Economics of aquaculture feeding practices: a synthesis of case studies undertaken in six Asian countries

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SUMMARY

Objective of the study: The general objective of the study is to assess the economic implications of, and the reasons for, adopting various feeding practices in aquaculture in Bangladesh, China, India, the Philippines, Thailand and Vietnam.

Methodology: Three categories of feeding practices were studied: extensive/traditional, semi-intensive and intensive through interviews with 340 randomly selected fish farmers. In each of the six countries, with the exception of India, twenty respondents were interviewed for each feeding practice. In India forty farmers were interviewed as only two feeding practices (extensive/traditional and semi-intensive) were studied. The type of species varied by country and included sutchi catfish (*Pangasianodon hypophthalmus*) (Bangladesh), pangasiid catfish (*Pangasianodon hypophthalmus* and *Pangasius bocourti*) (Viet Nam), hybrid catfish (*Clarias gariepinus* x *C. macrocephalus*) (Thailand), carps (India and China), and prawn and milkfish (the Philippines). It should be noted that the analyses and findings presented in this report concern only these species or species-groups and hence do not necessarily reflect economic consequences of feeding practices in other aquaculture sectors in these six countries, or elsewhere in Asia.

Results: production, profitability and feeding regimes. In order to establish the nature and strength of the relationship between feeding practices and economic results the authors of the case studies have estimated and reviewed benefit-cost ratios, break-even prices and break even production.

The combined results of the six case studies do not fully support the hypothesis of a direct relationship between growing intensity of feeding on the one hand and an improving benefit cost ratio (BCR) on the other. The positive relationship between commercial feeding and a relatively high BCR is supported

by the data from Thailand and the Philippines. However, data from Bangladesh and Viet Nam does not support this hypothesis as their best BCR performers are in fact the traditional farms. Data from China and India did not show any conclusive pattern as the BCRs estimated for these two countries do not differ much from one feeding practice to another.

The lower the break-even price, in comparison to the market price, the better off is the producer. In this sense aquaculture farms from Bangladesh and India are the most efficient as their break-even prices are the lowest, expressed as a percentage of the prevailing market or actual prices. The study reveals that aquaculture farms in these two countries can afford to absorb a 43 percent reduction of market prices and still break even. Aquaculture farms based in China, Thailand and the Philippines are somewhat more vulnerable to output price changes than they are in Bangladesh and India. Aquaculture farms in China, Thailand and the Philippines would break even given a 31 to 32 percent reduction in output prices. The most vulnerable farms in terms of output price decrease are those in Viet Nam. They cannot afford to absorb a decrease exceeding 15 percent.

Often farmers gauge their skills and resilience to production failures by comparing the productivity of their ponds with that needed to cover costs (break-even production levels) - the smaller the break-even production as proportion of the production achieved, the better. The estimated break-even production levels per hectare vary widely in absolute figures amongst the farmers interviewed in the six case studies in large part due to the differences of fish species produced. For all farm categories, the study reveals that China yielded the most favorable proportion of break-even production to actual production: 35 percent. This implies that overall production levels in China could fall by up to 65 percent before the average Chinese carp farm reaches its break-even production level. Aquaculture farmers in Bangladesh, India, Thailand and the Philippines likewise performed credibly with break-even proportions of 56, 58, 68 and 69 percent thus achieving production levels which were comfortably above the estimated break-even production levels. The most vulnerable farms in terms of yield fluctuations are those from Viet Nam where the break-even production level is 86 percent indicating that the average Vietnamese catfish farmer produces at only 14 percent above their break-even production level.

In respect of the connection between feeding and economically sound aquaculture the case studies did not reveal a very clear pattern. While data from China, the Philippines and Thailand supports the argument that intensified feeding shall result in more efficient aquaculture farming, data from Bangladesh and Viet Nam demonstrated the reverse, that is, intensified feeding seem to result in less efficient performances. In the case of India no clear pattern emerged.

Results: use of feeds and their cost. The share of feed in total costs varied from a low 25.0 percent in China to a high of 86.5 percent in Viet Nam. For the six case studies combined, cost of feeds accounted for an average of 58 percent, being the largest individual cost item, while fingerling acquisition and labour costs represented 15.5 and 14.4 percent respectively of the total. Overall, combining the results from the 340 farms, variable costs accounted for 94.2 percent of the total cost the remaining 5.8 percent being fixed costs.

In China intensive farms were major users of industrially manufactured feeds. On the average, for the sixty Chinese farms such feeds accounted for 75 percent of the total feed consumption. On aquaculture farms in Bangladesh and the Philippines, respectively, industrial feeds accounted for 54 and 49 percent of total feed consumption. In Thailand, and Viet Nam industrial feeds accounted for 35 percent of the total while India was the least user at only 31 percent. In terms of absolute volume of industrially manufactured feed utilization however, Viet

Nam and Thailand were the largest users while the Philippines and India used the smallest quantities.

Results: what promotes what hinders the use of a feeding strategy? Farmers reported that the most important enabling factors were improved water quality, intensified commercial feeding and increased rate of stocking. While water quality issues can be addressed both on and off the farm, intensified commercial feeding and increased stocking rate can be addressed rapidly if aquaculture farmers have access to cheap credit. According to the analysis, other enabling factors are: effective disease control, better farm management, and improved quality of fry.

Farmers differ in what they consider to be important for increased production according to the feeding strategies they use. Among intensive farmers, improved water quality, disease control and better management are identified as the most important factors. For semi-intensive farms, high stocking of fry, more commercial feeds and improved water quality are priorities. As could be expected, the most important enabling production factor reported by the traditional farmer is intensified commercial feeding.

Regardless of farm category, however, farmers have reported lack of capital to be the most important obstacle to increased aquaculture production. This may not be surprising as easy access to capital is required if farmers are to intensify use of commercial feeds and increase stocking rates.

Intensive (70 percent), semi-intensive (80 percent) and traditional farmers (78 percent) share concerns about the high cost of acquiring commercially or industrially manufactured feeds. While traditional farmers readily recognize the importance of commercial feeding, its high cost per unit has discouraged them from purchasing these types of feeds. Limited technical know-how was also mentioned as a disabling factor.

As many as 92 percent of the respondents say they started fish farming because they expected to make large profits. Farmers using intensive feeding strategies are generally more educated than those using the other two feeding strategies. So, educational attainment appears to be correlated with the feeding practices that farmers adopt.

Recommendations: Four major recommendations are made to stakeholders: (i) consider a larger range of non-economic factors in future economic studies of feeds in aquaculture; (ii) lobby for easy access to credit by small-scale aquaculturists: (iii) governments should design and implement capacity building in farm management; and, (iv) implement action oriented research about the use of farm-made and industrial feeds and devise ways to spread research findings to those concerned.

1. INTRODUCTION

1.1 RATIONALE

Aquaculture today comprises several different types of production systems. Many different practices and technologies co-exist in prevailing production systems. These systems are not static, they change over time. They change as most fish farmers, wishing to make profit, try to optimize their production systems by modifying what they do. Such changes of practices and technologies, e.g. from extensive to intensive feeding strategies, in fact can be seen as a technological innovations at least at the local level

A very important component of any aquaculture production system is the feeding strategy used and the various technologies that this strategy relies on. But different feeding strategies co-exist within the same production system. This fact is common in Asian aquaculture and exemplified in this study. Are these feeding strategies all equally profitable in any one fish production system or do results depend significantly on the surroundings in which they are used?

The six case studies presented in this report are expected to shed light on the extent to which economic considerations drive the use of three feeding practices in six fish farming systems in six Asian countries.

1.2 Objectives of the study

The objective of the study is to assess the economic implications of adopting various feeding practices in aquaculture production in six selected Asian countries.

Specifically, this synthesis report aims to:

(i) review the case study reports on the "Economics of aquaculture feeding practices" that were undertaken in Bangladesh, China, India, the Philippines, Thailand and Viet Nam;

(ii) process and analyse the assembled data to arrive at an integrative comparative analysis of the different farm categories and countries:

(iii) prepare a consolidated report of the six country case studies highlighting the following:

a) production (including feeding) practices,
b) production costs,
c) gross factor productivities or benefit cost ratio;
d) production problems,
e) break-even analyses (break-even price, break-even production), and
f) conclusions and recommendations.

2. GENERAL APPROACH AND METHODOLOGY

2.1 Comparative analysis

The case study provides a comparative analysis of three (3) different categories of feeding systems/practices; namely: (1) extensive/traditional; (2) semi-intensive; and (3) intensive. However, in order to enhance comparability of results obtained in different countries only one fish farming system was studied in each country. Three of these farming systems are polyculture systems, the other monoculture of various types of catfish.

The case study in China focused on polyculture of carps, including silver, bighead, grass, black and crucian carps as well as Wuchang fish. The Bangladesh and Viet Nam case studies specifically focused on the monoculture of sutchi catfish (*Pangasianodon hypophthalmus*) and pangasiid catfish (*Pangasianodon hypophthalmus* and *Pangasius bocourti*), respectively, while the Philippine case assessed the feeding practices used in the polyculture of milkfish (*Chanos chanos*) and giant freshwater prawn (*Macrobrachium rosenbergi*) aquaculture. The case study in India looked at the feeding practices in the polyculture of Indian major carps (catla *Catla catla*, rohu *Labeo rohita*, mrigal *Cirrhinus cirrhosus*), Chinese carps (silver carp, grass carp) and common carp (*Cyprinus carpio*). In Thailand the study concerned monoculture of hybrid clariid catfish (*Clarias gariepinus* and *C. macrocephalus*).

In the context of the study, traditional practice refers to a feeding practice in which the feeds utilized in the fish farms are sourced or developed on-farm or locally and are not being sold or distributed commercially. Fish farms based on traditional feeding practice generally use farm-made aquafeed and/or supplementary diets consisting of a mixture of locally available feed ingredients. Farms with intensive feeding practice depend largely on commercially manufactured pelleted feeds while a semi-intensive category refers to a feeding practice that combines the two with at least 25 percent of either one being utilized. Although the three farming systems in this report and elsewhere are often categorized into traditional, semi-intensive and intensive based on their stocking density and feeding intensity and type of feed, it must noted that intensity of farming and so the feeding intensity vary widely between countries. For example, in the traditional farming in Thailand, which uses locally sourced feed ingredients (e.g.,

poultry by-products), the fry stocking density is higher and the amount of feed used is much larger than what is commonly found in many other countries of Asia. Similarly, in Viet Nam the stocking density and feeding intensity (i.e., amount of feed) used is similar for three feeding systems (e.g., locally sourced home-made feed, mixture of home-made and pellet feed and industrially manufactured pelleted feed) and consequently stocking density and feeding intensity often are higher than those used in other countries. These differences have to be taken into consideration when anaysing the case studies.

2.2 Assessment indicators

This synthesis assesses the impacts of the various feeding practices in terms of: (i) gross revenues; (ii) gross margin/profit; (iii) net returns; (iv) break-even price levels; (v) break-even production levels; (vi) gross total factor productivity; and (vii) net total productivity. These indicators were estimated based on cost and returns tables derived from survey questionnaires.

2.3 Sampling technique

Each country case study includes three representative feeding practices or systems, with the exception of the Indian carp culture, which only provides an analysis of the semi-intensive and traditional aquaculture farms. Each feeding practice was analysed based on a survey of 20 replicate farms. A total of 60 fish farms represented the sample size for each country case study with the exception of India which had 40 respondents. The stratified random sampling (SRS) technique was utilized in selecting the individual sample farm. The SRS was directly applied on a general listing of fish farms obtained from the study sites of the six countries.

2.4 Data processing and analysis

In general, a tabular analysis was employed to develop the cost and returns tables for the various feeding practices observed in the study sites. The cost and returns analysis indicated the variable cost categories included feeds, fingerlings, fertilizers, labour and other miscellaneous inputs. The fixed costs and capital investments were also determined. Gross revenues and net revenues were also identified. A cross sectional analysis using graphs, percent changes and relative proportions were adopted to determine the relationship of feeding practices with selected impact indicators.

The various authors utilized regression analysis. They applied the Linear Profit Function models, Cobb Douglas Production and Profit Function models and Technical Efficiency analysis to determine the statistical significance and the nature and extent of the relationships between aquaculture production and profit levels as the dependent variables and the factors (independent variables) that would explain their behavior. This synthesis integrates the results of the country level statistical analyses done.

2.5 Scope and duration of the study

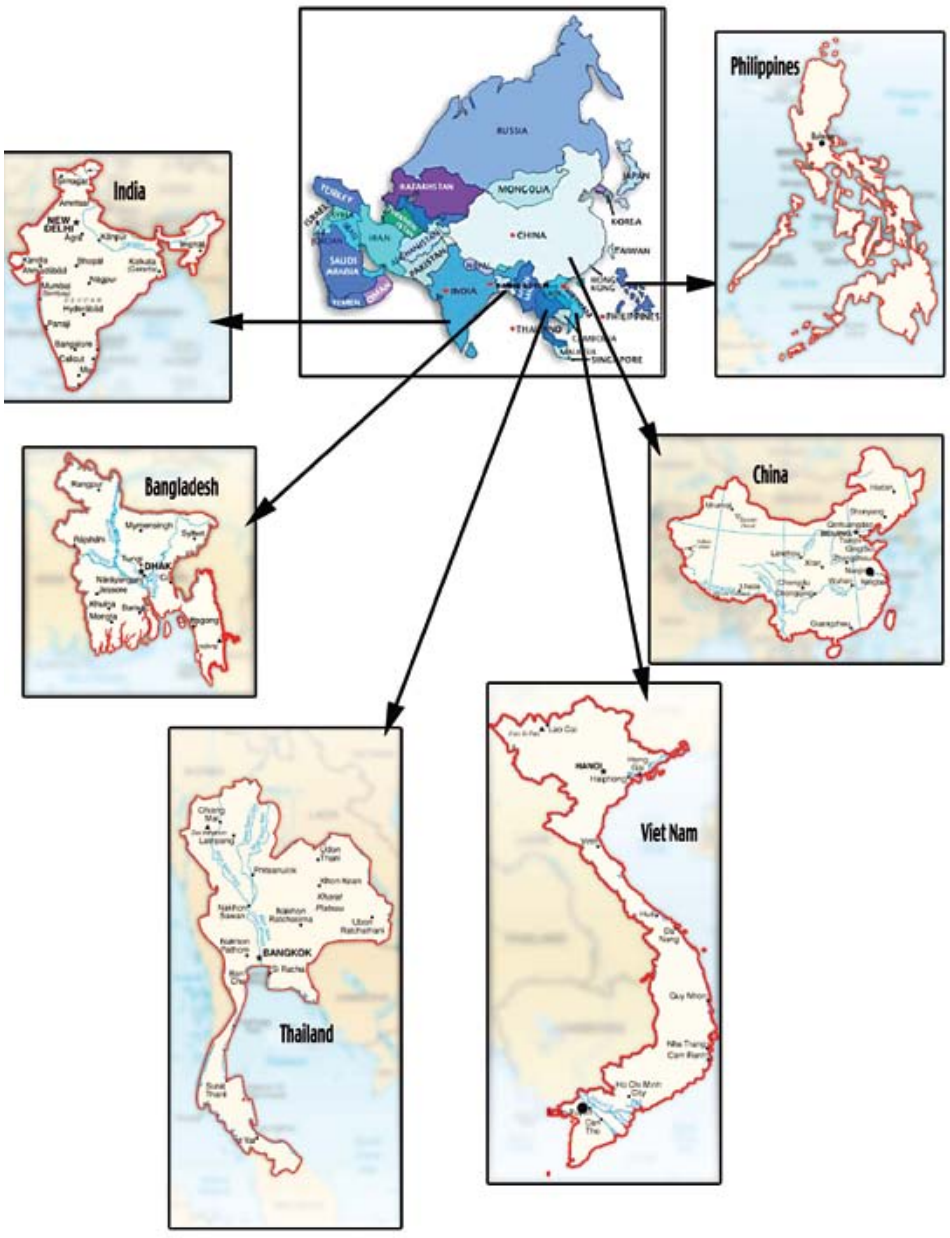
The study was conducted between 15 October 2005 and 14 February 2006. The study sites are indicated in Figure 1. The sample sites included ten counties in the province of Jiangsu in China; municipality of Hagonoy in the province of Bulacan in the Philippines; Bhaluka Upazila, Mymensingh district in Bangladesh; An Guiang Province in Viet Nam; Ludhiana, Gurudaspur, Patiala and Jalandhar districts in Punjab, India; and the provinces of Khon Kaen, Kalasin, Saraburi, Nakorn Sawan, Suphan Buri, and Pathum Thani in Thailand.

3. RESULTS AND DISCUSSION

3.1 Description of the study areas

The study covered six countries in Asia: Bangladesh, China, India, the Philippines, Thailand and Viet Nam. Bhaluka upazila was chosen as the study site in Bangladesh

FIGURE 1
Map of the study sites



being an important area for sutchi catfish aquaculture due its proximity to hatcheries, availability of ponds, low lying agricultural lands, warm climate, abundance of cheap labour and favourable socio-economic conditions. In the case of China, Jiangsu province was selected as the study site due to its long history in aquaculture production. It is known as the cradle land for aquaculture farming in China. The province is located at the lower stream of the Yangtze River and the Huai River. It is rich in natural water resources with a total pond area of 167 000 hectares. The study sites in Thailand are located in six provinces, of which three are located in the central plain region; two are in the north eastern region and one in the northern region. The study site for the Philippine case study is located in the municipality of Hagonoy, Province of Bulacan. The province is located in Region III among the eleven regions of the Government of

the Philippines. Of the total aquaculture production of the Philippines, the province of Bulacan accounted for about 5 percent. The study sites in Viet Nam included four districts of An Giang province. This province is located along the branches of Mekong River in Viet Nam. As in China, the study sites have the longest history of catfish culture which started as cage culture during the 1960s. The Mekong River Delta (MRD) in the southern part of Viet Nam covers 12 percent of the total area of the country and has a huge potential for increasing aquaculture production in the country. The MRD comprises approximately 650 000 ha of freshwater bodies; the freshwater surface area potentially expands to 1.7 million has during flooding periods. Ludhiana, Gurudaspur, Patiala and Jalandhar districts in Punjab, India, having major areas of carp aquaculture, were chosen as the study sites.

3.2 Description of the respondents

Respondents have an average age of 46 years. Aquaculture farmer respondents from the Philippines were the oldest at 51 years while those from Bangladesh were the youngest at 39. Respondents representing traditional farms have an average age of 47 years while intensive farm and semi-intensive farm respondents were younger with an average age of 45 and 46 years, respectively (Table 1). Respondents from the traditional farm category have average household size of 5.2 while intensive and semi-intensive farmers reported slightly lower household sizes of 5.0 and 4.8, correspondingly. Respondents from Bangladesh reported the largest household size at about six while China has the smallest household size at 4.4. Philippine respondents have an average household size of 5 while Viet Nam, Thailand and India reported average household sizes of 4.7, 4.6 and 5.7 respectively (Table 2). In terms of aquaculture farming experience, intensive and traditional farm respondents reported being in the profession for about 9 and 8 years, correspondingly. Respondents using semi-intensive feeding practices were slightly more experienced with 10.8 years. Respondents from China and the Philippines were the more experienced with 12.7 and 12.3 years in aquaculture farming while respondents from Thailand and India were less experienced with only 7.3 and 7.9 years of aquaculture farming, respectively (Table 3).

TABLE 1
Average age of respondents by category and country

Country	Farm category			All categories
	Intensive	Semi-intensive	Traditional	
Bangladesh	40	39	38	39
China	49	49	52	50
Philippines	49	52	52	51
Viet Nam	44	46	45	44
Thailand	45	48	46	46
India	*	43	44	44
All countries	45	46	47	46

Note: case study carried out in India did not have intensive feeding practice

TABLE 2
Average household size of respondents by category and country

Country	Farm category			All categories
	Intensive	Semi-intensive	Traditional	
Bangladesh	5.8	5.9	6.0	5.9
China	4.8	3.7	4.7	4.4
Philippines	5.0	5.0	5.0	5.0
Viet Nam	4.4	5.2	4.6	4.7
Thailand	4.9	3.8	5.1	4.6
India	*	5.3	6.1	5.7
All countries	5.0	4.8	5.2	5.1

Note: case study carried out in India did not have intensive feeding practice

TABLE 3
Average years in farming of respondents by category and country

Country	Farm category			All categories
	Intensive	Semi-intensive	Traditional	
Bangladesh	8.3	8.9	7.4	8.2
China	13.7	12.2	12.4	12.7
Philippines	15.0	14.0	8.0	12.3
Viet Nam	3.2	11.8	7.8	7.6
Thailand	4.5	9.6	7.7	7.3
India	*	8.4	7.5	7.9
All countries	8.9	10.8	8.4	9.4

Note: case study carried out in India did not have intensive feeding practice

A majority of the respondents had completed primary (34 percent) and secondary education (38 percent). Only 16 percent had completed tertiary education. Eleven percent of the respondents did not attend primary education (Table 4 and Figure 2). Table 4 also indicates that intensive farmers were more educated than semi-intensive and traditional farmers. Only two percent of intensive farmers did not complete primary education compared with 14 and 18 percent of semi-intensive and traditional farmers, respectively. In addition, 48 percent of intensive farmers completed secondary education compared to 32 and 34 percent for the semi-intensive and traditional farmers, respectively. The above statistics on educational attainment appear to have a degree of correlation with the feeding practices adopted by the respondents. The more formally educated respondents had practised intensive and semi-intensive feeding practices in favour of the traditional method of aquaculture farming.

Aside from aquaculture farming, the respondents also engage in other economic activities particularly agricultural crop production (23 percent) and other business enterprises (7 percent). It is interesting to note that a larger proportion (36 percent) of traditional farmers were simultaneously engaged in agricultural crop production activities compared with semi-intensive (21 percent) and intensive (6 percent) aquaculture farmers (Table 5). These findings suggest that traditional farmers do not solely rely on incomes derived from aquaculture business but tend to augment their incomes by engaging in other economic activities particularly agricultural crop production.

3.3 General profile of the farms

Three hundred of the farmers who participated in this study on the average each used three and one third ponds with a combined area just below three hectares. The forty Indian farmers operated much larger farms. They averaged about 50 ponds with a combined area just above 100 hectares (Table 6).

Excluding the Indian farmers from the analysis, respondents from Thailand used the largest number of ponds – six. They were followed by the Chinese respondents who were operating an average of four ponds. Respondents from Bangladesh had the smallest number of ponds - one.

Again considering only respondents outside India, aquaculture farmers from the Philippines reported the largest combined pond area of 8.77 ha while Bangladesh respondents reported the least at only 0.28 ha. By farm category, intensive farmers reported the largest number of ponds (3.8) while traditional farms had the least at 2.75. Similarly, intensive farms have the largest area for aquaculture production (4.51 ha) compared with semi-intensive (2.41 ha) and traditional farms (2.01 ha).

TABLE 4
Educational attainment of respondents by category and country

Country	Farm category/level of education															All categories				
	Intensive					Semi-intensive					Traditional									
	NE	P	S	T	Total	NE	P	S	T	Total	NE	P	S	T	Total	NE	P	S	T	Total
Bangladesh	0	40	60	0	100	55	35	10	0	100	70	30	0	0	100	42	35	23	0	100
China	0	30	45	25	100	0	35	40	25	100	0	50	40	10	100	0	38	42	20	100
Philippines	10	20	20	50	100	0	25	30	45	100	10	30	35	25	100	7	25	28	40	100
Viet Nam	0	5	95	0	100	30	20	50	0	100	25	15	60	0	100	18	13	68	0	100
Thailand	0	65	20	15	100	0	90	10	0	100	0	75	20	5	100	0	77	17	6	100
India						0	5	50	45	100	0	30	50	20	100	0	18	50	32	100
All	2	32	48	18	100	14	35	32	19	100	18	38	34	10	100	11	34	38	16	100

Note: Case study carried out in India did not have intensive feeding practice; NE = No Education, P = Primary, S = Secondary, T = Tertiary

TABLE 5
Major occupation of the farmers by category of respondents and country

Country	Farm category/type of occupation																		All categories					
	Intensive						Semi-intensive						Traditional											
	F	CP	B	FT	O	Total*	F	CP	B	FT	O	Total*	F	CP	B	FT	O	Total*	F	CP	B	FT	O	Total*
Bangladesh	100	10	30	0	0	140	100	25	10	0	0	135	100	45	5	0	0	150	100	27	15	0	0	142
China	100	10	0	10	5	125	100	35	0	0	5	140	100	35	0	0	0	135	100	27	0	3	3	133
Philippines	100	0	35	0	0	135	100	0	15	0	0	115	100	0	15	0	5	120	100	0	22	0	2	123
Viet Nam	100	8	0	0	25	133	100	15	0	0	0	115	100	20	0	0	0	120	100	14	0	0	8	123
Thailand	100	0	0	0	0	100	100	0	0	0	15	115	100	70	0	0	0	170	100	23	0	0	5	128
India							100	50	5	5	0	160	100	45	0	0	0	145	100	47	3	3	0	100
All	100	6	13	2	6	127	100	21	5	1	3	130	100	36	3	0	1	140	100	23	7	1	3	125

Case study carried out in India did not have intensive feeding practice; Note: F = fish farming, CP = crop production, B = own business, FT = fish trading, O = others

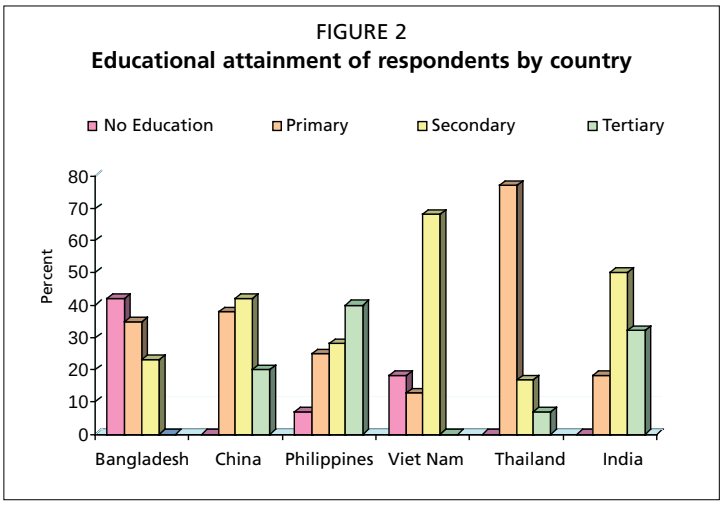
*Total exceeds 100 due to multiple responses

TABLE 6
Total number and area of ponds by farm category and country

Country	Farm category						All categories	
	Intensive		Semi-intensive		Traditional			
	Total number of ponds	Total pond area (ha)	Total number of ponds	Total pond area (ha)	Total number of ponds	Total pond area (ha)	Total number of ponds	Total pond area (ha)
Bangladesh	1.35	0.49	1.05	0.22	1.00	0.12	1.13	0.28
China	2.90	2.70	4.50	2.65	4.85	6.23	4.08	3.86
Philippines	3.95	16.88	2.75	7.28	2.05	2.16	2.92	8.77
Viet Nam	1.95	1.50	2.65	0.69	2.50	0.86	2.37	1.02
Thailand	9.00	0.96	6.10	1.19	3.35	0.68	6.15	0.94
All five	3.83	4.51	3.41	2.41	2.75	2.01	3.33	2.97
India*			64.00	144.70	40.00	67.50	52.00	104.00

*Case study carried out in India did not have intensive feeding practice

FIGURE 2
Educational attainment of respondents by country



The average area of a pond was 1.21 ha, which ranged from a low of 0.15 ha in Thailand to a high of 2.53 ha in the Philippines. Viet Nam and Bangladesh reported an average pond area of less than one hectare while respondents from the India and the Philippines reported respective average pond sizes of 2 and 2.5 ha. Average pond sizes in Bangladesh, India, Viet Nam and the Philippines showed that average pond area increases as the aquaculture farms progress from traditional to intensive feeding practices (Table 7).

Table 8 indicates that single ownership of ponds generally prevails in the study sites (63 percent). The other types of ownership reported were singly leased (26 percent), multiple ownerships (8 percent) and jointly leased (3 percent).

TABLE 7
Average area of ponds and water depth by category of respondents and country

Country	Farm category									All categories		
	Intensive			Semi-intensive			Traditional					
	Average area of one pond	Average water depth (m)		Average area of one pond	Average water depth (m)		Average area of one pond	Average water depth (m)		Average area of one pond	Average water depth (m)	
		Rainy	Dry		Rainy	Dry		Rainy	Dry		Rainy	Dry
Bangladesh	0.36	1.83	1.24	0.21	1.54	1.03	0.12	1.65	1.19	0.23	1.67	1.15
China	1.27	2.27	1.88	0.74	2.50	1.89	3.96	2.49	2.01	1.87	2.42	1.93
Philippines	4.18	1.47	0.98	2.38	1.41	0.99	1.02	1.43	0.88	2.53	1.44	0.95
Viet Nam	1.42	3.52	3.18	0.27	3.80	3.33	0.25	3.79	3.19	0.44	3.76	3.23
Thailand	0.12	1.80	1.50	0.11	1.90	1.72	0.23	1.76	1.52	0.15	1.80	1.55
India				2.26	2.17	1.94	1.69	1.68	1.46	2.04	1.94	1.71
All	1.47	2.18	1.76	0.99	2.22	1.82	1.21	2.13	1.71	1.21	2.17	1.75

TABLE 8
Type of pond ownership of respondents by category and country

Country	Farm category/type of ownership															All categories				
	Intensive					Semi-intensive					Traditional									
	SO	MO	SL	JL	Sum	SO	MO	SL	JL	Sum	SO	MO	SL	JL	Sum	SO	MO	SL	JL	Sum
Bangladesh	55	25	20	0	100	75	15	10	0	100	80	20	0	0	100	70	20	10	0	100
China	20	0	80	0	100	25	15	60	0	100	35	5	55	5	100	27	7	65	2	100
Philippines	50	20	20	10	100	75	10	15	0	100	45	10	45	0	100	57	13	27	3	100
Viet Nam	100	0	0	0	100	100	0	0	0	100	100	0	0	0	100	100	0	0	0	100
Thailand	100	0	0	0	100	100	0	0	0	100	35	0	65	0	100	78	0	22	0	100
India*						30	15	35	20	100	65	0	25	10	100	48	7	30	15	100
All	65	9	24	2	100	68	9	20	3	100	60	6	32	2	100	63	8	26	3	100

*Case study carried out in India did not have intensive feeding practice; SO = single ownership, MO= multiple ownership, SL = singly leased, JL = jointly leased

Seventy-two percent of the respondents reported that they use the fish farms exclusively for fish culture while the rest of the respondents were using the fish farms for other purposes. Amongst such purposes are: as the raising of ducks and chickens on the pond dikes in China and washing of clothes and dishes, for bathing and as a source of irrigation water for home gardening in Bangladesh. A higher percentage of intensive farmers (74 percent) used the fish farms exclusively for fish production than did semi-intensive (71 percent) and traditional farmers (68 percent) (Table 9).

TABLE 9
Pond utilization of respondents by category and country

Country	Farm category									All categories		
	Intensive			Semi-intensive			Traditional					
	FC	MP	Total	FC	MP	Total	FC	MP	Total	FC	MP	Total
Bangladesh	70	30	100	40	60	100	5	95	100	38	62	100
China	85	15	100	70	30	100	75	25	100	77	23	100
Philippines	15	85	100	20	80	100	45	55	100	27	73	100
Viet Nam	100	0	100	100	0	100	100	0	100	100	0	100
Thailand	100	0	100	100	0	100	100	0	100	100	0	100
India				95	5	100	80	20	100	88	12	100
All	74	26	100	71	29	100	68	32	100	72	28	100

Note: FC = fish culture only; MP = multipurpose

The major factor considered for engaging in fish farming was the expectation of large profits, as cited by 92 percent of the respondents. This expectation of high profits caused a rapid expansion of catfish pond culture in Viet Nam during the last few years. The dramatic increase in inland aquaculture production in Bangladesh is also a reflection of the expectation of high profits. An average annual growth rate of nearly 20 percent was reported for this activity (Muir, 2003). All respondents from Viet Nam, India and Thailand considered profitability to be the only factor that made them decide to pursue the business while more than 75 percent of the farmer respondents from China, the Philippines and Bangladesh cited the same reason for going into the fish farming business. The other factors considered included access to fish culture technology and availability of fingerlings each reported by 10 percent of farmers (Table 10).

TABLE 10
Main factors considered by farmers in undertaking fish farming country

Factor	Country						
	Bangladesh	China	Philippines	Viet Nam	Thailand	India	All Countries
Profitability	90	78	83	100	100	100	92
Own consumption	8	3	10	0	0	0	4
Access to fish culture technology	0	10	48	0	0	0	10
Feed availability	0	7	15	0	0	0	4
Fingerling availability	2	2	22	33	0	0	10
Total*	100	100	178	133	100	100	118

*Total exceeds 100 percent due to multiple responses, specifically from the Philippines

Table 11 shows the average number and type of farm labourers employed by country and farm category. Irrespective of farm category, an average of 11 workers was employed per farm. China reported the highest number of average fish farm workers at 15 while Philippine respondents employ an average of 12 workers. Viet Nam and Thailand employed the least number of workers at 8. Irrespective of farm category, average employments of full time, part time and occasional labourers were estimated at 2, 3 and 6, respectively. Intensive, semi-intensive and traditional farms generated an average employment of 11, 13 and 10 workers respectively. In general labourers are hired for pond preparation, dike repair, pre-stocking activities, procurement of feeds, feeding and marketing related activities.

3.4 Farm production practices

3.4.1 Stocking strategies

Stocking rates by aquaculture farmers varied by country, fish species and type of farm. Overall, stocking rates are generally higher on intensive and semi-intensive farms than on traditional farms regardless of species. The main reason for these differences in stocking rates by farm category is the relatively better financial capabilities of semi-intensive and intensive farmer. The trend of stocking rates by species in the region did not demonstrate a clear pattern as indicated in Table 12.

TABLE 11
Average number of farm labourers employed by category of respondents and country

Country	Farm category												All categories			
	Intensive				Semi-intensive				Traditional							
	Full-time	Part-time	Occasional	Total	Full-time	Part-time	Occasional	Total	Full-time	Part-time	Occasional	Total	Full-time	Part-time	Occasional	Total
Bangladesh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
China	2	2	6	10	3	3	12	18	3	3	12	18	2	3	10	15
Philippines	3	6	6	13	2	4	11	17	1	2	2	5	2	4	6	12
Viet Nam	2	4	4	10	3	2	4	9	3	2	4	9	2	2	4	8
Thailand	2	4	3	9	4	4	0	8	1	4	4	9	2	4	2	8
India					-	-	-	-	-	-	-	-	-	-	-	
All	2	4	5	11	3	3	7	13	2	3	5	10	2	3	6	11

* Note: India and Bangladesh case studies did not have the data to quantify type of farm labourers employed

TABLE 12
Average stocking rate (no./ha/year) by species, country and farm category

Countries & species	Farm category			All categories
	Intensive	Semi-intensive	Traditional	
Bangladesh				
Pangas	35 900	23 575	12 065	23 847
China				
Grass carp	10 678	5 323	4 553	6 851
Black carp	752	541	441	578
Crucian carp	14 604	16 966	11 039	14 203
Bighead carp	2 393	2 160	1 365	1 973
Wuchang fish	3 145	2 604	2 689	2 813
Silver carp	15 653	5 652	7 285	9 583
Other fishes	2 068	1 414	53	1 178
Philippines				
Milkfish	7 826	4 348	2 923	5 032
Prawn	27 798	26 329	26 500	26 876
Viet Nam				
Hybrid catfish	268 257	278 805	308 783	285 282
Thailand				
Pangasiid catfish	453 546	231 302	266 198	317 015
India*				
Rohu		6 820	6 518	6 669
Catla		2 713	4 179	3 446
Mrigal		6 190	4 607	5 398
Common carp		5 368	3 121	4 203
Silver carp, grass carp, etc.		3 894	2 511	3 202

*Note: Case study carried out in India did not have intensive feeding practice

3.4.2 Stocking strategy/frequency

Regardless of farm category, 65 percent of the respondents practised a single stocking strategy and the remainder adopted multiple stocking. The majority of traditional farmers (78 percent) claimed that they practiced single stocking. On the other hand, single stocking was being practised by 56 and 59 percent of semi-intensive and intensive farmer respondents (Table 13). The data revealed that as aquaculture farming intensified, multiple stocking increasingly became a common practice as farm operators were able to finance stocking and harvesting - particularly the cost of acquisition of fish stocks.

Amongst those undertaking multiple stockings, the most widely practised stocking frequency reported were two (35 percent) and three (51 percent) times a year. Only a small number of farmers reported stocking frequencies of more than 3 times a year. Low stocking frequencies were used largely to reduce the cost of harvesting and for marketing of fish.

TABLE 13
Stocking strategy and frequency by farm category, all countries

Strategy/frequency	Farm category				
	Intensive	Semi-intensive	Traditional	All	Percent
Strategy					
Single stocking	59	68	94	221	65
Multiple stocking	41	52	26	119	35
All	100	120	120	340	100
Frequency					
2x per year	10	23	9	42	35
3x per year	28	23	10	61	51
4x per year	2	6	2	10	9
Continuous	1	0	5	6	5
Total	41	52	26	119	100

3.4.3 Feeding practice

Feeding rates

The average annual feeding rates per hectare by type of feeds are shown in Table 14. Aquaculture farms from China were major users of industrially manufactured feeds accounting for 75 percent of the total feed consumption regardless of farm category (Figure 3). They are followed by aquaculture farms from Bangladesh and the Philippines where industrially manufactured feeds respectively account for 54 and 49 percent. On aquaculture farms in Thailand and Viet Nam the same type of feed accounted for 35 percent of the total while India was the least user at only 31 percent. In terms of absolute volume of industrially manufactured feed utilization however, Viet Nam and Thailand were the largest users while the Philippine and India-based farms were the lowest. Among intensive farms, industrially manufactured feeds were the only feed used except in the Philippines and China. In the Philippines, about 65 percent of the volume of feeds used, were industrially manufactured while in China only 7 percent of total volume of feeds were of farm-made origin and the remaining 93 percent were industrial feeds. It was also noted that semi-intensive farms in Bangladesh resorted to full utilization of farm-made feeds at an average of 13 010 kg per ha per year. On the average, annual feeding rates among traditional farms in Bangladesh per ha were estimated at 2 054 kg of rice bran, 2 071 kg of wheat bran and 1 665 kg of oil cake; for an aggregate annual feeding rate per ha of 5 790 kg. The use of farm-made and supplementary feeds is likewise high on semi-intensive farms in Viet Nam (96 percent), the Philippines (72 percent) and Thailand (67 percent).

Among semi-intensive farms, use of industrially manufactured feeds is dominant in India (74 percent), and China (46 percent). On semi-intensive farms in Viet Nam and in the Philippines industrially manufactured feeds occupy a lower proportion of total feed at 4 and 28 percent, respectively.

Frequency and intensity of feeding

A summary of data on feeding frequency is shown in Table 15. For all farm categories, the most widely practised feeding frequency was "once a day" as reported by 68 percent of the respondents. Feeding frequencies of "more than once a day" and "once or twice a week" were observed by 16 percent and 12 percent of the respondents, respectively, while an irregular feeding frequency was only noted among four (4) percent of the respondents. It is noted that frequency of feeding increases as the fish pond operation becomes more intensive. Only seven percent of traditional farms practised a feeding frequency of "more than once a day" compared with 20 and 21 percent among semi-intensive and intensive farms. These findings may imply that feed management is of least importance among traditional farmers. However, these farmers may be guided by their limited capability to supply the feed more frequently as well as their difficulties in sustaining the larger expenditures associated with an increase in feeding.

3.5 Regional comparative analysis of production costs

3.5.1 All farms

The percentage distribution of aquaculture farm production cost by item for all farm categories are shown in Table 16 and illustrated in Figure 4. Feeds accounted for the largest percentage of the total cost at 58 percent while fingerling acquisition and labour costs represented 15.5 and 14.4 percent of the total, respectively. "Other variable cost" accounted for only 4.9 percent while the cost of fertilizer represented 1.3 percent. Variable costs accounted for 94.2 percent of the total cost while the remaining 5.8 percent are classified as fixed costs. The percentage distribution of feed costs among all farm categories varied from a low 25 percent in China to a high of 86.5 percent in

Viet Nam. In regard to the percentage cost distribution of fry/fingerlings a high of 42.2 percent was noted in China compared to a low 6.2 percent in Bangladesh and Thailand. As a proportion of the total, labour cost has been high in the Philippines (34.2 percent) compared to Viet Nam (0.30 percent). The labour cost in Viet Nam, considering the huge amount of feed handled due to the high feeding rate (as high as 1.47 tonnes/ha/day in some cases), is unusually low and deserve special mention. These statistics illustrate the very important role of feeds in the total cost of production in aquaculture farms. As such, decision-making in terms of the quality and quantity of feed is a major aspect of the production process.

TABLE 14

Feeding rate (kg/ha/year) by type of feeds, farm category and country (as fed basis except for China and the Philippines where feeding rates are shown on dry matter basis)

Country/type of feed	Farm category							
	Intensive	%	Semi-intensive	%	Traditional	%	All	%
Bangladesh								
Industrial feed	22 370	100	0	0	0	0	7 457	54
Farm-made feed	0	0	13 010	100	5 970	100	6 327	46
Total	22 370	100	13 010	100	5 790	100	13 723	100
China								
Industrial feed	14 202	93	3 621	46	0	0	5 941	75
Farm-made feed	1 078	7	4 296	54	1 500	100	1 932	25
Total	15 280	100	7 917	100	1 500	100	7 873	100
Philippines								
Industrial feed	2 950	65	391	28	0	0	1 114	49
Farm-made feed	1 615	35	1 316	72	844	100	1 158	51
Total	4 565	100	1 707	100	844	100	2 272	100
Thailand								
Industrial feed	92 160	100	64 903	33	2 516	2	53 078	35
Farm-made feed	0	0	134 779	67	155 984	98	96 921	65
Total	92 160	100	199 682	100	158 500	100	149 999	100
Viet Nam								
Industrial feed	397 177	100	22 783	4	0	0	139 987	35
Farm-made feed	0	0	507 119	96	270 189	100	259 102	65
Total	397 177	100	529 902	100	270 189	100	399 089	100
India*								
Industrial feed			6 494	74	0	0	3 247	31
Farm-made feed			2 313	26	12 322	100	7 318	69
Total			8 806	100	12 322	100	10 565	100

*Note: Case study carried out in India did not have intensive feeding practice; farm-made feed include feed prepared on-farm as well as supplementary feed consisting of mixture of feed ingredients and/or single feed ingredient.

TABLE 15

Feeding frequency by farm category, all countries

Feeding frequency	Farm category				
	Intensive	Semi-intensive	Traditional	All	Percent
Once a day	55	79	98	232	68
More than once a day	21	24	8	53	16
Once/twice a week	24	15	1	40	12
Irregular feeding	0	2	13	15	4
Total	100	120	120	340	100

Note: The data for intensive feeding included five countries only as India case study did not include intensive feeding practice.

TABLE 16

Relative proportion (in percent) of aquaculture production cost by cost item, all farm category

Cost item	Country						All countries
	Bangladesh	China	India	Philippines	Viet Nam	Thailand	
A. Variable cost							
1. Labour cost	8.1	24.1	14.4	34.2	0.3	5.5	14.4
2. Fertilizer	1.9	0.1	4.8	0.2	0.0	0.6	1.3
3. Fry/fingerlings	6.2	42.2	11.2	15.7	11.4	6.2	15.5
4. Feeds	71.8	25.0	47.0	36.3	86.5	81.4	58.0
5. Miscellaneous			0.3	0.0	0.0	0.2	0.1
6. Other variable/ miscellaneous input costs	5.5	7.6	9.6	2.8	1.5	2.1	4.9
Subtotal	93.7	99.0	87.8	89.2	99.7	96.0	94.2
B. Fixed costs	6.3	1.0	12.2	10.8	0.3	4.0	5.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

FIGURE 3

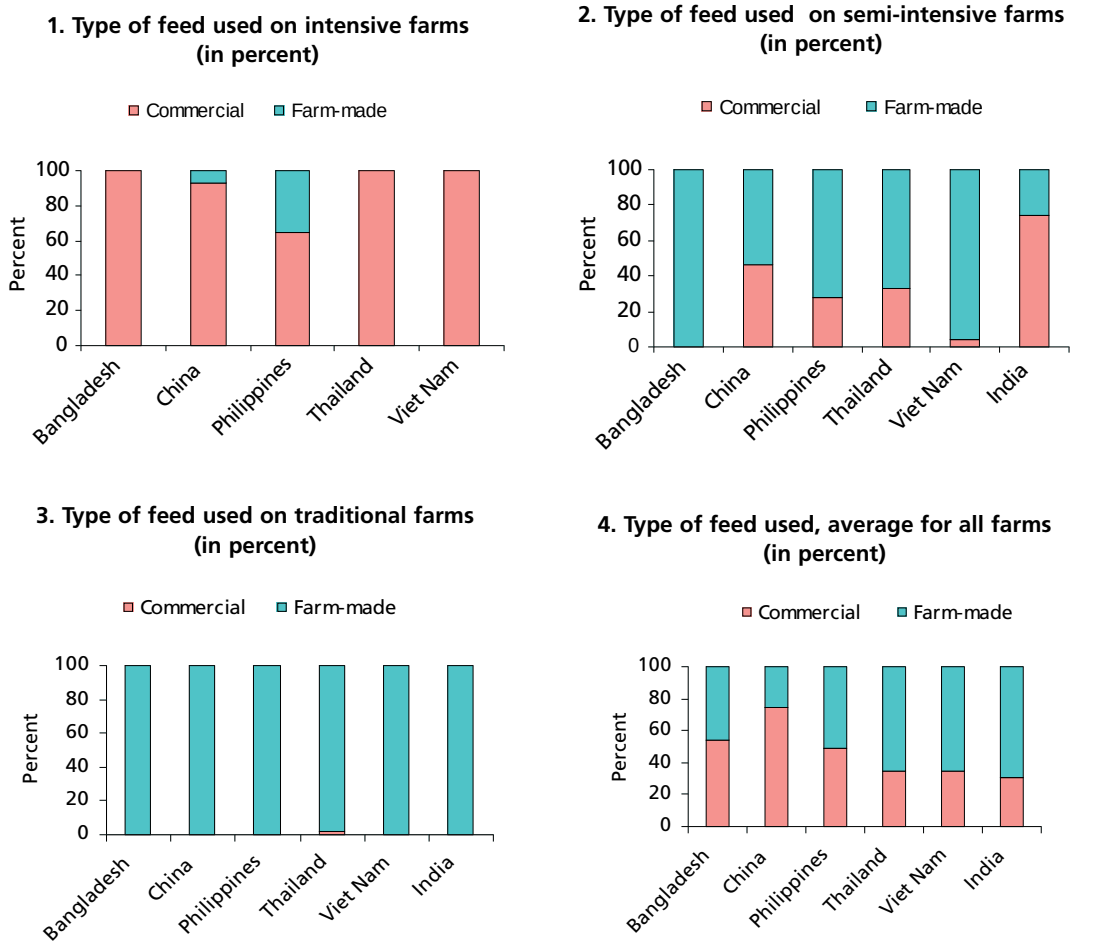
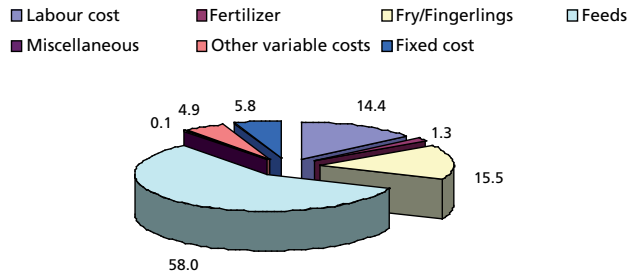


FIGURE 4

Relative proportion (percent) of aquaculture production cost by item, all farm categories and all countries



3.5.2 Intensive farms

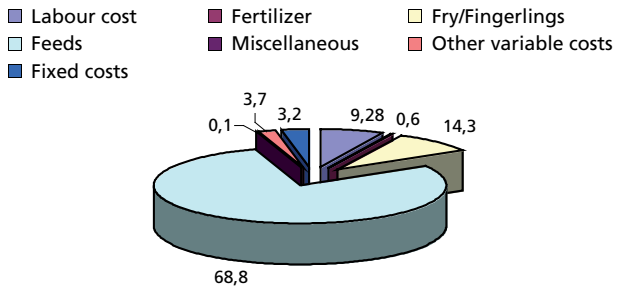
At the regional level, intensive farms have allocated 68.8 percent of the total production budget on feeds alone. Costs of fry/fingerlings and labour respectively accounted for 14.3 and 9.3 percent of the total while fertilizer cost only represented 0.6 percent of the total (Table 17 and Figure 5). These findings indicate that feed cost has been a major cost item among intensive farms and should require careful management. The high proportion of feed costs to total production costs has been particularly noted in Viet Nam, Thailand and Bangladesh. Intensive farms in China and the Philippines have reported relatively lower proportions of feed costs to total production costs. China and the Philippines have invested relatively higher proportions on fry/fingerlings and labour costs. Variable and fixed costs accounted for 96.8 and 3.2 percent of the total costs, correspondingly.

TABLE 17
Relative proportion of aquaculture production cost (in percent) by cost item and country, intensive farms

Cost Item	Country					All countries
	Bangladesh	China	Philippines	Viet Nam	Thailand	
A. Variable cost						
1. Labour cost	6.9	18.8	15.6	0.2	4.8	9.3
2. Fertilizer	2.2	0.2	0.1	0.0	0.5	0.6
3. Fry/fingerlings	5.3	38.7	16.4	6.3	4.6	14.3
4. Feeds	75.8	32.4	56.2	92.5	87.2	68.8
5. Miscellaneous	-	-	-	-	0.2	0.1
6. Other variable/ miscellaneous input costs	4.3	8.8	3.9	0.9	0.8	3.7
Subtotal	94.5	98.9	92.6	99.9	98.0	96.8
B. Fixed costs	5.4	1.1	7.4	0.1	2.0	3.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Note: Case study carried out in India did not have intensive feeding practice

FIGURE 5
Relative proportion (percent) of aquaculture production cost by item, intensive farms, all countries



3.5.3 Semi-intensive farms

At the regional level, semi-intensive farms have allocated 55.5 percent of the total budget on feed acquisition. This proportion is about 13 percent lower than the share of feed expenditure in intensive farms. Costs of fry/fingerlings and labour among semi-intensive farms have been estimated at 16.7 and 15.8 percentage of the total, respectively. Semi-intensive farms started to confront some financial difficulties and hence lesser proportions are spent on feed. However, variable costs remained very important at 94.5 percent of the total production costs (Table 18 and Figure 6). Over 68 percent of the total costs have been spent on feed by semi-intensive farms in Viet Nam, Thailand and Bangladesh. Semi-intensive farms in China and the Philippines had the least percentage spent on feed at 21 and 28 percent, correspondingly.

TABLE 18
Relative proportion (in percent) of aquaculture production cost by cost item, semi-intensive farms

Cost Item	Country						All countries
	Bangladesh	China	India	Philippines	Viet Nam	Thailand	
A. Variable cost							
1. Labour cost	8.9	25.3	13.9	42.3	0.3	4.3	15.8
2. Fertilizer	2.0	0.1	4.8	0.5	-	0.7	1.5
3. Fry/fingerlings	6.7	45.4	12.1	18.9	11.7	5.8	16.7
4. Feeds	68.8	21.0	47.6	28.4	86.5	81.2	55.5
5. Miscellaneous		-	-	-	-	0.1	0.1
6. Other variable/ miscellaneous input costs	6.5	7.4	9.4	2.8	1.1	3.0	4.9
Subtotal	92.9	99.2	87.3	92.9	99.7	95.0	94.5
B. Fixed costs	6.9	0.8	12.7	7.1	0.3	5.0	5.5
Total	100	100	100	100	100	100	100.0