Economics of aquaculture feeding practices: the Philippines

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SUMMARY

The objective of the study was to assess the economic implications of adopting various feeding practices in aquaculture production in the Philippines. The case study provided a comparative analysis of three different categories of feeding systems/practices in freshwater prawn (*Macrobrachium rosenbergii*) and milkfish (*Chanos chanos*) polyculture, or in some cases milkfish monoculture. The systems explored are: (1) traditional/extensive, (2) semi-intensive, and (3) intensive. To make a comparative analysis of the various feeding practices only two species were studied.

Likewise bioeconomic models relating net profit with economic variables (e.g. input and output prices) and non-economic variables (e.g. recovery rate, stocking rates, quantity of feeds and size of ponds) were also undertaken to determine the existence of statistical relationships between them.

Intensive farms fed an average of 58.3 and 4.9 kg (53.3 and 1.39 kg on dry weight basis) per 100 pieces of milkfish and prawn, respectively while semi-intensive farms fed lower averages of 31.9 and 4.5 kg (21.03 and 0.73 kg on dry weight basis) per 100 pieces of milkfish and prawn respectively. Traditional farms had the least feed consumption with 28.6 and 2.7 kg (16.08 and 0.28 kg on dry weight basis) per 100 pieces of milkfish and prawns respectively.

Consumption of industrial feeds was higher among intensive farms at 33.8 and 1.1 kg (30.4 and 1.0 kg on dry weight basis) per 100 pieces of milkfish and prawns, respectively. Semi-intensive farms reported a low industrial feed consumption of only 8.1 and 0.3 kg (7.3 and 0.29 kg on dry weight basis) per 100 pieces of milkfish and prawn, correspondingly while traditional farms did not use any industrial feeding.

The annual average aquaculture production cost was highest among intensive farms at US$1 975/ha. This was followed by traditional farms which incurred an average production cost of US$1 249/ha. Semi-intensive farms recorded the lowest production cost of US$993/ha. As expected, the major cost item for intensive farms was the cost of feeds which was estimated at US$1 110. This represented 56.2 percent of the total production cost. Among traditional and semi-intensive farms, labour costs accounted for the largest proportions of their total production costs at 56.5 percent and 42.3 percent, respectively.

The average annual gross aquaculture margin per hectare was highest for intensive fish farm operators (US$3 422) compared with those of semi-intensive farms (US$1 072). A very low margin of US$238 was computed among traditional farms. Nevertheless, the actual returns above cash costs (gross margin) among traditional farms were much better when the imputed cost of family labour at US$309 was excluded.

Gross total factor productivities of 2.66 and 2.01 were estimated for intensive and semi-intensive farms, respectively. In terms of net total factor productivity, intensive farms (1.66) and semi-intensive farms (1.01) were able to register favourable figures while traditional farms yielded a slightly negative net factor productivity coefficient of –0.002.

The estimated break-even prices among intensive farms were 82 percent and 143 percent lower than the prevailing market prices of milkfish and prawn. In the case of semi-intensive farms, the estimated break-even prices for milkfish (US$0.72/kg) and prawn (US$2.38/kg) were also lower than the prevailing respective market prices of US$0.94/kg and US$7.57/kg. Traditional farms performed below in terms of break-even price for milkfish but has performed well as far as prawn production is concerned.

Intensive farms have exceeded their break-even productivity levels by 80 percent and 450 percent for milkfish and prawn, correspondingly. The actual level of milkfish production per hectare among traditional farms was 22 percent below the break-even production level while their average prawn production level at 87 kg was 27 percent above its estimated break-even production.

The break-even analysis on productivity levels implies that as commercial feeding intensifies, the higher yields support their adoption. Both intensive and semi-intensive farms were able to register productivity levels that exceeded the break-even point while traditional farms, due to their non-adoption of commercial feeding practices, were slightly below their break-even level of productivity for milkfish production.

Lack of capital has been a major constraint among traditional farmers (80 percent) which is perhaps the principal reason why they do not engage in commercial feeding practices.

The high cost of industrial feeds has been a major concern among traditional farms (90 percent) and semi-intensive farms (45 percent). While traditional farm respondents have readily recognized the importance of commercial feeding, its high cost per given unit has resulted in a reduced dependence on these feeds.

Higher fish weights at harvest show that the adoption of commercial feeding benefited intensive and semi-intensive farms in terms of higher yields as measured in kilograms of milkfish and prawn production. Traditional farms suffered from poor production levels relative to other farms solely because of they stuck to a less effective feeding practice. Except for the adoption and non-adoption of commercial feeds, the feeding technologies during the grow-out periods for all farm categories were similar. Likewise, since the farm conditions of the study areas were geographically similar, it emphasized the definitive edge of commercial feed users in terms of increasing their production per given area.

The higher levels of milkfish and prawn production among intensive and semi-intensive generated high gross revenues, gross and net margins, net returns on land, labour and capital. Gross and net factor productivities were financially sound. In addition, the break even price and production figures of both the intensive and semi-intensive farms were exceeded by the prevailing market prices. Traditional farms on the other hand, did not perform as sound business entities and could be interpreted as subsistence aquaculture farm operations.

Results of the regression analyses reveal that variations in the disaggregated net profit for either milkfish or prawn production as well as the aggregated net profit for both milkfish and prawn production were statistically explained either by stocking rate, recovery rate, total cost of all feeds, total cost of industrially-manufactured feeds. Total area of operation and cost of stocks also explain the variation of net profits in some of the best fit models identified in the study.

1. INTRODUCTION

1.1 Rationale

Aquaculture production as practised today is represented by different types of production systems. In the history of civilization, addressing food scarcity has been directly associated with innovations in production practice/systems. Different production practices and systems co-exist with one another depending upon the level of technology that prevails. In aquaculture production, any change in the practice of feeding (e.g. from traditional to intensive feeding practice) represents a technological innovation and this is assumed to generate increases in aquaculture production and income.

On the other hand, farmers' adoption of technology such as industrially produced complete feed for aquaculture production must be justified on the basis of its financial soundness. A technology that provides reasonable financial incentives to the fish farmers will easily be adopted than technology which does not. This case study is expected to shed light on the economics of the various feeding practices in the Philippines.

1.2 Objectives of the study

The general objective of the study is to assess the economic implications of adopting various feeding practices in aquaculture production in the Philippines.

Specifically, this country case study is aimed at:

(i) conducting a survey of twenty (20) aquaculture farms for each of three (3) different categories or systems of feeding practices, using a pre-tested questionnaire;

(ii) processing and analysing the data to arrive at a comparative analysis of the different farm categories highlighting the following:
   a) general profile,
   b) production (including feeding) practices,
   c) production costs (fixed investment as well as maintenance and operating costs),
   d) income (gross margin and net margin/return),
   e) production problems,
   f) returns on investments (including labour, land and capital),
   g) break-even analyses (break-even price, cost, production, and sales), and
   h) suggestions/recommendations;

(iii) prepare a consolidated report of the case study based on the above information.

2. GENERAL APPROACH AND METHODOLOGY

2.1 Comparative analysis

The case study provides a comparative analysis of three different categories of feeding systems/practices: namely (1) traditional/extensive, (2) semi-intensive, and (3) intensive. To minimize variation in terms of fish species being produced, the comparative analysis of the various feeding practices was undertaken for same species in the country.

In the context of the study, extensive/traditional systems refer to a feeding practice where the feeds utilized in the fish farms were sourced or developed locally and were not being sold or distributed commercially. Fish farms based on traditional feeding

practices generally use farm-made aquafeed and/or supplementary diets consisting of mixture of locally available feed ingredients. Farms with intensive feeding practices 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.

2.2 Assessment indicators

The case study assesses the impacts of the various feeding practices in terms of (i) gross margin, (ii) net margin/return, (iii) returns on investment, (iv) returns to labour and land, (v) break-even price coefficients, (vi) break-even production coefficients, (vii) gross total factor productivity (benefit cost ratio, BCR), and (viii) net total factor productivity.

2.3 Sampling technique

The case study includes three representative feeding practices for the aquaculture farms. Each feeding practice was analysed based on a survey of 20 farms. A total of 60 fish farms represented the sample size for the country case study. 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 municipality. The complete listing was obtained from the field office of the Bureau of Fisheries and Aquatic Resources (BFAR) in Hagonoy, Bulacan. From this listing of aquaculture farms, they were categorized by type of feeding practices namely (i) intensive, (ii) semi-intensive, and (iii) traditional. After which, the respondents for each feeding practice were randomly selected.

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 including feeds, fingerlings, fertilizers, labour, gasoline and electricity. The fixed costs and capital investments were also determined. Information on gross revenues was also determined to be able to address the objectives of the case study. A cross sectional analysis using graphs, percent changes and/or growth rates were adopted to determine the basic relationships of feeding practices with selected impact indicators. Regression analyses using economic and bioeconomic models that relate net incomes derived from milkfish and prawn productions with various predictors and state variables (e.g. shifters) have been undertaken. In particular, regression runs based on a profit function (for economic regression models) relating net profit with input and output prices and variables such as education, training attendance and farming experience, were undertaken. Likewise bioeconomic models relating to net profit with economic variables (e.g. input and output prices) and non-economic variables (e.g. recovery rate, stocking rates, quantity of feeds, size of ponds, etc) were also undertaken to determine the existence of statistical relationships between them.

2.5 Scope and duration of the study

The study was conducted from 15 October 2005 to14 February 2006. The municipality of Hagonoy in the province of Bulacan, Philippines was selected as the site of the study (see Figure 1). The study site has been selected based on the availability or presence of aquaculture farms that represent the three feeding categories for similar species of fish. A total of 60 milkfish *(Chanos chanos)* and prawn (giant freshwater prawn *Macrobrachium rosenbergii*) farms were analysed in the study. A total of 20 respondents for each of the three feeding categories observed in the fish farms were interviewed.

2.6 Limitations of the study

This study has been limited in terms of its nature and scope. One major limitation of this study is its heavy emphasis on the economic and financial aspects of aquaculture feeding practices. Amongst the important non-economic parameters that were not included in the study were water quality, stocking rates, feed quality and types of training. An analysis of their effects could have enriched the analysis and interpretation section of the report. For example, the volume of feeds consumed by the various farm categories could have improved the study findings if the feed consumption data had been broken down by the quality of feeds consumed.

Another major limitation of the study is the nature of data collection system (e.g. personal interviews by recall) which may question the reliability of the data generated in the study. Finally, the number of samples per category of feeding practice (e.g. 20 samples) could have been increased for the country case studies to arrive at more robust estimates. This was not possible due to financial constraints encountered when increasing the number of samples. Nevertheless, the analysis at the regional level has the advantage of a larger number of samples.

3. RESULTS AND DISCUSSION

3.1 Description of the study area

The study site is located in the municipality of Hagonoy, Province of Bulacan. It has a total land area of 103 square kilometers or an equivalent of 10 310 hectares (ha). Of the total land area, 24 percent is devoted to agriculture, 60 percent to the aquaculture industry while 16 percent represent dwellings for more than 100 000 residents.

The town is a marshland and its elevation is only a couple of feet above sea level. Hagonoy has the lowest elevation level among the 24 municipalities of Bulacan. At the southern part of the town, the elevation is even lower and it is under water throughout the year. This condition however, makes the place suited for the aquaculture activity/ industry.

The province is located in Region III among the eleven Regions of the Government of the Philippines (see Figure 1). The Philippines recorded a total fish production of 4 163 150 tonnes in 2005, of which 1 895 790 tonnes (46 percent) was produced from aquaculture. The proportion of aquaculture production to total fish production has been steadily increasing from 40 percent in year 2003 (Table 1).

TABLE 1
Proportion of fish production (in thousand tonnes) by source and year, the Philippines

Source	2003	%	2004	%	2005	%
Commercial	1 110	31	1 128	29	1 135	27
Municipal	1 055	29	1 081	28	1 132	27
Aquaculture	1 455	40	1 717	44	1 896	46
Total	3 620	100	3 926	100	4 163	100

Source: BAS (2005)

3.2 Description of the respondents

The respondents of the study comprised 85 percent male and 15 percent female. The average age of the respondents was 51 years. Respondents representing semi-intensive and traditional farms had an average age of 52 years while intensive farm respondents were younger with an average age of 49 years. All respondents from the three farm categories reported similar average household sizes of five. In terms of aquaculture farming experience, semi-intensive and intensive farm respondents reported being in the profession for 14 years and 15 years, respectively. Respondents using traditional feeding practices had only 8 years of experience (Table 2).

FIGURE 1
The Study Area of Hagonoy, Bulacan, Philippines

Source: Wikipedia (2007)

TABLE 2
Average age, household size, and years in fish farming by category of respondents

Category	Age	Household size	Years in farming
Intensive farms	49	5	15
Semi-intensive farms	52	5	14
Traditional farms	52	5	8
All farms	51	5	12

Of the total respondents in the case study, 57 (95 percent) were married, two (3 percent) were single and one (2 percent) was widowed (Table 3). Most of the respondents (40 percent) had completed tertiary education while 28 and 25 percentages of respondents had respectively completed their primary and secondary education. Only a few respondents (7 percent) were unable to attend any formal education.

Fifty percent and 45 percent of respondents engaged in intensive and semi-intensive feeding practices were formally educated. Only 25 percent of the respondents belonging to the traditional fish farming category had reportedly completed tertiary level of education (Table 4).

TABLE 3
Marital status by category of respondents

Marital status	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Married	19	95	19	95	19	95	57	95
Single	0	0	1	5	1	5	2	3
Widowed	1	5	0	0	0	0	1	2
Total	20	100	20	100	20	100	60	100

TABLE 4
Educational attainment by category of respondents

Education	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
No education	2	10	0	0	2	10	4	7
Primary	4	20	5	25	6	30	15	25
Secondary	4	20	6	30	7	35	17	28
Tertiary	10	50	9	45	5	25	24	40
Total	20	100	20	100	20	100	60	100

The above statistics on farming experience and educational attainment appear to have influenced the feeding practices adopted by the respondents. As indicated in

Table 4, the more experienced and formally educated respondents tended to practice the intensive and semi-intensive feeding practices in favour of the traditional method of aquaculture farming. These demographic characteristics may have influenced the respondents to adopt the use of commercial feeds based on their better awareness of the benefits of adopting the technology.

On the average, 77 percent of the respondents claimed that aquaculture farming was their major occupation while 22 percent of the respondents were engaged in other business ventures. Only 65 percent of the respondents from the intensive farming category reported that it was their major occupation while 85 percent and 80 percent of the respondents from semi-intensive and traditional farming categories stated that fish farming was their major sources of income, correspondingly (Table 5).

TABLE 5
Major occupation of the farmers by category of respondents

Occupation	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Fish farming	13	65	17	85	16	80	46	77
Business	7	35	3	15	3	15	13	22
Carpenter	0	0	0	0	1	5	1	2
Total	20	100	20	100	20	100	60	100

3.3 General profile of the farms

The average size of aquaculture farm was estimated at 8.77 hectares (ha). Intensive farms were generally big farms with an average of 16.88 ha while semi-intensive farms recorded an average of 7.28 ha while traditional farms have the lowest average of 2.16 ha. Intensive, semi-intensive, and traditional farms operated an average number of 4, 3 and 2 ponds respectively with an average area of 4.18, 2.38, and 1.02 hectare per pond. As practised, the over-all average water depth of the aquaculture farms was 1.43 and 0.95 metres during the dry and wet season cropping, correspondingly (Table 6).

TABLE 6
Number and area of the ponds, and water depth by category of respondents

Item	Intensive	Semi-intensive	Traditional	All categories
Total number of ponds	4.0	2.8	2.1	2.9
Total area of ponds (ha)	16.88	7.28	2.16	8.77
Average area of ponds (ha)	4.18	2.38	1.02	2.53
Depth during rainy season (m)	1.47	1.41	1.43	1.43
Depth during dry season (m)	0.98	0.99	0.88	0.95

Fifty seven percent of the respondents were single owners of the fish farms and 13 percent were multiple owners. These types of ownerships have prevailed based on the land tenure and the financial capabilities of the respondents. A farmer owning the fishpond and who has sufficient capital to run the operation will tend to decide as a single owner. On the other hand, a farmer who owns his pond but has insufficient capital to run the business will tend to invite others to jointly operate the aquaculture business. Twenty-seven percent of the respondents were single lessees while 3 percent of the fish farms were jointly leased. Statistics on pond ownership indicated that 85 and 70 percent of the respective respondents from the semi-intensive and intensive farm categories were either single and/or multiple fish farm owners. Fourty five percent of traditional farmers owned their own ponds, with 45 percent leasing the ponds (Table 7). This information may imply that traditional fish farmer-respondents were less well-off compared with the intensive and semi intensive farmer-respondents.

TABLE 7
Type of pond ownership by category of respondents

Type of ownership	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Single ownership	10	50	15	75	9	45	34	57
Multiple ownership	4	20	2	10	2	10	8	13
Singly leased	4	20	3	15	9	45	16	27
Jointly leased	2	10	0	0	0	0	2	3
Total	20	100	20	100	20	100	60	100

TABLE 8
Average number of ownership for multiple ownership and average number of lessee and duration of lease for jointly leased farms by category of respondents

Item	Intensive	Semi-intensive	Traditional	All categories
Number of owners (multiple ownership)	3	2	5	3
Number of lessees (jointly leased)	4	-	-	4
Duration of lease (months)	12	12	8	10

Table 8 indicates that the average number of multiple owners was three while the number of lessees for jointly leased fish farms was four. The average duration of leasehold contracts were reported at 12 months for semi-intensive and intensive fish farmer-respondents and 8 months for traditional fish farmer-respondents. This short contract period has been a traditional practice in the area. This has been practised to allow both the leasers and lessees to have more flexibility particularly in terms of crop failures (for lessees) and general price increases (for leasers). It should be noted however, that the contract is renewable annually. The fish ponds were only being utilized for aquaculture purposes. The decision of the respondents to engage in aquaculture production was largely influenced by their perceived profitability (83 percent). It was common knowledge among the fish farm operators that a sound knowledge of the aquaculture technology coupled with favourable weather conditions and output prices would provide huge returns on investment. The next most important factor that influenced the respondents into aquaculture production was their easy access to fish culture technology as reported by 48 percent of the respondents (Table 9). In the study site, aquaculture production technology was disseminated through relatives, neighbours and extension workers from the Bureau of Fisheries and Aquatic Resources.

TABLE 9
Main factors considered in undertaking fish farming by category of respondents

Factor*	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Profitability	20	100	16	80	14	70	50	83
Own consumption	4	20	2	10	0	0	6	10
Access to fish culture technology	14	70	8	40	7	35	29	48
Feed availability	6	30	2	10	1	5	9	15
Fingerling availability	4	20	6	30	3	15	13	22

*Multiple responses

3.4 Farm production practices

3.4.1 Stocking strategies

The survey revealed that the majority (73 percent) of the respondents were engaged in the production of both milkfish and prawn production in a single pond while only 27 percent opted to raise a single species (e.g. milkfish only) (Table 10). The practice of polyculture was more dominant among intensive (85 percent) and semi-intensive (80 percent) farms compared with traditional farms where only 55 percent of the farmers resorted to polyculture (Table 10). The rearing of prawns with milkfish in the same pond provides the fish farmers with additional income due to the high market price of the former. For the milkfish-prawn pond system, prawns are normally stocked ahead of the milkfish while the ponds are still growing aqua green plants (PCARRD, 1983). The main reason cited by traditional farmer-respondents for monoculture fish production was lack of access to finance to support the input costs required for polyculture production.

TABLE 10
Reported aquaculture practices by category of respondents

Aquaculture practices	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Monoculture	3	15	4	20	9	45	16	27
Polyculture	17	85	16	80	11	55	44	73
Total	20	100	20	100	20	100	60	100

The average culture period (days) observed by all the respondents was four months or 120 days for both milkfish and prawn production with two cycles per year. This has been a tradition among the fish farms in the municipality of Hagonoy, Bulacan (Table 11). The culture period was the same for all farming systems. The cycle periods were perceived to be particularly prohibitive for smaller farmers were low feed input in this period resulted in very low average sizes of prawn harvested. Further discussion on this aspect is found on the gross revenue section of this study.

TABLE 11
Average culture period (days) by type of species and category of respondents

Type of species	Intensive	Semi-intensive	Traditional	All categories
Milkfish *(Chanos chanos)*	122	118	118	119
Prawn *(Macrobrachium rosenbergii)*	121	119	121	120
All species	122	118	120	120

The average stocking rate per hectare per year for milkfish varied from 2 923 pieces among traditional farms to 4 348 and 7 826 pieces for semi-intensive and intensive aquaculture farms respectively. The overall average for all farms was 5 033 pieces. The stocking rates per hectare per year (considering a two-season crop) was way below the recommended stocking rate of about 10 000 fish per hectare as prescribed by the Philippine Council for Marine and Aquaculture Research and Development (PCMARD) and Bureau of Fisheries and Aquaculture Research (BFAR). It may be interesting to determine the impact of varying stocking rates on the production potential of this species in future studies. Until the 1980's high density stocking rates were not economically attractive to farmers. In 1987, research conducted at the University of the Philippines' research centre in Iloilo successfully demonstrated the technological and economic feasibility of raising milkfish at densities of 7 000–12 000 fingerlings per hectare. By the late 80's private companies have made initial gains in raising the stocking density to 10 000–20 000 fingerlings per hectare (Aqua Farm News, 1995).

TABLE 12
Average stocking rate and size by species and size category of respondents

Item	Intensive	Semi-intensive	Traditional	All categories
Milkfish				
Stocking rate (No./ha/year)	7 826	4 348	2 923	5 033
Stocking size (cm)	10	11	11	10
Prawn				
Stocking rate (No./ha/year)	27 798	26 329	26 500	26 876
Stocking size (cm)	3	3	3	3

In the case of prawn production, the average stocking rate was estimated at 26 876 pieces per hectare per year (Table 12). The variation in stocking rates by farm category was minimal. This stocking rate was lower than the ideally prescribed stocking rate (e.g. 50 000 pieces per hectare per year or 25 000 pieces per cropping per season) recommended by Philippine fishery agencies. The effect of the level of stocking rates on production levels is also very interesting to determine for this particular species especially when mixed with milkfish.

FIGURE 2
Aquaculture practices by farm category

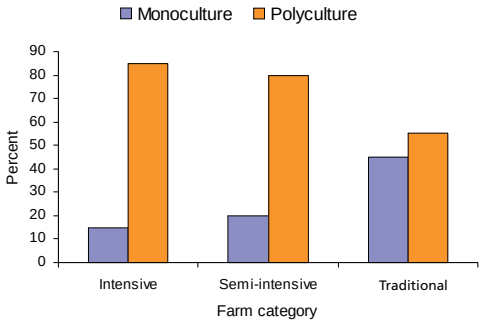
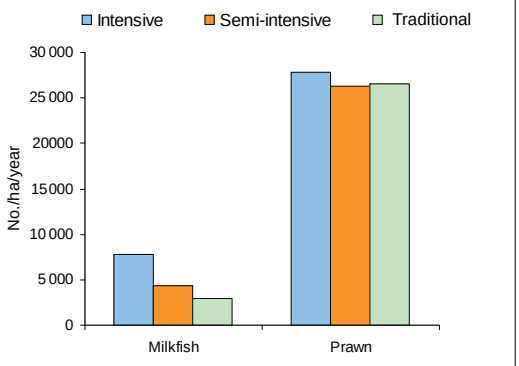


FIGURE 3
Stocking rate by species and by farm category



Stocking sizes for both species were determined based only on the length since the respondents failed to account for their weights as payments were made based on the length and not on the weight of the fry/fingerlings. For milkfish, the stocking size of the fingerlings was reported at 11 cm for semi-intensive and traditional farms and 10 cm for intensive farms. In the case of prawn, the stocking size of 3 cm has been a general practice for all farm categories.

The majority of the respondents adopted the multiple stocking strategy as reported by 78 percent of the respondents. Fifty seven percent of the traditional farms reported that they stocked their ponds twice a year which implied that one stocking was made per cropping season. About 29 percent of the traditional farms recorded a stocking frequency of three times a year which indicates that there was more than one stocking made per cropping season.

In the case of semi-intensive and intensive farms, 65 percent and 63 percent (Table 13) were observed practising three stockings per year which implies that more than one stocking was done made per cropping season of 120 days[1].

[1] It must be noted that aquaculture production in the study site reported a maximum of two croppings per year per given pond.

TABLE 13
Stocking strategy and number of stocking by category of respondents

Item	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
Stocking strategy								
Single stocking	3	15	4	20	6	30	13	22
Multiple stocking	17	85	16	80	14	70	47	78
Total	20	100	20	100	20	100	60	100
Number of stocking (for multiple stocking)								
2x per year	4	24	5	31	8	57	17	36
3x per year	11	65	10	63	4	29	25	53
4x per year	1	6	1	6	1	7	3	6
Continuous stocking	1	6	0	0	1	7	2	4
Total	17	100	16	100	14	100	47	100

3.4.2 Feeding practice

Type of feeds

Aquaculture producers used five different types or categories of feeds, namely; (i) industrial or commercial feeds, (ii) aqua green plant or generally called hydrophytes or macrophytes (also termed "lumot" in the local dialect), (iii) bread, (iv) noodles, and (v) snail meat (termed "sulib" in the local dialect) (Table 14). Industrial feeds were generally used for both milkfish and prawn consumption during the rearing period and was the most expensive type of feed, costing about P10–15 per kg (US$0.196–0.294)[2]. Aqua green plant was likewise used during the rearing stage and was considerably cheaper at P1.0–2.0 (US$0.0196–0.0392) per kg. Bread and noodles were considered as supplementary feeds for milkfish production and were moderately priced at about P6.0 (US$0.118) per kg and was generally used during the "on-growing" or "grow-out" period prior to harvesting. As reported, these supplementary feeds were used to fatten milkfish immediately before they were sold. Snail meats were also fed during the "grow-out" stage to harden the covering of the prawn in order to increase its marketability.

All semi-intensive and intensive farms were found to use commercial/industrial feeds in their milkfish and prawn productions while traditional farms did not use these feeds. As expected aqua green plants was used as the main feed item for all traditional farms. Most of the semi-intensive (85 percent) and intensive (70 percent) farms also fed their fish with aqua green plants as supplementary feed. The strategy of using aqua green plants as part of their feeding practice was reportedly to reduce overall feed costs because of the high price of commercial feeds.

Old bread was a popular feed item used by 92 percent of all respondents during the milkfish "grow-out" period. Its intended impact was to add more fats to the belly (portion) of milkfish in order to enhance its marketability. Filipino consumers have developed their preference for fat-bellied milkfish products. The use of bread for grow-out feeding was being practised by at least 90 percent of the respondents regardless of farm categories. In some instances, intensive farms would resort to using "noodles" during the grow-out period to enhance the quality of milkfish. This was reported by 20 percent of intensive farmer-respondents (Table 14). Unfortunately, this study did not quantify the productivity impacts of these practices but it has reportedly contributed to increased buyers' preference.

[2] US$1.00 = P51.00

TABLE 14
Type of feeds used by category of respondents

Item	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
A. Type of feeds								
1. Industrial feeds[1]	20	100	20	100	0	0	40	67
2. Aqua green plants[1]	14	70	17	85	20	100	51	85
3. Bread[2]	18	90	19	95	18	90	55	92
4. Noodles[2]	4	20	0	0	0	0	4	7
5. Snail meat[3]	16	80	11	55	11	55	38	63
B. Feed type based on mode of sinking								
1. Industrial feeds[1]								
a. Floating	1	5	5	25	0	0	6	16
b. Slow sinking	18	90	15	75	0	0	33	87
c. Fast Sinking	1	5	0	0	0	0	1	3
2. Aqua green plants[1]								
a. Floating	14	100	17	100	20	100	51	100
3. Bread[2]								
a. Floating	16	89	17	89	17	94	50	91
b. Slow sinking	2	11	2	10	1	6	5	9
4. Noodles[2]								
a. Floating	1	25	0	0	0	0	1	25
b. Slow sinking	3	75	0	0	0	0	3	75
5. Snail meat[3]								
a. Fast sinking	16	100	11	100	11	100	38	100

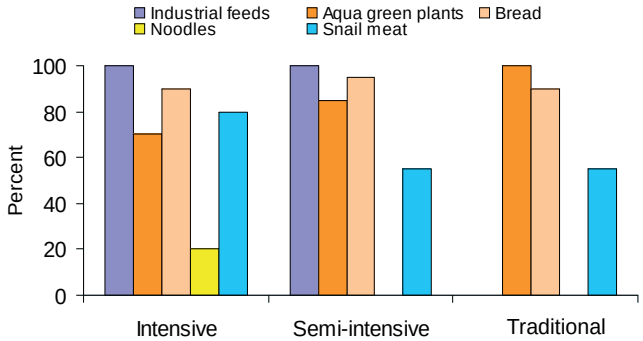
[1]Feeds used for milkfish and prawn; [2]Feeds used for milkfish; [3]Feeds used for prawn

Semi-intensive and intensive farms have generally favoured to use "slow-sinking" types of pelleted industrial feeds as cited by 75 and 90 percent of the respondents. Though there was no technical explanation provided, respondents claimed that this mode of sinking was the most efficient during the rearing stage of milkfish and prawn (Table 14).

Aqua green plants (e.g. macrophytes or hydrophytes) by its physical characteristics, is a floating type of feed. In the same manner bread and noodles are also floating when being fed to the fish. Snail meat is the only fast-sinking type of feed.

Table 15 indicates that most intensive farms (80 percent) utilized industrial commercial feeds strictly for the rearing of fingerling while 15 percent of the respondents claimed that commercial feeds were used for both the rearing and "grow-out" periods of milkfish and prawn production. Among semi-intensive farms, the majority of the respondents (65 percent) reported that commercial feeds were intended for both the rearing and "grow-out" periods of their operation. Only 25 percent reported that commercial feeds were strictly used during the rearing stage.

FIGURE 4
Type of feeds used by farm category



Aqua green plants were considered as a general purpose type of feed by all the respondents although semi-intensive farms (88 percent) and traditional farms (90 percent) reported that this type of feeds was addressing the feed demand of the fish crops during the rearing and "grow-out" stages. Most intensive farms (79 percent), however, used aqua green plants during the

rearing stage. Bread, noodles, and snail meat were considered by all the respondents as feed supplements which were essential during the "grow-out" period to enhance the quality of the milkfish and prawn products prior to their harvests.

3.4.3 Frequency and intensity of feeding

The most widely practised feeding frequency of commercial feeds was "once a day" as cited by 80 and 75 percent of semi-intensive and intensive fish farmers respectively. Aqua green plants were likewise available to the fish on a daily basis as they were left floating in the ponds. The feeding frequencies for bread products varied for each farm category. Among intensive farms, bread was fed twice a week by 61 percent of the respondents as a supplement feed during the "grow-out" period. A smaller proportion of intensive farms (17 percent) would feed bread once a day. Among semi-intensive farms, 42 percent of the respondents each reported feeding frequency of once a day and twice a week. In the case of traditional farms, feeding frequencies for bread products were weekly (39 percent), once a day (33 percent), and twice a week (28 percent) were noted.

The snail meat feeding frequency was weekly. This was reported 56, 73 and 45 percent of intensive, semi-intensive and traditional fish farms, correspondingly. Other feeding frequencies observed for snail meat products were "once a day" and twice a week (Table 16).

Industrial feeds (pelleted) were generally broadcasted when fed to the fish. Ninety and 80 percent of the respective respondents from semi-intensive and intensive farms reported using the broadcast method (Table 17). Only a few respondents among intensive farms used either the feeding tray (15 percent) and/or automatic feeding (5 percent). Among semi-intensive farms, only 5 percent each of respondents used either feeding bags or automatic feeding.

Aqua green plants were either planted or broadcasted among semi-intensive and intensive farms. Since these two types of farms generally used the commercial feeds, only about half of the respondents in those farm categories grew their own aquatic green plants in their ponds. However, the area covered was less when compared with traditional farms.

Bread, noodles and snail meat were all fed to the fish using the broadcast method. The broadcast method was being extensively followed by the fish pond operators since it was part of the work performed by the "watchers" employed by the fishpond owners. The watchers were given incentives by the owners which were based on the volume and quality of harvests.

Table 18 shows the amount of feed per hectare by type of feed and fish farm category. Semi-intensive farms consume an average of 435 kg of industrial feed per hectare per year or an average of 217.5 kg per hectare per cropping season. Intensive farms on the other hand, consume 3 278 kg per hectare per year which is 7.5 times more than the rate or intensity of feeding by semi-intensive farms. The rate of aqua green plant feeding ranged from 223 (intensive farms) to 388 (traditional farms) 416 (semi-intensive farms) per kg per hectare per year. The dry matter equivalents for the various types of feeds are also indicated in the Table 18. Overall, a dry weight equivalent of 4 565 kg of feed per hectare per year has been estimated among intensive farms relative to only 1 407 and 844 kg per hectare per year for semi-intensive and traditional farms, correspondingly.

TABLE 15
Type of feeds used at different stages of rearing by category of respondents

Type of feeds/stages of rearing	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
1. Industrial feeds[1]								
a. Rearing of fingerling	16	80	5	25	0	0	21	53
b. On-growing/grow-out	1	5	2	10	0	0	3	8
c. Rearing of fingerling and on-growing/grow-out	3	15	13	65	0	0	16	40
2. Aqua green plants[1]								
a. Rearing of fingerling	11	79	2	12	2	10	15	29
b. Rearing of fingerling and on-growing/grow-out	3	21	15	88	18	90	36	71
3. Bread[2/]								
a. Rearing of fingerling	0	0	0	0	1	6	1	2
b. On-growing/grow-out	18	100	18	95	17	94	53	96
c. Rearing of fingerling and on-growing/grow-out	0	0	1	5	0	0	1	2
4. Noodles[2]								
a. Rearing of fingerling	0	0	0	0	0	0	0	0
b. On-growing/grow-out	2	50	0	0	0	0	2	50
c. Rearing of fingerling and on-growing/grow-out	2	50	0	0	0	0	2	50
5. Snail meat[3]								
a. Rearing of fingerling	1	6	0	0	0	0	1	3
b. On-growing/grow-out	15	94	11	100	11	100	37	97

[1]Feeds used for milkfish and prawn. Field observations also indicate that intensive farmers do not use industrial feed during on-growing while semi-intensive farmers use industrial feed for both fingerling production and on-growing; [2]Feeds used for milkfish; [3]Feeds used for prawn

TABLE 16
Type of feeds and feeding frequency by category of respondents

Type of feeds/feeding frequency	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
1. Industrial feeds[1]								
a. More than twice daily	1	5	2	10	0	0	3	8
b. Once daily	15	75	16	80	0	0	31	78
c. Twice in a week	3	15	1	5	0	0	4	10
d. Weekly	1	5	0	0	0	0	1	3
e. Irregular	0	0	1	5	0	0	1	3
2. Aqua green plants[1]								
Once daily*	14	100	17	100	20	100	51	100
3. Bread[2]								
a. Once daily	3	17	8	42	6	33	17	31
b. Twice in a week	11	61	8	42	5	28	24	44
c. Weekly	2	11	2	11	7	39	11	20
d. Monthly	1	6	0	0	0	0	1	2
e. Irregular	1	6	1	5	0	0	2	4
4. Noodles[2]								
a. Once daily	3	75	0	0	0	0	3	75
b. Weekly	1	25	0	0	0	0	1	25
5. Snail meat[3]								
a. Once daily	5	31	2	18	2	18	9	24
b. Twice in a week	2	13	1	9	3	27	6	16
c. Weekly	9	56	8	73	5	45	22	58
d. Irregular	0	0	0	0	1	9	1	3

[1]Feeds used for milkfish and prawn; [2]Feeds used for milkfish; [3]Feeds used for prawn. *Once daily left on the surface of the pond.

TABLE 17
Feed application methods for industrially-manufactured pelleted feed by category of respondents

Feed application methods	Intensive		Semi-intensive		Traditional		All categories	
	No.	%	No.	%	No.	%	No.	%
1. Broadcasting	16	80	18	90	0	0	34	57
2. Feeding tray	3	15	0	0	0	0	3	5
3. Feeding bag	0	0	1	5	0	0	1	2
4. Automatic feeding	1	5	1	5	0	0	2	3
Total	20	100	20	100	0	0	40	67

It is interesting to note that the intensive farms used less aqua green plants compared to other farm types. Intensive farms considered aqua green plants as supplementary feeds since they relied more on commercial feeds to satisfy the feeding requirements. The traditional farmers grew all their own aqua green plants to ensure the adequate of supply on a daily basis. On the other hand, about half of the respondents of the intensive and semi-intensive farms did not plant their own aqua green plants but would buy their supply from co- fish farmers as and when the need arose. Despite the fact that aqua green plants can grow even when organic matter content of the soil is low, fish farmers limits its production. It was reported that much growth of aqua green plants could restrict the water circulation, fish movement and may even contribute to oxygen depletion (Aqua Farm News, 1990).

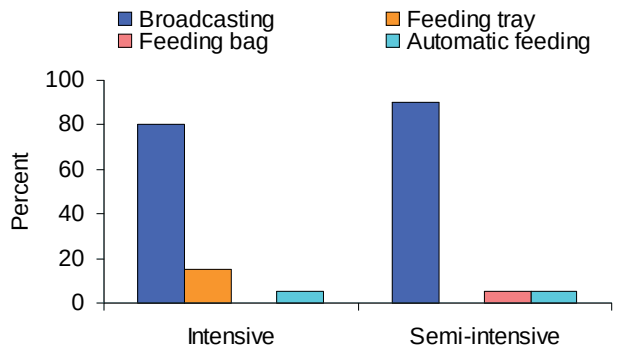
TABLE 18
Amount of feed (kg/ha/year) used by type of feeds and by category of respondents

Type of feeds used	Intensive		Semi-isntensive		Traditional		All categories	
	Fresh weight	Dry weight[4]	Fresh weight	Dry weight[4]	Fresh weight	Dry weight[4]	Fresh weight	Dry weight[4]
1. Industrial feeds[1]	3 278	2 950	435	391	-	-	1 238	1 114
2. Rice bran	543	470	188	163	421	364	384	332
3. Aqua green plants[1]	223	33	416	62	388	58	342	51
4. Bread[2]	869	759	802	701	401	350	691	604
5. Noodles[2]	301	271	21	19	12	11	111	100
6. Snail meat[3]	816	82	714	71	609	61	713	71
Total	6 030	4 565	2 576	1 407	1 831	844	3 479	2 272

[1]Feeds used for milkfish and prawn; [2]Feeds used for milkfish; [3]Feeds used for prawn.
[4]Conversion from fresh weight to dry weight were based on the following: industrial feeds = 90%, aqua green plants = 15%, rice bran = 86.6, wheat bran/flour/bread = 87.4%, noodles = 90% and snail meat = 10%

The average feeding rates for bread products of 401, 802 and 869 kg per hectare per year were respectively estimated for traditional, semi-intensive, and intensive farms (Table 18). These feeding rates of the various farm classifications were correlated with the stocking rates for milkfish. A high stocking rate requires higher feed requirements during the "grow-out" period assuming a constant mortality rate among all farm categories. In the case of snail meat feeding, semi-intensive and intensive farms recorded high rates of 714 and 816 kg/ha/year

FIGURE 5
Industrially-manufactured pelleted feed: application method by farm category



which was higher than the snail meat feeding rate of 609 kg/ha/year among traditional farms. Traditional farmers reported their incapacity to finance the perceived optimum feeding requirements particularly during the later stages of the farming operation. This resulted in lower snail meat feeding rates

Fertilizer application has not been a normal practice in the survey site. Only two respondents reported using fertilizer in their fish ponds.

A more meaningful assessment can be made by looking at feed consumption per 100 pieces of fish stocked as shown in Table 19. It shows that regardless of feed type, intensive farms fed an average of 58.31 and 4.89 kg (53.3 and 1.39 kg on dry weight basis) per 100 pieces of milkfish and prawn respectively while semi-intensive farms fed lower averages of 31.85 and 4.49 kg (21.03 and 0.73 kg on dry weight basis) per 100 pieces of milkfish and prawn respectively. Traditional farms had the least feed consumption of 28.64 and 2.65 kg (16.08 and 0.28 kg on dry weight basis) per 100 pieces of milkfish and prawn, respectively.

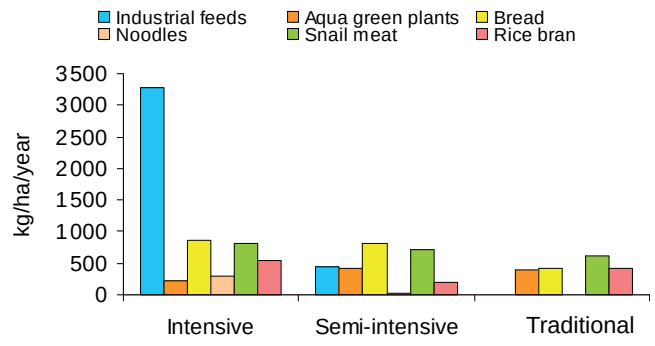
TABLE 19
Amount of feed (kg/100 fish) (as fed and dry weight basis), by species and by type of feeds used, by category of respondents

Type of feeds used	Intensive		Semi-intensive		Traditional		All categories	
	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight	Fresh weight	Dry weight
1. Industrial feeds[1]								
Milkfish	33.79	30.41	8.14	7.33	-	-	28.63	25.77
Prawn	1.11	1.00	0.32	0.29	-	-	1.07	0.96
2. Aqua green plants[1]								
Milkfish	3.34	0.50	9.57	1.45	12.18	1.83	7.12	1.07
Prawn	0.11	0.02	0.38	0.06	0.33	0.05	0.27	0.04
3. Bread[2]	15.35	13.29	14.14	12.25	16.46	14.25	15.22	13.18
4. Noodles[2]	5.83	5.10	-	-	-	-	5.83	5.10
5. Snail meat[3]	3.67	0.37	3.79	0.38	2.32	0.23	3.74	0.37
Total								
Milkfish	58.31	53.30	31.85	21.03	28.64	16.08	56.80	45.12
Prawn	4.89	1.39	4.49	0.73	2.65	0.28	5.08	1.37
All species	63.19	54.69	36.33	21.76	31.29	16.36	61.87	46.49

[1]Feed used for milkfish and prawn; [2]feed used for milkfish; [3]feed used for prawn.
Note: Estimates of rice bran has not been included due to lack of information.

Consumption of industrial feeds was highest among intensive farms at 33.79 and 1.11 kg (30.4 and 1.0 kg on dry weight basis) per 100 pieces of milkfish and prawn, respectively. Semi-intensive farms reported a low industrial feed consumption of only 8.14 and 0.32 kg (7.3 and 0.29 kg on dry weight basis) per 100 pieces of milkfish and prawn, correspondingly. It is interesting to note that aqua green plants consumption per 100 pieces of milkfish was highest among traditional farms (12.18 kg) compared with semi-intensive (9.57 kg) and intensive farms (3.34 kg). Bread consumption among all three farm categories was almost similar at about 14–16 kg per 100 pieces of milkfish. Snail meat

FIGURE 6
Amount of feed (as fed basis) by feed type and by farm category



consumption per 100 pieces of prawn is almost similar for semi-intensive and intensive farms at about 3.6–3.8 kg. Traditional farms provided the least quantity of snail meat at 2.32 kg per 100 pieces of prawn.

3.4.4 Labour utilization and cost

Part time and occasional labour were normally hired to do activities during pre-stocking operations such as excavation, cleaning and dikes repairs and post-stocking activities particularly harvesting.

On a per farm basis, fish farmers were able to employ full time employees with an average of one, two and three in traditional, semi-intensive and intensive farms, respectively. On part time basis, these farms were respectively able to employ averages of 2, 4, and 6 people. The average number of occasional employment generated by these farms was about 6 people, ranging from only two (traditional farms) to 11 for semi-intensive farms (Table 20).

TABLE 20
Average number of labour employed by category of respondents

Type of labour	Intensive	Semi-intensive	Traditional	All categories
Full-time labour	3	2	1	2
Part-time labour	6	4	2	4
Occasional labour	6	11	2	6
Total	15	17	5	12

In general, full time employment was required for fishpond "watchers" or "caretakers". Theft was common place if a farmer was unable to employ a trusted person on full-time basis. These full-time employees normally stay on the fish-farms for the duration of the production period particularly when the fish species reached marketable size.

On a per hectare basis, the total labour utilization (Table 21) for all farm operations was estimated at 165 man-days, for all farm categories, of which, 56 man-days (33.94 percent) came from family labour. Post stocking operations accounted for 87 percent of the total labour utilized. The largest proportion of labour utilization per hectare was spent on "caretakers" at 129 man-days representing 78.18 percent of the total.

The respondents claimed that this trend in labour utilization was primarily to minimize incidences of poaching activities among the various farms. In addition, caretakers provided assistance in other fish farming activities. Among traditional farms, a total of 257 man-

FIGURE 7
Average rate of feeding (as fed basis) per 100 pieces of milkfish by feed type and by farm category

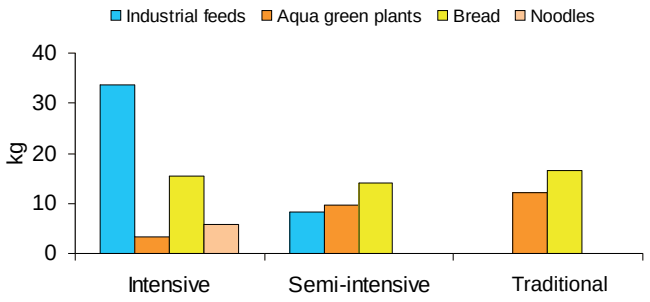


FIGURE 8
Average rate of feeding (as fed basis) per 100 pieces of prawn by feed type and by farm category

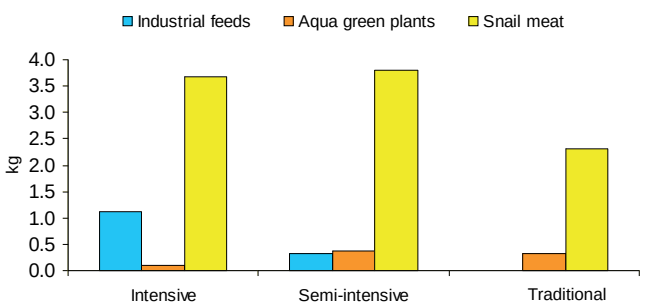
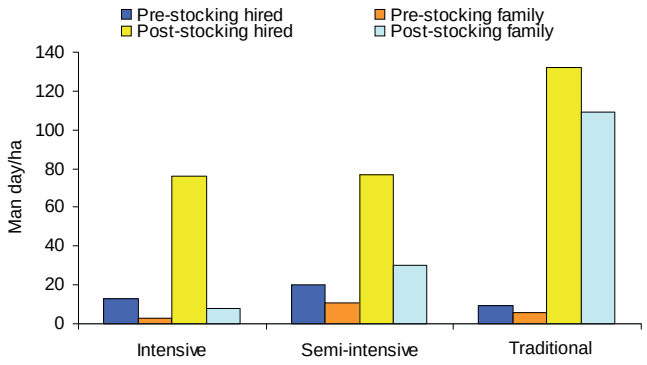


FIGURE 9
Average labour utilization (man day/ha) by farm category



days per hectare was utilized wherein family labour accounted for 44.75 percent of the total. For semi-intensive and intensive farms, labour utilization per hectare was pegged at 138 and 100 man-days, correspondingly. Respective family labour utilization per hectare accounted for 29.71 and 11 percent, among semi-intensive and intensive farms. The largest proportion of family labour inputs (44.74 percent) was observed among traditional farms.

3.5 Fish production costs

3.5.1 Capital investment

The major investment items identified during the survey included the construction of hut(s), acquisitions of banca(s)[3], a vehicle truck/pick-up, fish nets, coolers, and pumps (Table 22). Regardless of farm categories, the average fixed investment per hectare was estimated at US$369. Construction of huts (which were used for storage as well as field offices for caretaker), and acquisition of bancas required an average investment of US$111 per hectare. Equivalent per hectare fixed investments of US$32, US$29, US$25 were incurred for a truck/pick-up, coolers and fish nets.

It is interesting to note that by farm categories, fixed investment per hectare was largest among traditional farms at US$506 compared with semi-intensive and intensive farms with fixed investments of US$369 and US$230 per hectare, respectively. This trend is explained by the presence of economies of scale. Since traditional farms had smaller pond areas relative to semi-intensive and intensive farms, their equivalent fixed investment per hectare were higher than the other farm categories. This is manifested in higher equivalent fixed investment per hectare for bancas (US$175), huts (US$145) and fish nets (US$44) among traditional farms.

Table 22 also indicates that only the intensive and semi-intensive farms incurred fixed investments on pick-up trucks in their fish farming operations. The respondents of the study reported that such fixed investments were necessary to support the larger scale operations.

3.5.2 Variable costs

Variable cost items identified in the case study included the costs of labour, cost of fry/fingerlings, cost of feeds, cost of gasoline and electricity, and other rental costs. Variable costs were more directly related to the scale of operations of the fish farms at any given time.

[3] A "banca" is the local term for a motorboat used for fishing

TABLE 21
Average annual labour utilization (man-days/ha) by type of operation and category of respondents

Type of operation	Intensive			Semi-intensive			Traditional			All categories		
	Hired	Family	Total	Hired	Family	Total	Hired	Family	Total	Hired	Family	Total
A. Pre-stocking												
1. Excavation	4	0	4	10	8	18	1	0	2	5	3	8
2. Cleaning	5	1	6	5	2	7	7	2	9	6	1	7
3. Dikes repair/ construction	2	1	3	2	0	2	1	2	3	2	1	3
4. Fertilizer application	0	0	0	2	0	2	0	0	0	1	0	1
5. Procurement of feed ingredients	0	1	1	1	0	1	0	0	0	0	1	1
6. Transport of feed ingredients	1	0	1	0	1	1	0	1	1	0	1	1
7. Storage of feed ingredients	1	0	1	0	0	0	0	0	0	0	0	0
Subtotal	13	3	16	20	11	31	9	5	15	14	7	21
B. Post-stocking												
1. Feed application	4	7	11	0	3	3	2	0	2	2	3	5
2. Sampling/netting for growth observation	5	0	5	10	0	10	0	0	0	5	0	5
3. Watchmen/caretaker[1/]	64	0	64	64	26	90	127	106	233	85	44	129
4. Harvesting	3	0	3	3	1	4	2	1	3	3	1	4
5. Marketing	0	0	1	0	0	1	1	1	2	1	0	1
Subtotal	76	8	84	77	30	107	132	109	241	95	49	144
All operations	89	11	100	97	41	138	141	115	257	109	56	165

[1] The watchmen/caretaker undertakes a multiple of activities aside from being a watcher of ponds and these included application of fertilizers, collection of feeds/ingredients, and feed preparation, procurement of fry/ fingerlings.

3.5.3 Labour costs

As expected, the annual labour costs per hectare incurred by traditional farms was highest among the three farm categories at US$706 compared with semi-intensive and intensive farms which reported labour costs of US$420 and US$317, respectively (Table 23). The proportion of costs allocated for family labour among intensive and semi-intensive farms was low at 15 percent and 29 percent, correspondingly. Traditional farms on the other hand, provided about 44 percent of family labour as a proportion of the total cost of labour. The labour cost figures also showed that in absolute figures, the hired labour cost per hectare was highest among traditional farms at US$397 when compared with the respective hired labour costs of semi-intensive and intensive farms at US$299 and US$275. For all farm categories,

FIGURE 10
Average labour cost by farm category