there is a possibility that the demand for fingerlings will continue to increase as more new entrants take up marine cage culture. Fingerling production and supply should therefore be reviewed in near future for sustainability of this sector.
- d. Farmers expressed the need for *increased access to credit*. Currently, a limited amount of credit, such as the village fund is available; however, the amount that each individual can borrow is small. Farmers have access to other sources of credit, the amount being based on the individual farmer's circumstances - such as value of assets owned. Farmers believe that access to larger amount of credit would allow them to expand their businesses and improve profits.

3) Viet Nam

Vietnamese marine cage culture industry stakeholders prioritised their needs as follows:

- a. Top priority is *better management practices for marine cage farming focusing on feed management*. Farmers lack sufficient information and knowledge about management practices for marine cage culture, and specifically, the efficient use of feed and feeding practices. Farmers are concerned about the increasing costs of production. Currently, feed represents the single largest production cost, and farmers are unsure of the most appropriate way to feed trash fish/low-value fish or pellets. In addition, they generally feed to satiation which results in overfeeding. Guidelines on appropriate stock management and feeding rates that maximise economic efficiencies will increase the profitability of their operations and promote environmental sustainability.
- b. The second priority is the development of *high quality feeds for large cobia and lobster production*. The main species currently cultured (lobsters and cobia) use trash fish/low-value fish, and at present, there are no suitable pellet feed available for the larger cobia, and for the lobster grow-out cycle. In Viet Nam, larger pellets that are suitable for cobia are not available in the market - the industrial demand

is currently too low to warrant commercial production. It is likely that if cobia farmers are trained to use pellets efficiently, and are provided with appropriate pellets so that they can observe their efficacy for themselves, they are likely to start using pellets. This would create the market demand conditions that are required to stimulate commercial production.

- c. The third priority is to *increase local fingerling supplies through the development of a local “backyard” marine finfish hatchery industry*. This would reduce the reliance on imported fingerlings from Taiwan Province of China (POC). An intervention of this nature could be based around the renovation of 10–20 ex-backyard shrimp hatchery producers, and integrating them with existing broodstock holding and spawning facilities, for example, those facilities that are available at the government hatcheries. In Indonesia, this model proved effective, and could be adapted in Viet Nam.

3.3 An assessment of the uptake of farmers’ participatory trial results

1) Indonesia

The uptake of the project findings in Indonesia was limited. Prior to the project, the farmers were already using pellet feeds to culture small grouper (≤ 250 g), and were feeding trash fish/low-value fish to the larger fish (> 250 g). In general, they only fed pellets to the larger fish when disease treatments were required, as it was easier to administer the therapeutics in the pellet feeds as opposed to the trash fish/low-value fish.

After the project, the farmers continued to use their original feeding regimes. While the farmers know that groupers can be cultured throughout the culture cycle using pellet feeds, they maintain the belief that the growth of the large groupers (> 250 g) fed with pellets is inferior to that when they are fed trash fish/low-value fish. The trial results demonstrated that overall, the brown-marbled grouper fed trash fish/low-value fish grew more than those fed the pellet feeds, however the difference in growth rates was not significant. Nonetheless, the use of more replicate cages would have yielded a statistically significant difference. Furthermore, the trial in Indonesia was based on the brown-marbled grouper. While some farmers are still growing the brown-marbled grouper, most farmers are now primarily growing the humpback grouper. Some farmers suggested that the results from the trial with the brown-marbled grouper do not apply to the humpback grouper, and that they believed that the growth of the humpback grouper (the preferred culture species of most of the farmers in Lampung), when fed with pellet feeds, was slower than that observed when they were fed with trash fish/low-value fish.

2) Thailand

In Thailand, there was some uptake of the trial results pertaining to barramundi culture, however, this was not the case for the brown-marbled grouper farmers who maintained their original culture practices. In terms of barramundi cultivation, one trial farmer who was not using pellet feeds before the trial reported using pellet feeds after the trial. Others who participated in the trial continued using trash fish/low-value fish. Despite the trial, many farmers including many of the trial farmers, maintain the belief that feeding trash fish/low-value fish produces better growth performance than feeding pellets.

There is a major issue of pellet availability in the Krabi/Phuket/Phang Nha area. In Krabi, there are no feed dealers, however there is a pellet feed being sold in “SuperCheap” (a large store selling many products). However, the pellet feeds are sometimes out of stock. Only a floating barramundi pellet is sold, and at US\$ 1.30/kg, some of the farmers consider the price to be too high. The farmers also reported that they preferred to use sinking pellet for grouper culture.

The trial farmer who had been using pellet feeds prior to the trial and continues to use pellets, does so because the costs associated with transporting the trash fish from the landing site are excessive, and sometimes the trash fish/low-value fish is of poor quality, and laced with formalin. This being the case, it is more cost effective to use pellet feeds. The farmer reported purchasing the feed in a store in Krabi, where he goes two or three times a week to deliver fish.

3) Viet Nam

In Viet Nam, there were positive signs of farmers adopting the project findings. Prior to the project, none of the trial farmers was using pellet feeds. However, after the trial, some of the farmers continued to use pellets, whilst others have plans to use pellets when their newly formed aquaclub is in a position to bulk-purchase feed at a discounted price.

Furthermore, farmers who were not involved in the trials are starting to experiment with pellet feeds. As the farmers are all located in aquaculture zones, it is likely that these non-trial farmers have observed the trials, or heard about them from the farmers that were involved in the trials.

Currently, both the trial and non-trial farmers are using pellet feeds that have not been specifically formulated for marine fish. For example, they reported using chicken feed mixed with squid oil or even striped catfish feed. As a result, they are experiencing mixed results. In this regard, one farmer that was using catfish feed reported poor growth, and has recently changed his feed to a marine finfish diet.

3.4 Project proposals

Based on the consultations with the marine cage culture stakeholders in Indonesia, Thailand and Viet Nam, three project concepts have been developed. These cover the key issues that need to be addressed to ensure the sustainable development of the industry in the Asia region. These comprise:

1. Development of a suitable pellet feed for large humpback and brown-marbled grouper

Target beneficiaries

The target beneficiaries of the project are the grouper farmers with additional benefits to farm workers and the pellet feed manufacturing industry. In addition, the reduced demand for trash fish/low-value fish from the grouper farmers will reduce fishing pressure on the fish stocks. In time, the increased availability of feed fish species (low-value fish) in the fishery will likely result in higher yields of the high-value species that are used for human consumption. An improvement in the yield of these fisheries would be of particular benefit to poor communities.

Background

The marine finfish aquaculture industry in Indonesia is a lucrative and fast growing sector. Indonesia is one of the leading producers of cultured marine finfish. Currently, the growth sector is grouper culture, and most notably, the humpback and brown-marbled groupers. These are both high-value species that are almost exclusively produced for the export market. The culture of these species is primary undertaken in small cages (3-6 m in length and width), and in sheltered inshore areas. Both species can be bred and raised in captivity. Currently, the majority of the fingerlings that are used in production are sourced from hatcheries.

The Indonesian marine finfish aquaculture industry is primarily an export orientated industry with the majority of product being exported to Hong Kong SAR of China, mainland China, Taiwan POC and Singapore. Small volumes of fish are also marketed locally for the high-end restaurant trade, for example, to the high-end Chinese restaurants. In Indonesia, grouper aquaculture has been identified as one of

the priority areas for development, and according to the 2011 Plan developed by the Directorate General of Aquaculture of the Ministry of Marine Affairs and the Fisheries, a production target of 20 000 tonnes is to be realized by 2014 (MMAF, 2011). To reach this target, a production increase of 31 percent per annum is required.

Issues to be addressed

The main constraint to the expansion of the grouper culture sector is the lack of appropriate pellet feeds. The industry continues to use trash fish/low-value fish as the primary feed source. However, the exploitation of this resource has reached its maximum potential. Trash fish/low-value fish is becoming increasingly scarce, and prices are rising rapidly. In 2002, Indonesia used an estimated 96 134 tonnes of trash fish/low-value fish for aquaculture (Stobutzki *et al.*, 2005).

Typically, the industry uses pellets for smaller (≤ 250 g) fish, and achieves good growth using the current formulations. However, for larger fish (> 250 g), the pellets that are available in the market are of inferior quality, and in comparison with trash fish/low-value fish, result in reduced growth. The harvest size for humpback grouper and brown-marbled grouper is 0.4–0.6 kg and 0.5–0.7 kg respectively. As the bulk of the feed that is used in production is consumed by groupers that are more than 250 g in weight, considerable amounts of trash fish/low-value fish is required.

Typically, trash fish/low-value fish is sourced locally, and although it is of a high quality, there are limited supplies and prices continually increase. While the availability of trash fish is limiting the expansion of this sector, and price increases erode profit margins. Clearly, there are concerns that trash fish/low-value fish is becoming scarce, and that the future dependence on trash fish/low-value fish as a feed source is will become unsustainable.

The need to develop suitable commercial pellets for larger fish (> 250 g) to replace the trash fish/low-value fish feed was first identified in 2005 (Williams and Rimmer, 2005). The development of a suitable pellet feed for grouper is now an urgent consideration for sector development, and in a 2011 stakeholder meeting for the project “Reducing the dependence on trash fish/low-value fish as a feed for aquaculture of marine finfish in the Asian region”, the need to develop a pellet feed was stressed. The farmers have indicated that they would very much like to use pellet feeds throughout the entire grow-out period, but are unable to do so as the diets that are currently available result in inferior growth in the larger groupers. In addition, disease transmission from feeding trash fish/low-value fish to the culture species has been identified as a significant production risk.

The grouper farming industry is small compared to other sectors, however there are still significant feed sales to be made, and a profitable business can be made from the production and sale of pellet feeds for the large groupers. However, feed companies appear to see a high risk in undertaking research and development for specific feed formulations. The reason being that they cannot be sure that they will receive an adequate return on investment.

The following business case for grouper pellet feed production has been developed:

- The maximum price that farmers are willing to pay for a pellet feed that is suitable for brown-marbled grouper = US\$2.5/kg.
- The maximum price that farmers are willing to pay for a pellet feed that is suitable for humpback grouper = US\$3.5/kg.
- At current production levels of 9 000 tonnes of grouper per annum in Indonesia, and assuming an FCR 1.2, there are potential annual feed sales of US\$27 million.
- At Indonesia’s 2014 target production level of 20 000 tonnes of grouper a year, this equates to about US\$84 million in potential feed sales per annum.

The development of specific diets for grouper will likely lead to improvements to growth rates above those currently achieved using trash fish/low-value fish, lower levels of disease, and greater environmental sustainability.

Objective

To develop grouper pellet feeds that achieve superior growth rates when compared to currently available commercial grouper feeds.

Outputs

Output 1: Current knowledge of grouper nutrition reviewed

Output 2: Feed companies engaged in projects to work in developing pellet feeds

Output 3: Grouper pellet trials

- Theoretical feed formulations
- Manufacture of a small batch of grouper feeds
- On farm trials of different feed formulations

Output 4: Dissemination of feed trial results to the feed companies

Output 5: Promotion of the new pellet feeds for adoption by the grouper farmers

2. Development of better management practices for cage mariculture in Indonesia, Thailand and Viet Nam

Stakeholder analysis and target beneficiaries

The target beneficiaries of the proposed project would be marine cage farmers in Southeast Asia focusing on Indonesia, Thailand and Viet Nam. During the period between 7 June to 23 July 2011, field visits were undertaken and stakeholders' workshops were held with farmers in Indonesia, Thailand and Viet Nam as part of an FAO mission to understand the bottlenecks in the development of sustainable marine cage culture in Southeast Asia. The lack of guidelines of farm management practice for the marine cage culture industry was highlighted as a key constraint to the sustainable development of the industry in Southeast Asia. In the Indian shrimp farming industry, and more recently in the Vietnamese catfish farming industry, the development and improvement of management practice guidelines, through a research program, has been shown to improve the environmental, social and economic sustainability of the industry. The better management practice approach would expect to bring substantial benefits for the marine cage culture industry.

Background

Mariculture in cages in inshore areas is a fast growing industry. The industry is characterized by the culture of a range of high-value species. Some of the important culture species in Indonesia, Viet Nam and Thailand include: humpback grouper, brown-marbled grouper, coral trout grouper, barramundi, snubnose pompano, red snapper, cobia, golden trevally and lobsters. Although marine cage farming is considered to be lucrative sector, the industry is characterised by variable performance levels between farms. In addition, it is coming under pressure from increasing costs, particularly feed, the lack of an adequate and timely supply of fingerlings, and increasing incidences of disease. The industry provides income for small-scale family owned cage culture businesses, and employment and income for larger scale cage culture businesses. The sector is predominantly export orientated with products primarily exported to mainland China, Hong Kong SAR, Taiwan Province of China and Singapore. In this respect, the industry contributes to valuable foreign exchange earnings to these Southeast Asian countries.

Issues to be addressed

The marine cage culture industry is characterised by a wide range of species, environments, culture scales, management practices, and levels of profitability. Feed is

the largest input cost in marine cage culture in Asia, and while poor quality feeds are generally held responsible for aquaculture pollution, poor feed management is often the leading cause of this pollution. The amount of feed that is not consumed by the culture species can be significant, and depends not just on the physical characteristics of the feed, but also on the way that it is fed (New, 1996).

Feeding and feed management is perhaps one of the most critical aspects of farm management - feed represents the highest production cost, and many farmers feed inefficiently. For example, under experimental conditions, food conversion ratios (FCRs) for trash fish/low-value fish are about 3.5:1 (Chua and Teng, 1982; Millamena, 2002). However, under farming conditions, FCRs often vary between 6:1 to 17:1 (Williams and Rimmer, 2005). Furthermore, reported differences in the FCRs between individual farmers indicate that FCRs can be even higher. Clearly, if the FCR under farming condition can be reduced to even approaching 6:1, enormous amounts of trash fish/low-value fish can be conserved.

Due to the variety of species cultured and their different culture requirements, farmers often find it difficult to recognise the species-specific culture requirements, and optimize performance. Considerable feed wastage occurs; without adequate feed guidelines, farmers typically feed to satiation or at an arbitrary ration rate without understanding the implications on performance and profitability. Farmers lack the information, resources, and are adverse to the risk of undertaking their own rigorous trials to determine the efficacy of different feeding methods. Although farmers generally use feeding systems that are based on their own trials, the trials that are undertaken are usually not repeated, and are often stopped once a system is found to work, regardless of whether it is optimized or not.

In addition to the feed composition and the physical properties of the feed, there are species-specific feed management issues that can influence feed efficiency, these include: feed rations, feeding time and frequency, and stocking density. The optimal feed rations, feeding times, and stocking densities have been shown to change with the life stage or size of the fish.

Objectives

To develop better management practices (BMPs) for marine cage culture in Southeast Asia and promote their adoption by the industry. The BMPs aim to increase the economic, environmental and social performance of the marine cage culture industry in Southeast Asia.

Outputs

Output 1: Review the current status of marine cage farming practices in Southeast Asia, focusing on grow-out management practices such as feed use, feeding methodologies, stocking methodologies, but also covering cage siting, cage maintenance, disease treatments, grading, harvesting, and the economics of the farming operations.

Output 2: Farmer participatory trials to improve feed management for each key culture species in Indonesia (humpback grouper and brown-marbled grouper), Thailand (barramundi, brown-marbled grouper and coral trout grouper) and Viet Nam (snubnose pompano, lobster and cobia) conducted.

Output 3: Better management practice guidelines for marine cage culture focusing on key species in Indonesia, Thailand and Viet Nam developed and disseminated.

Output 4: Farmer trainings conducted, demonstration farms established and farm visits carried out to promote BMPs

3. Development of the marine finfish backyard hatchery industry in Viet Nam

Background

Marine finfish cage culture has significant potential in Viet Nam, and the country has a wide range of suitable environments for marine cage culture. The country is also near the major Chinese market for marine finfish, and due to the low transport costs, it can deliver live fish to the market. As a result, live fish from Viet Nam commands higher prices than other countries in the region - boats of buyers from Southern China travel down to Southeast Asia to collect the harvests.

Issues to be addressed

Though Viet Nam commands a high price for its live marine fish products, the sector is constrained by a lack of local fingerling hatcheries. This means that fingerlings are either wild caught, or imported at high cost. The imported fingerlings are often of a poor quality, and usually they could not have been sold to the local farmers in the country of origin. Furthermore, during transportation fingerlings are subject to high levels of stress, resulting in poor condition and quality.

Marine finfish hatcheries are all but absent in Viet Nam. The government hatchery in Nha Trang has state-of-the-art research and development facilities, but there is insufficient professional staff to make the effective use of the well-equipped facility. The government hatchery is primarily geared to research and development, but has the facilities (e.g. large broodstock holding/spawning tanks and associated egg collection equipment) and the specific expertise to produce large quantities of fertilized marine finfish eggs.

In comparison, Indonesian backyard shrimp hatchery producers, with training and technical advice from the Government breeding and hatchery experts, have successfully transformed into marine finfish seed producers. The backyard marine finfish producers generally do not hold broodstock - large tanks are required to hold broodstock and each broodstock pair can produce more eggs than a small-scale/backyard hatchery can use. As a result, fertilized eggs are purchased from the government hatcheries, or private facilities holding broodstock. In terms of Viet Nam becoming self sufficient in marine finfish seed production, the backyard hatchery model of converting ex-shrimp backyard hatcheries into marine finfish hatcheries shows significant promise.

Objectives

To develop a small-scale/backyard marine finfish hatchery industry in Viet Nam.

Target beneficiaries

The target beneficiaries are the marine finfish cage farmers, who are mostly small-scale producers. It is also anticipated that some of the backyard shrimp hatcheries that have been converted to marine finfish hatcheries will also benefit from the project.

Outputs

Output 1: A model of a marine finfish hatchery industry developed that illustrates linkages between:

1. Broodstock holding facilities producing fertilised eggs
2. Backyard hatcheries producing fingerlings
3. Growout cage farms producing table fish

Output 2: Small-scale shrimp hatchery operators interested in becoming marine finfish hatchery operators are identified.

3.5 SUMMARY REPORT OF MISSION ACTIVITIES

This section describes the activities and salient findings of the mission.

1) Indonesia

Key activities in Bandar Lampung included farmers' interviews, workshops with project partners, and a stakeholder workshop with farmers. Interviews with cage farmers were undertaken to determine current feeding activities, their knowledge of the trial results, the level of uptake of the trial results, and the identification of the current issues and constraints to their culture activities that could be solved with technical assistance from FAO and other development agencies. Interviews with hatchery operators were undertaken to evaluate the major constraints to the supply of fingerlings to the growout sector. Discussions with project partners were undertaken to clarify issues and gaps relating to the participatory trials that compared the use of trash fish/low-value fish with pellet feeds for brown-marbled grouper.

A stakeholders' workshop with farmers and staff from Main Centre for Mariculture Development (MCMD) was facilitated to provide information to non-trial farmers about the farmer participatory trial results, further understand the current practices, the level of uptake by the farmers of the project findings, the current issues and constraints to grouper culture development, and to prioritise potential project concepts to assist the development of the sector.

Findings

Growout farmers' interviews

Four growout farms were visited (two of the farms also operated hatcheries). The farmers who were visited have shifted to culturing humpback grouper as their primary culture species. This was due to their high market price when compared to brown-marbled grouper. As the trials were undertaken with brown-marbled grouper, the trial results were not directly applicable to humpback grouper. One of the two non-trial farmers who was visited knew about the trials and trial results. However, he did not implement the recommendations as he was raising humpback grouper. The other farmer visited was a relative of one of the farmers involved in the trial, but was not familiar with the trial results.

Hatchery farmers' interviews

The main hatchery area is Kalianda which is far from the growout farms, and is characterized by its exposure to unsheltered seas and the availability of good quality seawater. There are 18 small-scale 'backyard' marine finfish hatcheries in the Kalianda area, and three more hatcheries outside the Kalianda area but within Lampung Province (a total of 21 hatcheries are located in Lampung Province). The hatcheries are primarily producing humpback grouper fingerlings as this is the popular species in the Lampung area. The hatcheries purchase fertilized eggs from the government hatchery, or produce fertilized eggs from broodstock held in cages at the growout sites. One hatchery reported holding its own broodstock on site.

A typical hatchery runs 3-4 production cycles per year. One cycle comprises a batch of eggs that are reared to fingerling size (4–8cm total lengths). Typically, each batch that is received by the hatchery comprises 30 000 to 40 000 eggs. However, there are also 2-3 larger hatcheries that can accommodate 300 000–500 000 eggs per month. Stocking densities are about 500 fingerlings per 4 m³ tank. It takes between 3-4 months for the eggs to hatch and grow to a size that is ready for stocking into the growout cages (4-8 cm). The fingerlings of the humpback grouper are currently sold for about US\$0.2/cm (= 1 800 IDR). Most of the grouper hatcheries were converted from old shrimp hatcheries where disease issues have resulted in reduced demands for shrimp PL. In this regard, many shrimp hatcheries have gone out of business and are remained unused.

Hatcheries operate on a flow-through basis. Water is treated as it enters the farm. Farms use mostly activated carbon (from coconut husks) and sand to filter incoming seawater that is pumped into the hatchery from a depth of about 10 m, and 100 m from the beach. Depending on the weather and the water quality conditions, the filter media are changed every 4–7 days - rainy conditions results in high water turbidity clogging filters, requiring their frequent cleaning. Hatcheries often use antiseptics such as iodine to treat incoming water, and maintain sanitary conditions to reduce disease problems.

In terms of hatchery feeding protocols, *Artemia* are enriched with different commercial enrichment liquid/oils that are designed for rearing of marine fish larvae. Pellets are also mixed with enrichment lipids (HUFAs), and a vitamin and mineral mix to improve their nutritional profile.

Hatcheries suffer from a range of diseases including parasites, viruses and bacteria. Disease prevention and treatment protocols are briefly as follows: eggs are bathed in antiseptic and freshwater on arrival at the hatchery. Separate equipment is used for the larvae and larger fish. Prophylactic treatments of freshwater with an antiseptic are provided. If a disease occurs, the water in the tank is replenished, and therapeutic treatments are applied. Though survival to marketable size (4–8 cm) is only 3 percent, the hatchery operation remains highly profitable.

Farmers' workshop

Sixteen growout farmers attended the workshop. Some of the farmers also operated hatcheries. Generally, the farmers cultured humpback grouper, and sometimes brown-marbled grouper or other fish species. Farmers attending the workshop had between 3 months to 20 years experience (mean: seven years of experience). In terms of feed use, they reported that between 5 to 25 percent of their feed was pellets (generally about 20 percent), with the remainder being trash fish/low-value fish.

Generally, fish are fed pellets when they are small (<10 cm or less than 250 g), the larger fish are fed trash fish/low-value fish. The farmers' reasons for applying these feeding practices were that the trash fish is time consuming to cut into small pieces for the smaller fish, and the pellets for smaller fish give a reasonable growth rate in comparison to trash fish/low-value fish. Furthermore, when humpback grouper are fed the larger pellets (>5 mm) that are suitable for larger fish, the growth rate is inferior to that achieved when feeding trash fish/low-value fish.

There are imported brands of formulated marine fish feeds that farmers reported could be used to produce growth comparable to that of trash fish/low-value fish. The brands reported by the farmers included: NRD (Thai brand) and Otohimi (Japanese brand). However, the price for these feeds is about three times higher than the price of trash fish/low-value fish. The current price for Commfeed (Indonesian brand) is about US\$ 1.5/kg (376 000 IDR/25kg bag).

2) Viet Nam

The key activities were based around Nha Trang, Viet Nam, and included farmer interviews, discussion with project partners, and a stakeholder workshop with farmers. Interviews with cage farmers were undertaken to determine current feed practices, and establish their knowledge of the trial results, the uptake of the trial results, and identify current issues and constraints to their culture practices that could be solved with technical assistance from FAO and other development agencies. Interviews with government hatchery and others about the status of the marine finfish hatchery industry, and sources of fingerling were undertaken to evaluate any major constraints to fingerling supply to the growout sector. A stakeholders' workshop was held with the farmers and staff from Research Institute for Aquaculture No. 3.

Findings

Growout farmers' interviews

Farmers are primarily growing lobster and cobia. Cobia production from the Nha Trang area in Viet Nam is about 400 tonnes/year. Other species cultured include red snapper, snubnose pompano, coral trout grouper, orange-spotted grouper and brown-marbled grouper and pink ear emperor (*Lethrinus lentjan* - a new species introduced for cage culture, locally known as 'gay gay' in Vietnamese). Some farmers have begun to try pellet feeds. Farmers have a little knowledge of pellet quality, and some farmers were using a freshwater catfish feed. However, as the fish did not grow well on this formulation, one farmer has switched to "Tomboy", a brand of marine fish pellets, and is now observing improved growth rates. Farmers are feeding to satiation, with some farmers using the initial stocking weight of the cage to guide the initial feeding level. Even those farmers that use pellet feeds also use trash fish/low-value fish for their lobster and the larger cobia - pellets suitable for these species/sizes are not available in the market. Larger cobia (older than three months or 0.5 kg) require a very large pellet, and larger than those currently available in the market. In contrast, to suit its slow feeding habit, lobster requires a pellet that is water stable.

Prior to feeding, some farmers soak their pellets in water to soften them. This they believe increases its palatability. This practice may result in a large loss of nutrients from the pellets, and will likely result in reduced growth rates. It was evident that the farmers have a low level of understanding of appropriate feed management practices (either trash fish/low-value fish or pellet feeds), or of marine cage farming in general.

Disease is sometimes an issue for the farmers. Farmers use freshwater baths on a regular basis to reduce parasitic infestations. Freshwater baths are typically given every 10 to 15 days. Antibiotics are also used in lobster culture. Some farmers only administer antibiotics (human grade medicines obtained from pharmacies) when the lobsters appear sick, however, other farmers administer antibiotics as a prophylactic, and on a regular basis (such as three times per month). It is likely that the inappropriate use of antibiotics will lead to antibiotic resistant strains of bacteria in lobster culture systems. Guidelines on disease treatment, including the use of registered products and withholding periods would assist the sustainability of the lobster culture industry.

Local fingerling supplies are sourced from the government hatchery and one private hatchery. Currently, supply volumes cannot be met by local production. Fingerlings are therefore also imported from Taiwan POC, and these are often of low quality. The reliance on imported fingerlings is a major problem for the expansion of the local industry. When available, farmers are also using wild caught fingerlings, for example, pink ear emperor fingerlings. Some farmers reported waiting for Nha Trang University to import pompano fingerlings for sale to farmers. The lack and irregularity of fingerling supply is one of the major constraints to the expansion and profitability of the industry.

Hatchery farmers' interview

The government hatchery has excellent facilities and equipment but is short of experienced professional staff. Undertaking of large-scale spawning and the nursing activities to meet the commercial demand may take staff time away from their research and development activities, which are the primary aims of the centre. Production is a commercial responsibility, and in this respect a local hatchery industry should be encouraged and supported. The Indonesian model of backyard hatcheries that buy fertilized eggs from the government centres (that have large broodstock holding tanks), and culture the juveniles until they reach fingerling size, could be adopted in Viet Nam.

Farmers' workshop

Twelve grow-out farmers attended the workshop. In general, the farmers cultured lobsters (several species are cultured) and/or cobia. However, some farmers reported culturing grouper, pompano, red snapper and the pink ear emperor.

Farmers requested the development of marine cage culture guidelines, and training assistance to improve their culture practices in marine cages.

The marine cage culture industry in Viet Nam is constrained by a lack of fingerlings. Most fingerlings are imported from Taiwan, and there are issues of poor seed quality, delays in receiving fingerlings when they are required, and variable fingerling sizes in the same shipment. The farmers prioritized local hatchery production as a way to resolve these issues.

The farmers expressed concerns about the sustainability of lobster culture. Currently, this is the primary culture species in the area. Small lobster for on-growing in cages are caught in the local area where there is an abundant resource. The lobsters are primarily fed on trash fish/low-value fish but also on bivalves. Farmers would like to use pellet feeds but currently the pellets that are available are unsuitable due to their low water stability. Lobsters are slow feeders, and therefore prior to ingestion, the pellets must be water stable for at least 45 minutes.

3) Thailand

The activities that were undertaken in Krabi, Phang Nha and Phuket included farmer interviews, workshops with project partners, and a stakeholder workshop with farmers. Cage farmers were interviewed to determine current feed management practices, and establish their knowledge of the trial results, the uptake of the trial results, and the current issues and constraints to their culture practices that could be solved with technical assistance from FAO and other development agencies. Interviews with government hatchery personnel (the primary supplier of fingerlings for small-scale farmers) and other stakeholders in the marine finfish hatchery industry were undertaken to evaluate the major constraints in the supply chain.

A stakeholders' workshop was organized with 18 farmers (seven women) from the three areas (Krabi, Phang Nga and Phuket), and the staff from the Krabi and Phuket Coastal Fisheries Research Centres. The workshop was designed to provide information to non-trial farmers about the farmer participatory trial results, gain further understanding of the farmers' current culture practices and their adoption of the project findings, identify current issues and constraints to marine cage culture development, and to prioritise potential project concepts to assist marine cage culture development.

Findings

Growout farmers' interviews

Marine cage farmers in the Southwest region of Thailand (which includes Krabi, Phuket and Phang Nha) culture fish primarily for the domestic market. This area of Thailand is a popular tourist destination, and the live marine fish are primarily targeted to high-end restaurants catering to tourists. Though the export markets such as China, Hong Kong SAR of China, Taiwan POC and Singapore pay high prices, the transport costs to these markets from the west coast of Thailand is high - either as air freight or by boats that travel down the west coast of Thailand and Malaysia to reach Singapore and then sail back to China. The high transport costs and the relatively high demand and prices obtained on the local market, make the local market attractive to marine fish farmers.

Depending on the environmental conditions (primarily salinity), a number of species are cultured. These include barramundi or Asian seabass, brown-marbled grouper, orange-spotted grouper, cobia, pomfret, giant grouper, red snapper and coral trout grouper.

Conflicts with other resource users such as vessels (navigation), and infrastructure development is an issue in the region. For example, a marina is being built adjacent to sites of some of the project trial farmers. These farmers have since moved further upstream from the marina. There is also potential conflict between aquaculture zones and fishing zones, and more conflicts of this nature are expected in the future.

Generally farmers use low-value fish/trash fish but many of them also use pellet feeds (usually in combination with trash fish). A problem that was reported was that the pellet feeds can be difficult to obtain, and the ones that are available are not always suitable for marine finfish, or are out of stock. In addition, farmers' cash flow is often inadequate, and they cannot always afford to purchase the pellet feeds. The 2004 tsunami and the floods that have recently affected the area have also had a severe impact on the industry in terms of infrastructure damage, the loss of stock, or both.

Farmers' workshop

The workshop discussion focused on six related issues. The farmers were divided into three working groups by province (Krabi, Phang Nga and Phuket), and addressed these six questions: (i) why they do not use more pellet feeds; (ii) why their yield is low or not higher; (iii) why their costs are high or not lower; (iv) why their profit is low or not any higher; (v) why they cannot expand their farm; and (vi) what are the major risks at their farm? A women's mini-workshop was also convened to describe their roles and constraints to fulfilling some of these roles.

The responses, compiled from the three groups, are as follows:

1. **Why they do not use more pellet feeds.** The constraints ranged from the high cost of feed to absence of a local dealer. The two commonly cited constraints were high cost of feed and lack of capital. A group that cultivates mostly grouper cited the lack of species-specific feed formulation. A few thought the fish grew slowly on pellet. In relation to feed cost, they put the acceptable price of feed at the time at US\$ 1.30-1.40/kg. They also suggested a packaging size of 5-10 kg a pack rather than the current 20 kg pack. The volunteered to provide the feed company with feed size mould for different stages in the fish growth (i.e., starter, grower, finisher).
2. **Why yields are low or not any higher.** The constraints were a combination of economic constraint and natural hazards: uncertainties in the business so that they are reluctant to intensify and lack of capital so that they cannot even if they wanted to for the former, and disease, the shortage of fingerlings and natural hazards such as flooding for the latter.
3. **Why production costs are high.** As might be expected, the high cost of feed (both pellets and low-value fish) is the prominent constraint. The farmers cited a number of reasons, which include the high cost of transport - as the source of pellet feed is far, the higher cost of fishing from an increasing fuel cost as some of them fish for their own low-value fish, and the need to buy low-value fish from a distant place during closed fishing season.
4. **Why profits are low or not any higher.** Not surprisingly, their reasons are a combination of the high cost of inputs and low product price i.e. increasing feed costs, high cost of seed and low buying price set by middlemen. The other two reasons are a low level production - which is a result of lack of seed, and lack of capital to expand and low yields as a result of, mostly, fish mortalities. One bright note came from one group of farmers who are members of a cluster. They claimed that since they started the business they have not lost money and that their profitability is usually around 45 percent over operating cost.
5. **Why they cannot expand the farm.** A variety of constraints prevent them from expanding, an obvious pair being a limited culture area and lack of capital, but also insufficient labour - the high cost of labour is also felt because the three

provinces are major tourist areas and workers tend to look for jobs in the service sector. Some said they might expand if feed costs were lower. Some farmers said the low water salinity in the growing site does not allow growing some preferred species such as coral trout grouper.

- 6. Major risks.** Uncertainties in the business and various natural hazards comprise the risks that they perceive to be significant including the natural disasters, diseases, and the abundance of predators especially monitor lizards in culture areas near mangrove.

During an extended break in the workshop, the women agreed to organize into two working groups to discuss and provide answers to these issues: (i) the three most important problems related to the farm operations; (ii) three major problems in the household; and (iii) their role in the fish farming business.

On the first issue, they said they cannot operate the boat or dive to maintain the cages and some chores require intensive and hard work. Three major problems in the household include the predictable financial difficulty - more expenses than revenue and not having enough money to cover daily expenses. The two others are taking care of the children and spending more time with the family. Their major roles in the fish farming business include feeding as well as preparing the feed, marketing, net mending and some cage maintenance and preparing food for the workers.

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This technical paper presents the findings of an FAO Regional Technical Cooperation Project on the use of trash fish/low-value fish and pellets as feed for marine cage farming. Implemented in China, Indonesia, Thailand and Viet Nam, its components included a farmers' participatory on-farm trials and a concurrent survey of farmers' perceptions concerning the use of trash fish/low-value fish and pellet feeds and microcredit, environmental impact assessments of the use of two feed types, and a survey of the potential impacts of a change to pellet feeds on livelihoods of fishers and suppliers of trash fish.

There were indications of benefits to farmers and the environment of adopting pellet feeds. Improving feed management can boost technical and economic performance from pellet feeds. The recommendations include providing the opportunities and enabling farmers to translate their positive attitude into sustained adoption of pellet feeds. Enablers include reasonable credit facility, species- and growth-stage-specific feed, farmers being associated and sound technical advice. Farmers requested a standardized better management practice guide in cage mariculture. Losing the cage culture industry as their direct market would have minimal impact on the livelihood of fishers and fish suppliers; they have robust coping mechanisms that policy and technical assistance from government could strengthen.

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