

# Transition from low-value fish to compound feeds in marine cage farming in Asia



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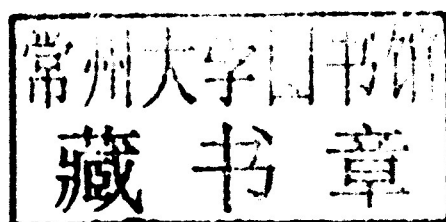
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# Preparation of this document

This fisheries and aquaculture technical paper presents the results of the FAO Regional Technical Cooperation Project “Reducing the dependence on the utilization of trash fish/low-value fish as feed for aquaculture of marine finfish in the Asian Region (TCP/RAS/320 (D))”, which was implemented between August 2008 and July 2011 in four selected countries in Asia; China, Indonesia, Thailand and Viet Nam. The project has been implemented in collaboration with the FAO Regional Office for Asia-Pacific (FAORAP) and the Network of Aquaculture Centres in Asia and the Pacific (NACA) and was coordinated by Mohammad R. Hasan, Aquaculture Officer (FIRA). This document comprises two sections; Part A being the consolidated report and a synthesis of the results of the different components and activities of the project, and Part B being the annexes containing the detailed reports of the above mentioned components. The preparation of this technical paper was also coordinated by Mohammad R. Hasan and many persons contributed both technically and/or editorially to the production of this volume.

# Abstract

This technical paper presents the findings of the FAO Regional Technical Cooperation Project TCP/RAS/3203 (D) “Reducing the dependence on the utilization of trash fish/low-value fish as feed for aquaculture of marine finfish in the Asian Region,” which was implemented between 1 August 2008 and 31 July 2011 in China, Indonesia, Thailand and Viet Nam. It comprises the results of the project components, namely, farmers’ participatory on-farm trials and a concurrent survey of farmers’ perceptions concerning the use of two feed types and microcredit, environmental impact assessments of the use of both feed types, and a survey and analysis of the potential impacts of a change to pellet feeds on the livelihood prospects of fishers and suppliers of trash fish/low-value fish. An assessment of changes in the perceptions of farmers before and after the farm trials was undertaken, and a final regional stakeholders’ workshop was conducted after the completion of all the project components. Incorporated in the relevant parts of the report are the findings of a follow-up mission conducted 16 months after the end of the project. This mission was designed to confirm the findings, and assess further activities in line with the recommendations made at the final regional stakeholders’ workshop.

There were indications of the clear benefits to farmers as well as to the environment of adopting pellet feeds. Some indicators were not statistically significant, but present opportunities for addressing the constraints to the farmers’ adoption of pellet feeds. A dominant finding was that the technical and economic performance from pellet feeds can be considerably enhanced by improving feed management, which was not a common attribute among the trial farmers. Furthermore, overall farm performance, whichever feed type was used, could be improved by introducing better management practices. The environmental impact assessments on the use of the two feed types suggested that good feed management and overall farming practices, and improving the quality of trash fish/low-value fish or pellets reduce the impacts of feed on the water beneath and around the culture sites. In addition, a good culture site where the carrying capacity is not stressed by aquaculture and non-aquaculture activities will considerably reduce the mortality risks from biotic and abiotic hazards. The technical and economic findings of the study were noted by the farmers, and contributed to the changes in their attitudes towards the pellet feeds from negative or neutral to positive. The recommendations of the project included providing the opportunities and enabling the farmers to translate their positive attitude into actual and sustained adoption of pellet feeds. Interventions that would promote the adoption of pellet feeds, among others, would include reasonable credit facility, species- and growth-stage-specific feed formulations, farmers being associated to take advantage of economy of scale, and advice on better management practices. A standardized guide for a better management practice in cage mariculture was unanimously requested by the farmers.

The impact on the livelihood of fishers and fish suppliers from losing the cage culture industry as a direct market for their trash fish/low-value fish was found to be minimal; they have robust coping mechanisms, which can be strengthened by policy and technical assistance from government.

**Hasan, M.R.**

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# Abbreviations and acronyms

AA	amino acid
ACIAR	Australian Centre for International Agriculture Research
AOAC	Association of Analytical Communities (previously Association of Official Analytical Chemists; previously Association of Official Agricultural Chemists)
BMP	better management practice
CF	condition factor
cfu	colony forming unit
CNY	Chinese Yuan Renminbi
DO	dissolved oxygen
EEZs	exclusive economic zones
eFCR	economic feed conversion ratio
FAO	Food and Agriculture Organization of the United Nations
FAO RAP	Regional Office for Asia and the Pacific of FAO
FCR	feed conversion ratio
FIEP	Fisheries Economics and Policy Division of the FAO Fisheries and Aquaculture Department
FIFO	fish-in fish-out
FIRA	Aquaculture Service of the FAO Fisheries and Aquaculture Department
GIS	geographical information system
ICZM	integrated coastal zone management
IDR	Indonesian Rupiah
LRFFT	live reef food fish trade
LFFRT	live food fish restaurant trade
NACA	Network of Aquaculture Centres in Asia-Pacific
NGOs	non-governmental organizations
NH <sub>3</sub>	ammonia
NO <sub>2</sub>	nitrite
NO <sub>3</sub>	nitrate
Pf	pellet feed
pH	potential hydrogen ion concentration
PO <sub>4</sub>	phosphate
PPP	public private partnership
R&D	Research & Development
SGR	specific growth rate
Tf/Lvf	trash fish/low-value fish
TCP	Technical Cooperation Programme
THB	Thai Baht
TNC	the Nature Conservancy
TOM	total organic matter
US\$	US dollar
VND	Vietnamese Dong
VNN	viral nervous necrosis

# Contents

Preparation of this document	iii
Abstract	iv
Contents	v
Acknowledgements	viii
Contributors	ix
Abbreviations and acronyms	xi
<b>Part A – Consolidated report and synthesis of the project findings</b>	<b>1</b>
Executive Summary	1
<b>I. Introduction</b>	<b>7</b>
1. Background and rationale	7
<b>II. Project activities</b>	<b>11</b>
<b>III. Synthesis of project findings</b>	<b>13</b>
1. Project components	13
2. Outcomes	13
3. Linkages among the project components	13
4. Salient findings	15
5. Broader regional concerns addressed by the project	18
6. Opportunities identified	21
<b>IV. Farmers’ participatory trials</b>	<b>23</b>
1. Rationale	23
2. Summary of findings	23
3. Methodology	24
4. Findings	24
5. Synthesis of results in four countries	31
<b>V. Farmers’ perceptions</b>	<b>33</b>
1. Rationale	33
2. Methodology	33
3. Findings	33
<b>VI. Environmental impact study</b>	<b>41</b>
1. Rationale	41
2. Summary of findings	41
3. Methodology	42
4. Results	43
<b>VII. Livelihood analysis of low-value fish suppliers</b>	<b>51</b>
1. Rationale	51
2. Methodology	51

<b>VIII. Crosscutting issues</b>	<b>57</b>
1. Fundamental issues	57
2. Crosscutting issues	58
3. Priorities	58
<b>IX. Conclusions and recommendations</b>	<b>61</b>
A. Conclusions	61
B. Recommendations	63
<b>References</b>	<b>67</b>
<b>Part B – Annexes</b>	<b>69</b>
<b>1. Farmers' participatory trials</b>	<b>71</b>
Executive summary	71
1. Introduction	72
1.1 Objective	72
2. General methodology	72
2.1 Proximate and amino acid composition	73
2.2 Performance parameters	73
2.3 Statistical analysis	74
3. Farmers' participatory trial: China	74
3.1 Materials and methods	74
3.2 Results	77
3.3 Discussion	83
4. Farmers' participatory trial: Indonesia	85
4.1 Materials and methods	85
4.2 Results	87
4.3 Discussion	92
5. Farmers' participatory trial: Thailand	93
5.1 Materials and methods	93
5.2 Results	96
5.3 Discussion	102
6. Farmers' participatory trial: Viet Nam	103
6.1 Materials and methods	103
6.2 Results	106
6.3 Discussion	110
7. Synthesis of the four country studies	112
7.1 Limitations on comparisons between four country trials	112
7.2 Groupers	114
7.3 Red snapper	115
7.4 Barramundi and snubnose pompano	115
7.5 Pellet feeds	116
7.6 Common themes	116
References	116
Annexure A – List of fish species cultured in cages in the Asia-Pacific	119
Annexure B – Trash fish/low-value species commonly used as feed in cage culture	120
<b>Annex 2. Comparision of the environmental impact between fish fed trash fish/low-value fish and pellet</b>	<b>121</b>
Executive summary	121
1. Introduction	122
2. Environmental impact	122
3. Methodology and findings	123

3.1 GIS mapping of the project cages	124
3.2 Current speed, direction and dispersion	124
3.3 Bathymetry	126
3.4 Water quality	126
3.5 Comparison of nutrient discharge	134
3.6 Sediment quality	136
3.7 Pathogen transfer	138
3.8 Trash fish/low-value fish quality	138
3.9 Bacterial levels in water column	138
3.10 Nutrient leaching to the water column	140
3.11 Comparison of energy use	142
3.12 Fish-in Fish-out Ratio (FIFO)	143
4. Conclusions	145
References	147

### **Annex 3. Impacts of pellet feed use in marine cage culture on the sector and livelihoods**

Executive summary	149
1. Introduction	152
1.1 Objectives	152
1.2 Methodologies	153
2. Findings	153
2.1 The outlook for fishers and suppliers of trash fish/low-value fish	153
2.2 Institutional support	161
2.3 Household decision-making livelihood strategies	161
2.4 Decision factors	162
3. Observations and conclusions	164
3.1 Changes in perceptions and attitudes to pellet feed	165
3.2 Perceptions and outlooks of fishers and traders of low-value fish	165
3.3 Issues related to the changes in perceptions and attitudes	171

### **Annex 4. Report of the final regional stakeholders' workshop**

Executive summary	173
1. Project rationale, objectives and deliverables	173
2. Workshop presentations	174
3. Major findings and inferences of the workshop	174
4. Identified issues and workshop recommendations	176
4.1 Pellet feeds for mariculture	176
4.2 Trash fish/low-value fish	176
4.3 Better management practices (BMP)	177
4.4 Dissemination of findings	177
4.5 Other recommendations	178
5. Concluding remarks	178
Annexure A – Participants of the workshop	180

### **Annex 5. Project uptake and future priorities**

Executive summary	183
1. Introduction	183
2. Methodology	184
3. Results	184
3.1 Issues requiring attention in the final report	184
3.2 Relevance of project recommendation	185
3.3 An assessment of the uptake of farmers' participatory trial results	187
3.4 Project proposals	188
3.5 Summary report of mission activities	193
References	198



# Part A – Consolidated report and synthesis of the project findings<sup>1</sup>

## EXECUTIVE SUMMARY

Three strategic outlooks guided the methodological approach of the project. The first was to understand the roles of the immediate stakeholders of the marine cage culture industry – fishers and traders of low-value fish, farmers, and feed manufacturers – in the pursuit of the main objective of the project; the second was to treat the transition to commercially formulated feeds as a process of adopting a package of technology rather than the use of an alternative material input; and the third was to study the technical, economic, environmental and social constraints to the transition to commercial pellet feeds. Part of the social component of the project was an assessment of the possible impacts that a transition to pellet feeds would have on the livelihoods of the fishers and suppliers of trash fish/low-value fish.

The context of this regional project was defined by two regional trends in the marine aquaculture sector in Southeast Asia and Southern China and one global concern. These are (i) the increasing production in high-value carnivorous marine finfish, (ii) the decreasing supply of low-value aquatic animals that are extensively fished and used as feed for the cultured fish, and (iii) the increasing global concern over the use of fish to feed fish. The first and second issues highlight two problems, namely, a growing shortage and rising cost of trash fish/low-value fish, and the likely over exploitation of the fishery resources. The third is a potential trade problem arising from an ethical issue. This issue may not be wholly addressed by the use of pellet feeds in which the main protein and lipid sources is fishmeal and fish oil respectively. The switch however would increase the efficiency of feed (and therefore fish as feed) utilization. Nonetheless, these three issues collectively serve as the justification for the overall objective of the project, which is *to reduce the reliance of cage culturists on wet fish as a direct source of nutrition for their stock, and move them towards the use of commercial feed formulations*.

The project found that the farmers who have been using commercial feed formulations solely or in combination with trash fish/low-value fish tend to better understand the linkages between profitability and good feed management. This affirms the technical justification for the corollary objective of the project, which was *to improve the farm management practices of farmers* regardless of the feed they were using. The received wisdom from agricultural technology diffusion studies is that a better farm manager is likelier to adopt a technological innovation earlier.

The broader perspective adopted by the project is that a commercial feed formulation is part of a new technology package - rather than a more efficacious material, and this is reflected by its having technical and economic, environmental and social components. These are described briefly as follows:

- The technical component comprises the on-farm trials using farmers' standard practices and supervised by the technical personnel of the project. It compared the technical and economic efficiencies of pellet feed and trash fish/low-value fish and demonstrated the possibility of using pellet feeds in marine fish farming, and especially on grouper farms, where the farmers have well-entrenched attitudes towards the use of trash fish/low-value fish and are sceptical of pellet feeds.

<sup>1</sup> Part A of this technical paper has been prepared by Mr Pedro B. Bueno and Dr Mohammad R. Hasan.

- The environmental component compared the biological and physical impacts of trash fish/low-value fish and pellet feed on the water column, and the bottom sediments in the immediate culture area, the amount of embodied energy required to produce a kilogramme of fish, and the amount of fish needed to produce a kilogramme of fish (fish-in fish-out ratio, or FIFO).
- The social component comprises three aspects: an assessment of the livelihood assets and options available to fishers and traders of trash fish/low-value fish, and their perceptions of the potential impacts that a wholesale switch by the farmers from trash fish/low-value fish to pellet feed would have on their livelihoods. An assessment of the perceptions and attitudes of the fish farmers towards the use of trash fish/low-value fish and pellet feeds before and after the farm trials, and an assessment of farmers' perceptions of their access to, and use, of credit for capital and operational expenses including the purchase of pellet feeds. Attached to the farm trials and the farmers post-trial perceptions were a series of assessments of the farmers' knowledge of the attributes of pellet feeds, their access to supply, and the feed manufacturers' perspectives on the issues.

The relevant findings are:

- Farmers do not always have good access to pellet feeds, and while trash fish/low-value fish is more readily available, and its price is increasing, it is still generally cheaper than pellet feeds.
- Farmers are aware that those pellet formulations that are available, apart from those produced specifically for some species, are not specific to the species or the growth stage of the stock so that they use cheaper or less suitable substitutes resulting in poorer FCR.
- Many farmers have been using a combination of pellet feeds and trash fish/low-value fish, i.e. pellets for small fish and trash fish when fish are larger,
- Feed management is generally poor, and is given less attention than health management by the farmers.
- Accessing seed of the desired culture species is a general problem - more so in Thailand and Viet Nam where supplies are unreliable, or of poor quality, or both,
- Diseases cause significant reduction in profitability in China, Indonesia and Viet Nam, while influx of freshwater into the estuaries where cages are sited causes massive mortalities in Thailand.
- Cash flow does not match, or credit is inadequate, for the capital outlay needed to purchase pellet feeds.
- Feed manufacturers are hesitant to produce a feed that is tailored to a species that is not being produced in enough volume to create an economy of scale - with the exception of humpback grouper in Indonesia, cobia in Viet Nam and barramundi in Thailand.

A follow-up mission to Indonesia, Viet Nam and Thailand that was undertaken 16 months after the end of the farm trials found varying levels of uptake of the project findings by the farmers. Vietnamese farmers had begun trying pellet feeds; Indonesian farmers were hesitant to use the results of the trials on brown-marbled grouper for their preferred species, humpback grouper; Thai farmers found accessing pellets difficult. An encouraging finding was that all the farmers would switch to pellet feeds if suitable formulations and sizes were available. An issue shared by the Vietnamese and Thai farmers was the lack of quality seed. Access to capital remained a prominent constraint to the uptake of pellet feeds, and farm expansion. Finally, a business case, drawn from the potential market for grouper feed in Indonesia, can be made for the production of species-specific feeds.

To place these findings in the context of the project objective, access to feed, seed, and operating capital are technical constraints associated with a lack of inputs. Poor feed management and disease control are operational problems exacerbated by the lack

of proper technical and management guidance. The lack of suitable pellet feeds in the market is first and foremost a business issue. In this regard, research on the nutritional requirements of specific species and use of alternative low-cost ingredients may help feed manufacturers develop suitable formulations. Research on alternatives to fishmeal has in fact been intensified, especially in Europe, but the projects are mostly geared to salmon and other species, and none or hardly any research has been undertaken on groupers. However, some of the results could be used by Research & Development (R&D) institutions in Asia-Pacific to develop specific feeds for species that are cultured in the region. Policy incentives to promote technology development and for the manufacture of feeds that are specific to mariculture species in Asia could facilitate the commercial production and marketing of the products. Meanwhile, feed manufacturers may consider organized farmer groups as part of the feed supply chain to which the usual distributor or retailer discounts could be granted.

The assessments found that the attitude of most farmers is generally favourable towards the use of pellet feeds; prior to the trials, some had been using them, and others have seen the possibility of their use from the farm trials. These findings suggest that the key to adoption is to make the right kind of feeds available and easily accessible. Everything else supports the farmer's decision to adopt the feed. After adoption, there is a need to reinforce the farmer's decision so that he or she does not revert to using trash fish/low-value fish. The supporting elements would be technical advice on better management practices, enabling ready access to operating capital with timely cash flows, or the provision of commercial loans on favourable terms, enabling the purchase of feed at discounted prices (through bulk buying, for instance), providing the right motivation for farmers to organize, and sustaining technical advice through extension. A major assistance would be to encourage and facilitate the organization of farmers' associations or to strengthen existing ones. The project had inspired the Vietnamese and Indonesian farmers to infuse professionalism in the programme, and to improve the operation of their existing associations. Some of the Thai farmers were beneficiaries of a government funded Community-based Enterprise Development Programme, in which contiguous farmers are participants, and are provided access to training, technical advice and small loans.

The environmental assessment showed no significant difference in the biological and physical impacts of using either feed source on the waters and sediment of the farm sites; the slight differences that were found were attributed to feeding practices and the quality of the feed used, particularly the trash fish/low-value fish. This in fact is a significant result, and it highlights the need to regulate the density of farm units to an optimal number that does not exceed the carrying capacity of the area. The finding further highlights the importance of applying appropriate stocking densities and feeding practices. The finding on site pollution, notwithstanding the statistical insignificance of the impacts, would be an important part of a better management guide. The estimations of energy usage revealed that more energy is embodied in the amount of pellet feeds than feed fish needed to produce a kilogramme of fish. On the other hand, calculations of FIFO (fish-in fish-out) showed less fish is used with pellet feeds to produce a kilogramme of fish. The comparative energy consumption can be an important issue from a global perspective. However it is hard to see how this could be incorporated into an extension message. The same might be said of the FIFO result. In the end, the pollution, energy and fish-in fish-out issues will be addressed at the farmer level by promoting the efficient use of feed and better management practices. These could be more broadly addressed through Research & Development (R&D) on alternative feed ingredients, which has been intensifying, and policy incentives for technology development and manufacture of less polluting and more efficacious feeds that uses less or no fish. The embodied energy issue would have to be part of national and global programmes to reduce the carbon footprint of the industry.

The social component of the project addressed the livelihood alternatives of the fishers and traders of trash fish/low-value fish. Its justification was that the livelihoods of fishers and traders – who have long been important stakeholders in the development and expansion of the marine cage culture sector of Southeast Asia and Southern China – are threatened by a wholesale shift to commercially formulated feeds. The findings indicate that the fishers principally target food fish which brings a higher income or, in the case of small fishers, is for home consumption. Fishers have a market for the trash fish/low-value fish in terms of the fishmeal processors, and already have or can find alternative occupations. The findings suggest that the greater threat to the fishers' livelihoods will not come from farmers ceasing to buy trash fish/low-value fish, but from the depletion of the fishery resources. The policy implications from these findings include providing assistance to the fishers that use large boats to improve their on-board preservation techniques so that they can land a higher proportion of food grade fish; in the event that policies are developed to reduce fishing capacity, there will be a need to develop alternative livelihood opportunities and training programmes, better management of the fishery resources, including the introduction of closed seasons, appropriate gears, and the withdrawal of fuel subsidies. In addition to the impact on the fishery resource, fuel subsidies fail to reflect the true market price of the fish, which in the long run, when the supply of trash fish comes to an end, would expose the low efficiency and therefore poor competitiveness of a country's cage culture industry. Furthermore, a higher price for trash fish/low-value fish may even hasten the farmers' transition to pellet feeds.

There are a number of issues that the project brought to light but did not address directly in the implementation. Foremost among these was the market and market access. The market prospects in Southeast Asia and southern China remain positive. The diminishing wild catch of, particularly, grouper, would increase demand for farmed fish. Ironically, the lack of seed stock helps to maintain high prices as the farmers cannot stock their cages. The industrial scale production of marine fish in large offshore cages has started, but is not expected to expand rapidly so that in the foreseeable future, much of the supply will still come from the inshore or near shore small- to medium-scale cage farms. The occasional natural disaster and fish kill from biotic and abiotic causes keep a check on oversupply. The growth in trade of live fish to supply the restaurant trade in Southeast Asia and southern China is not showing signs of abating, and the issue of certification is not as yet a major concern. However, an international standard on live reef food fish trade has been issued by the Nature Conservancy (TNC) and several collaborating organizations, which includes management and operational requirements for cultured live food fish. It is for voluntary adoption in the live reef food fish trade. Certification standards could be the next area of concern for farmed fish. Better management practice (BMP) guides that are developed should incorporate these standards.

Marketing issues are dependent on the species being farmed: premium species such as coral trout grouper and mouse grouper are primarily exported to southern China and China, Hong Kong SAR. Lower priced species like brown-marbled and orange-spotted groupers are raised for the local market or sold directly to seafood restaurants. Price related risks are higher for premium species that are exported and therefore have a longer market chain. In the future, assistance would be needed in terms of supplying real time market information and organized marketing. Prices in the local markets are more easily monitored, and communication between farmers and buyers can be facilitated by the cellular phone.

The marketing, credit and cash flow issues influence the farmers' decisions in terms of whether to adopt pellet feeds or continue using low value/trash fish. The lack of sufficient capital restricts a farmer's ability to buy pellet feeds. Lines of credit could alleviate this problem and ensure that there was sufficient operating capital throughout



the production cycle. In addition, increased credit and improved cash flow, would increase the farmers' ability to negotiate product prices and prevent them from being forced to sell their fish at a low price - although an inescapable bio-economic constraint is the diminishing economic returns from feeding fish beyond a given optimal size. The marketing-credit nexus has been given due attention by the project, and the general need is the provision of adequate loans on reasonable and easy terms. This becomes a crosscutting issue that has to be addressed by convincing the institutional lending agencies that the cage culture farmers are creditworthy. Creditworthiness could be linked to the adoption of better farming practices, and the farmers being organized. Lending schemes at low interest rates could be developed for organized farmers adopting BMPs.

Closely related to creditworthiness is the provision of insurance for the cage farmers. The high risk associated with cage culture would normally require a high premium assuming a commercial insurer finds the business of insuring cage farms worthwhile. As with credit, insurance could be linked to farmers being organized and adopting BMPs.

The issue that pervades the effort to effect a transition to pellet feeds, and which in practical terms promotes the adoption of technological innovations, is risk management. It would be applied to actual and perceived risks to the profitability of adopting pellet feeds, the environment, and the impacts on the livelihoods of fishers and fish suppliers. This requires an integrated approach to the development and implementation of the different instruments and risk management strategies. The risk management instruments and risk reduction strategies include the BMPs, farmers being organized, the assurance of supply and the quality of inputs including seed, feed and credit, aquatic animal health management, market based insurance, public compensation for catastrophic damage, better marketing of products, product certification, coastal zone management, and alternative livelihood opportunities. The policy, regulatory, implementing, and technical support components of these various instruments will benefit from the strengthening of institutional and human resource capacities. This in turn is facilitated and made more cost-effective by institutional and stakeholder collaboration. Regionally, these linkages are already in place in terms of national and regional institutions, the collaborative arrangements, and the mechanisms for better cooperation that already exist.

The project adhered to a unifying principle: that regional policies and programmes to encourage the adoption of pellet feeds shall equally promote the objectives of food security, poverty alleviation and the sustainability of the environment.