# The Economics of Aquaculture with respect to Fisheries

95th EAAE Seminar
Civitavecchia (Rome), 9-11 December 2005

Edited by
Kenneth J. Thomson and Lorenzo Venzi

# SUSTAINABILITY AS COMPROMISE: AN ANALYSIS OF THE FARM-LEVEL TRADE-OFFS BETWEEN DEVELOPMENT OBJECTIVES IN PHILIPPINE AQUACULTURE

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## Abstract

*Farm-level trade-offs between development objectives are analysed using a three-stage methodological design. Firstly, a typology of farming systems is devised, using data from a farm-level survey and the methods of principal components analysis and cluster analysis. Five farm types are described that characterise current production practices in two regions in the Philippines. Secondly, a set of sustainability indicators are measured for each of the five farm types. Finally, the sustainability indicator results are analysed in a participatory multi-criteria decision-making model using weights established during a series of focus groups with stakeholders in the study regions. Very large farms perform particularly badly in these analyses, and the optimal farming system varies across social groups. The implications for the management of the sector are discussed, particularly in relation to aquaculture's continued exemption from agrarian reform legislation.*

## Aims

This aim of this paper is to examine how aquaculture is performing in two regions in the Philippines with regards to a number of specific objectives in economic, social and ecological dimensions. The underlying philosophy is that an appropriate balance between these dimensions is required for the farming system to be sustainable, but that this negotiation has to take place at the local level – the concept of sustainability cannot be imposed from above.

The work has three elements: a typology of farming systems constructed using data from a farm-level survey; collection of data for a series of six sustainability indicators; and a participatory multi-criteria decision-making model designed to assess the potential value conflicts underlying aquaculture development.

The manner in which these multiple methods combine into an overall research methodology is outlined in the conceptual model in Figure 1 below. The

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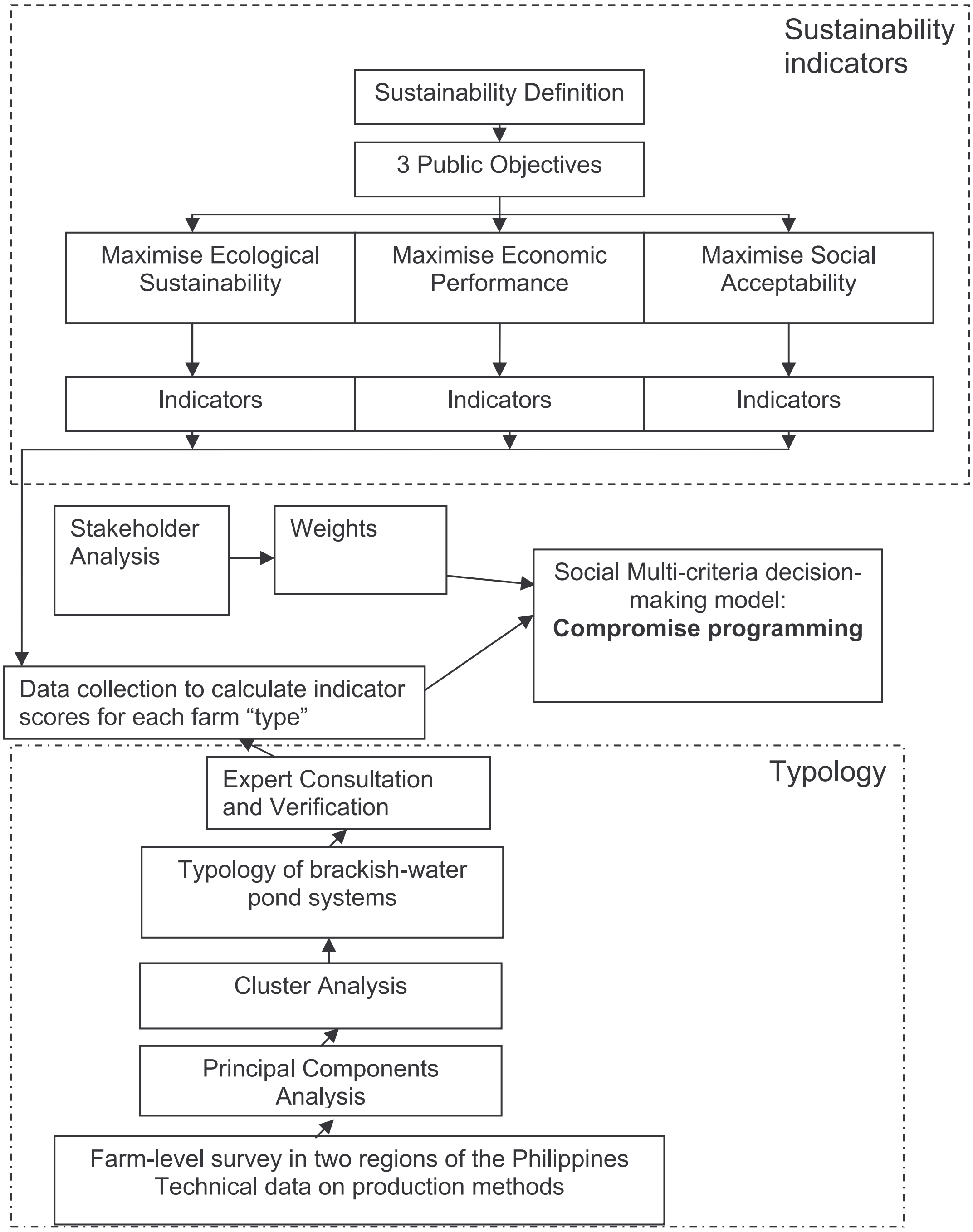
proceeding sections provide background information on the aquaculture sector in the Philippines.

## Background – History

The existence of fishponds in the Philippines was first recorded in 1863 (Primavera, 1995). Chinese and Indonesian recorded histories of pond aquaculture are significantly older, but the practice is certainly considered traditional in the Philippines. Primavera (1995; 2000) charts the development of aquaculture through the course of the twentieth century. During this time, the majority of fishponds were built on land covered by mangrove ecosystem, which was cut and cleared.

**Figure 1 - Conceptual Model of Methodology**



A true traditional production system would rely on the natural productivity of the waters and trap fry and small fish behind dykes at high-tide, the fish remaining in the pond when the tide recedes. In later years, this method (analogous to the Indonesian *tambak*) would be supplemented by wild-caught fry, organic fertilisers and possibly wild-caught feeds. Due to the lack of control imposed on the farming system, the number of species would vary, depending on the site, and might actually be considered a fishing-aquaculture hybrid. In the years between 1950 and 1980, milkfish production dominated this system, with wild-caught fry a limiting factor.

In the 1980s, the developments in hatchery and feed technologies led to an explosion in the growth of production of tiger prawn (*Penaeus monodon*). The controlled spawning of gravid female prawns would produce millions of fry that could be sold to fishpond operators. Feed mills ground fishmeal-based diets formulated for the intensive culture of prawns in a controlled environment. Dubbed variously "shrimp fever", the "blue revolution" and the "pink gold rush", investors flocked to the industry, attracted by high prices attainable in supplying the export market.

Leading this production in the Philippines was the province of Negros Occidental, in region VI. The Negros Prawn Producers and Marketing Co-operative (NPPMC) was established in Bacolod City, Negros Occidental, and the province was producing 29,801 metric tonnes in 1995 (Yap, Villaluz *et al*., 2003). This production was a result of intensive production practices in the region that bore no relation to the traditional aquaculture systems. The San Miguel Corporation, an agribusiness giant and the largest corporation in the Philippines, quickly and aggressively became involved in projects that encompassed feed, freezing and processing plants, hatcheries and marketing (Oe, 1994, cited in Hall, 2004).

Derek Hall's history of the emergence of diverse forms of prawn aquaculture in Philippines, Indonesia and Thailand, suggests that the Negros-centred boom had five components (Hall, 2004): San Miguel Corporation; Taiwanese capital (for the farming technology, feed, machinery, chemicals); the already wealthy landowning families in the region with capital for investment and sugar land for conversion; initial foreign investment ; and the Japanese market for prawn, which in 1995 was the largest agricultural import by value into Japan, surpassing the combined total value of soybeans, chicken and coffee beans (Otsuka, 1998, cited in Hall, 2004).

However, by 1995 the honeymoon was already over in the Philippines, as elsewhere in South-East Asia. Disease outbreaks were critical, associated with the spread of Luminous Vibriosis and Monodon Bacilovirus (MBV), with the viruses thriving in organic matter originating from the farms themselves (Huang, 1997; Holmer, Duarte *et al*., 2003). The Philippines were especially badly affected as these viruses are endemic to the country (Hall, 2004). A government ban on live prawn imports or exports since 1993 has attempted to prevent transmission of the White Spot and Yellow Head viruses that have caused losses in Thailand and Indonesia, but there have been recent outbreaks of these diseases, causing new problems for the operators.

While region VI, led by Negros Occidental, was at the heart of the new, intensive methods of prawn production, with all its associated possibilities for making millions and losing them, region III in Central Luzon did not follow the trend. Perhaps the most compelling reason for this is that of the shock of the eruption of Mount Pinatubo in 1991 – considered the largest and most destructive volcanic eruption of the twentieth century (Leung, Santos *et al*., 2003). Pinatubo's effect on the communities downstream was devastating, and its legacy of lahar (a mixture of volcanic ash, rock and mud) is felt to the current day. The re-suspension of sediments with heavy rainfall mean that destructive flows still occur in the area, more than a decade after the eruption (Lavigne and Thouret, 2000). Volcanic dust lines the roads across the lahar zone, which is having serious human health and environmental costs (Mason, 2002). However, the resilience of the fishponds in the lahar-affected areas matches the resilience of the people living there. While river dredging of the lahar is a year-round activity to ease the flow of floodwaters out to the sea, polyculture production in ponds neighbouring the affected waterways somehow survives.

The extent of the land coverage by fishponds in these regions is truly remarkable. In both cases, the land slopes very gradually out to the sea. This creates large areas of inter-tidal wetland that have been converted over the decades to a patchwork of ponds, linked by a maze of natural and semi-natural waterways. Not only are the ponds crowded, with very little natural vegetation or other land-uses in these areas, but the rate of tidal flushing is low due to the lack of slope. In addition, there are numerous sources of industrial pollution. For the case of region III, water comes in from Manila Bay, which is the centre of heavy industry in the Philippines. For the case of region VI, the waters are often polluted with effluents from sugar processing factories (Yap, Villaluz *et al*., 2003), as the Western Visayas retains a significant concentration of sugar fields. All of these conditions are anti-ideal for raising prawn.

## Background – Current Situation

Of the three fisheries sub-sectors, aquaculture is now the most important in terms of production by weight (Figure 2 below). It should be noted here that measures of weight in this case may be difficult to interpret, as products as diverse as seaweeds and prawns are counted together. Municipal fishing had the highest production by weight in 1991 but has declined and been overtaken by both aquaculture and commercial fishing. This has important implications for rural coastal areas, as livelihoods are lost and individual households dependent on fishing diversify. The dominance of aquaculture in these figures is propped up by the large productions of seaweeds in Mindanao included in these figures. In terms of quantity, the most important production after seaweeds is of milkfish.

In terms of production value in aquaculture (Figure 3 below), the stumble in growth in 1996 and 1997 can be linked to the fortunes of prawn production in intensive systems in Negros Occidental as previously outlined. This boom and bust production can be seen from the production quantity figures for prawn in Figure 4, below. National production has now stabilised at around 40,000 metric tonnes per annum.

**Figure 2: Production for the three fisheries sub-sectors (aquaculture includes seaweeds)**

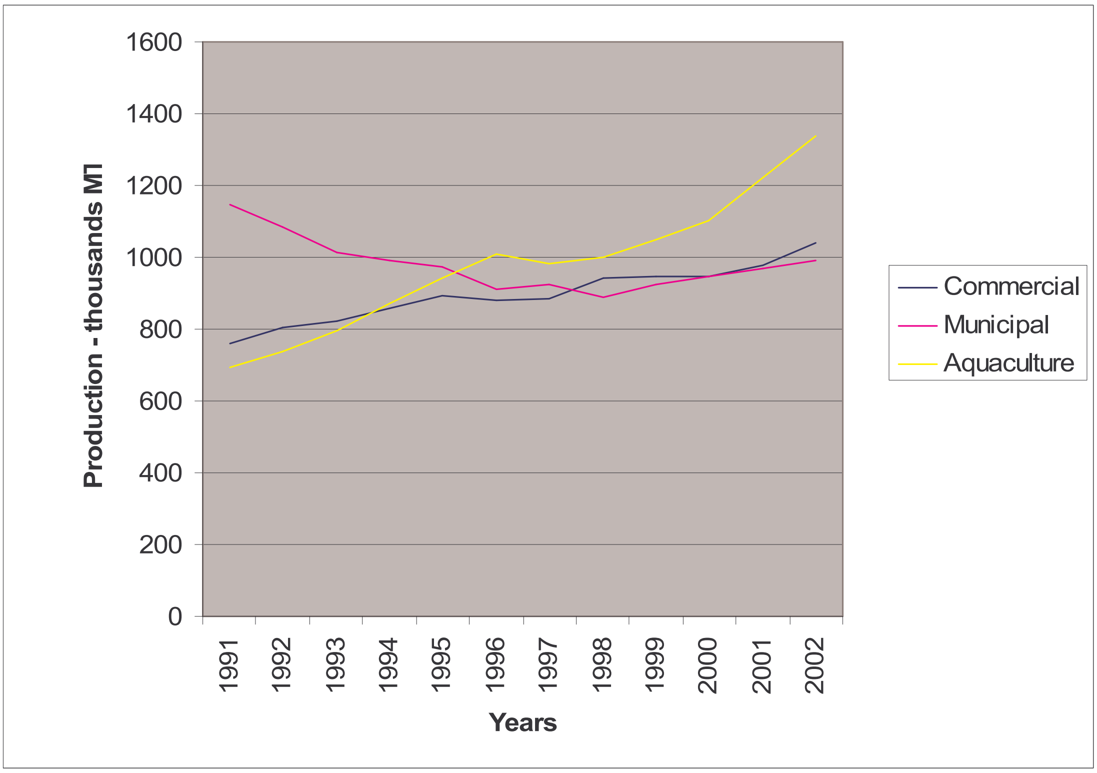



**Figure 3: Production value (at 1985 constant prices)**

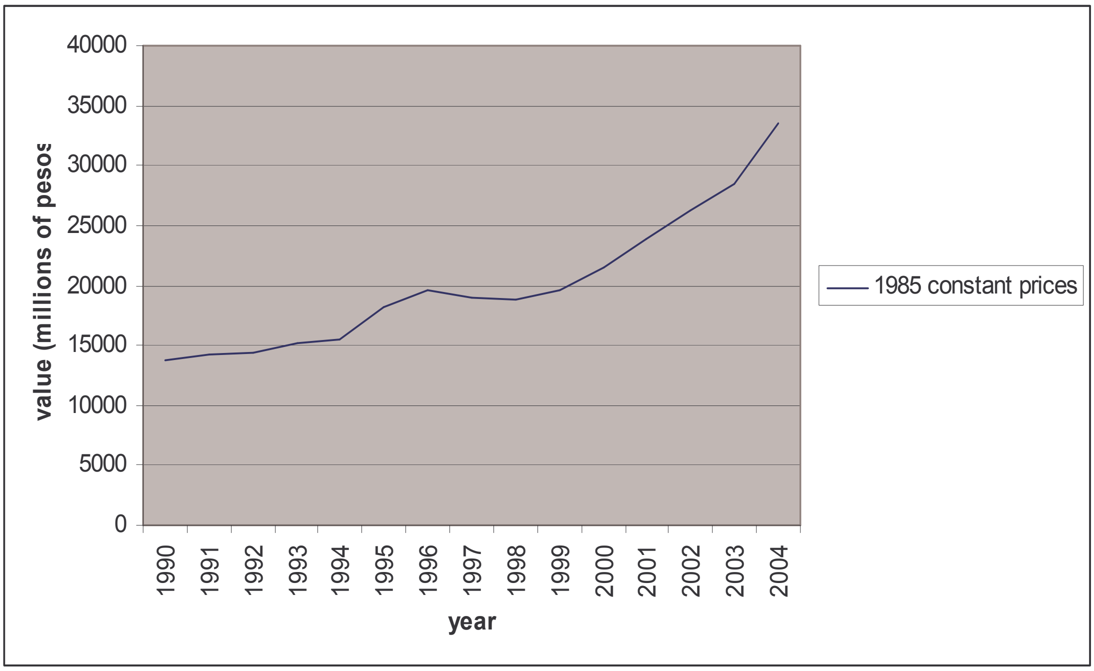
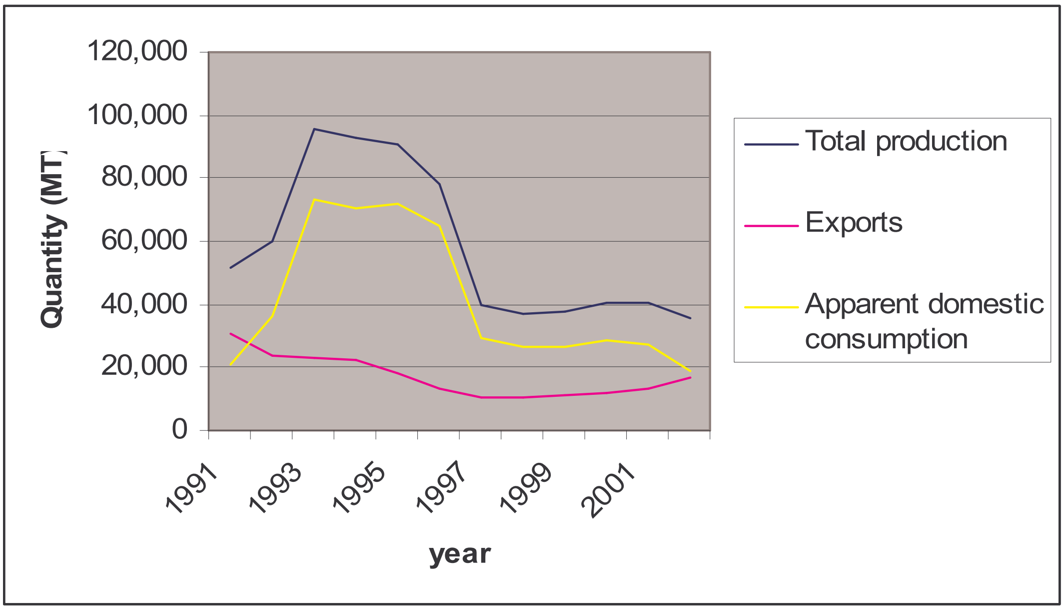


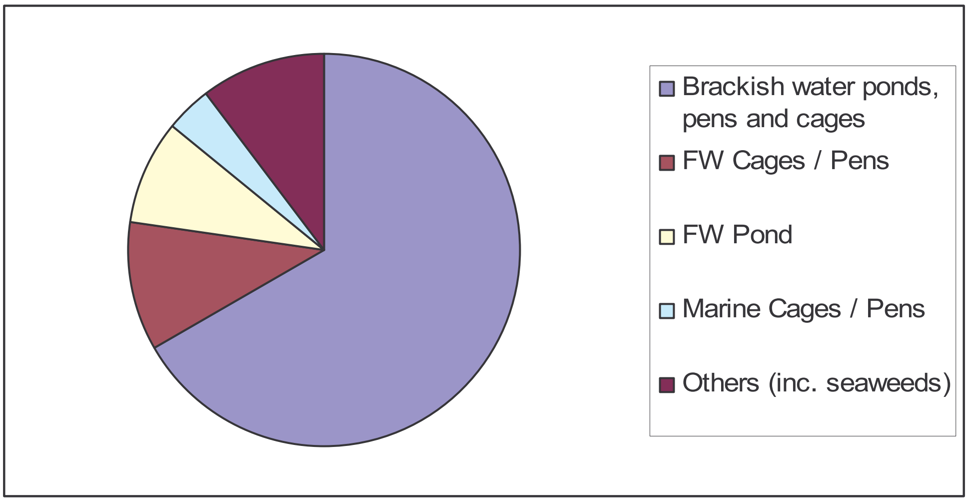
**Figure 4: Total prawn production, apparent domestic consumption, and exports from the Philippines, 1991 and 2002**




*Source: data from Yap, Villaluz et al. (2003)*

Reflecting the archipelagic nature of the Philippines (the country consists of more than 7,000 islands), brackish-water production systems dominate aquaculture. As Figure 5 shows, two-thirds of all aquaculture production by value is from brackish-water systems. The two major regions in which this brackish-water production is concentrated are regions III (central Luzon) and VI (Western Visayas), shown on the map in Figure 6.

**Figure 5: Share of production value by culture environment in the Philippines (2003)**




*Source data: Bureau of Agricultural Statistics.*

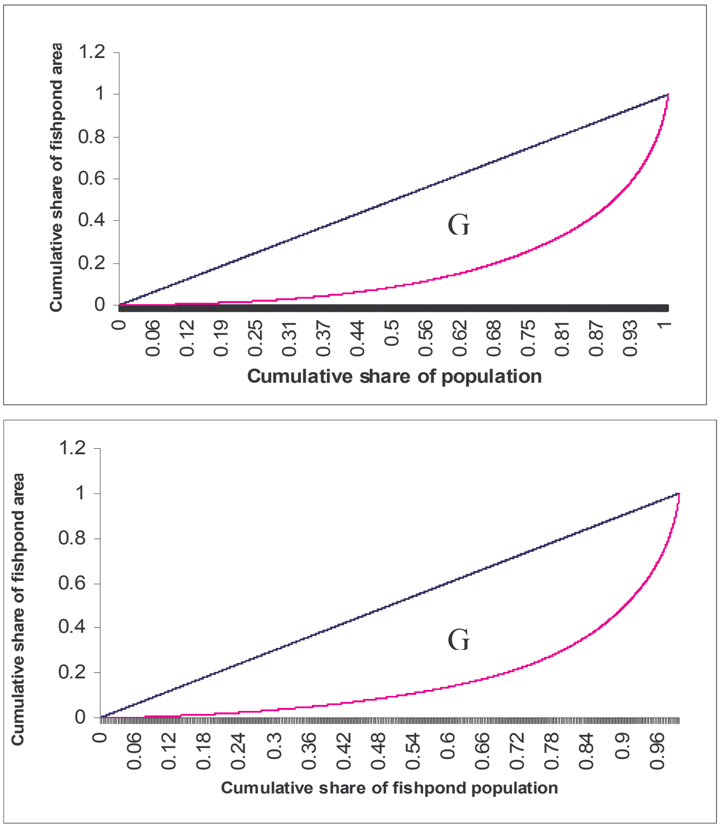
**Figure 6: Map of the Philippines with Regions 3 and 6 highlighted, and their provinces with significant brackish-water aquaculture production named in side-boxes**

**Aquaculture, Land-Use and Social Equity in Regions 3 and 6**

Using data from the Bureau of Agricultural Statistics (BAS) inventory of fishponds from 1997, we compared the distribution of the land given over to fishponds in Regions 3 and 6. By plotting Lorenz curves, one can see the cumulative distribution of farm sizes as a share of the total land given over to fishponds. We also calculate Gini coefficients to describe the degree of inequality in the distribution of farm size (see Figure 7 top and bottom for the Lorenz curves of Regions 3 and 6 respectively). The Gini coefficient is the summary statistic most commonly reported to measure inequality at the country level. Gini coefficients are bound between 1 and 0, where 1 represents perfect inequality (in this case, all the land is operated by one person) and 0 represents perfect equality (all farms are the same size).

The two regions are almost identical in their distribution of fishpond unit sizes; the Gini coefficient for Region 3 is 0.715 and for Region 6 is 0.719. It should be noted that the population for our analysis is the total number of brackish water fishpond units and so these results are only an indication of the concentration of pond ownership among those engaged in the industry. If data on family landholdings for the entire household population in these regions were available, the Gini coefficient for the distribution of all landholdings in general would approach 1 for both regions, showing the effect of including the functionally landless in the analysis.

**Figure 7: Lorenz Curves for Regions 3 (top) and 6 (bottom)**




The Gini coefficient is the ratio of the area enclosed by the Lorenz curve and the diagonal (G), and the area under the diagonal (i.e. Gini coefficient = G/0.5 = 2G). The greater the inequality in land distribution, the greater the value of the Gini coefficient up to a maximum of 1 where all the land is owned by one member of the population.

Aquaculture is exempted from the land reform legislation. Current government policy with regards to agrarian reform is formally stated in the 1987 Comprehensive Agrarian Reform Law (CARL) and its implementing guidelines, which comprise the basis of the Comprehensive Agrarian Reform Programme (CARP). After a period of intense lobbying by the landlord classes, fishpond areas were exempted from CARL for 10 years in 1988 (Republic Act 6657) and this exemption was extended in 1995 (Republic Act 7881).

Corruption and conflicts of interest are most acutely observed in the numerous cases where those in government are fishpond operators themselves, or have a financial investment in them (Siar, 2002). Financial interests in aquaculture are to be found in members of the congress in the Philippines, and continue down to the municipal and *barangay* levels of governance. While formally committed to the principles of sustainable aquaculture under the Philippines fisheries code of 1998 (Republic Act 8550), it is difficult to distinguish the practice of governance of aquaculture in the Philippines from *laissez-faire*.

**Typology of Farming Systems**

*Introduction*

The central proposition underlying work on typologies of farming systems is that farms are similar or identical to other farms of the same type (according to particular characteristics of interest) and that they are dissimilar to farms of other types. This follows from Derek Byerlee's idea (Byerlee, Collinson *et al*., 1980) of "recommendation domains", such that policy statements made regarding one member of a domain are likely to hold for the other members of the domain. While interesting as an end in itself, a typology increases the likelihood that analysis of, for example, productivity (within domain) or comparative study (between domains) will be conducted properly (Shang, 1981).

*'Intensity' relates to resource utilization (land, water, capital, labour, seed, feed, fertilizer and fuel) and different systems may be more or less intensive depending on which resource is considered. It is important to understand the use of all these resources if a thorough assessment of the sustainability of different kinds of shrimp culture is to be made. (World Bank, 2002)*

Many studies classify aquaculture systems using a measure of production intensity. However, the choice of variable or combination of variables with which to represent the concept of production intensity is not a trivial issue. The most important variables are perhaps stocking density, feeding rate and fertilizer application rate.

*Methods*

Data from 136 farms in a random sample from Regions 3 and 6 in the Philippines were collected regarding production practices. The eight variables listed below were selected for principal components analysis. Three components were extracted that explained 58% of the total variance in the original eight variables. These three components were interpreted and named as follows: Specialisation (orientation towards either prawn or milkfish stocking); land versus labour intensity (the relative importance of these two somewhat substitutable inputs as factors of production); and feed intensity. A full description of the principal components analysis is given in Stevenson *et al.*, (2005a).

List of farm-level variables used in the principal components analysis:

- Farm size (ha)
- Total inorganic fertiliser applied (kg/ha/yr)
- Total organic fertiliser applied (kg/ha/yr)
- Total labour input (man days/ha/yr)
- Ratio of commercial feeds to total feeds added (%)

Stocking density of tiger prawn (Fry/m2)
Stocking density of milkfish (Fry/m2)
Total feeds added (kg/ha/yr)

The scores for each individual farm for each of the three principal components analysis were then used in a cluster analysis. Using Ward's method, a five cluster solution was generated and is described here.

## Results

Type 1 – "**Extensive Polyculture**"
(n = 54, or 39.7% of sample)
A very tight cluster of farms that are non-specialised in either prawn or milkfish production in terms of the production practices employed. Mean farm size **9.24 ha** (+/- 1.09).

Type 2 – "**Semi-intensive Prawn-Oriented Polyculture**"
(n = 15, or 11.0%)

Farms of this type have negative scores for factor 1, and are therefore oriented towards the production of prawns. Relative to the sample, labour is more important than land as a factor of production, as can be seen from small farm size and above-average labour intensity. Mean farm size **2.88 ha** (+/- 0.77).

Type 3 – "**Low Input, Labour Intensive Farms**"
(n = 37, or 27.2%)
Farms of this type are neutral to factor 1, and are therefore not specialized with respect to either prawn or milkfish production. They have positive scores for factor 2 and so labour is much more important as a factor of production than land. From the results of a one-way ANOVA, we observe that these farms have higher labour use than farm types 1 and 4 (significant at the 1% level) and farm type 5 (significant at the 5% level). They have negative scores for factor 3 and are very feed-extensive. They have lower feed-intensities than all other farm types. Mean farm size **3.97 ha** (+/- 0.85).

Type 4 – "**Very large, Milkfish-Oriented Systems**"
(n = 11, or 8.1%)

Farms of this type are positive for factor 1 and are therefore specialized in milkfish production. They have negative scores for factor 2 and therefore land is more important than labour as a factor of production. Feeding rates are approximately average for the sample. Mean farm size **63.73 ha** (+/- 13.66)

Type 5 – "**Milkfish Monoculture Farms**"
(n = 19, or 14.0%)

Positive scores for factor 1 suggest that these farms are milkfish-specialised. They are positive for factor 2 and therefore labour is more important than land as a factor of production. From the results of a number of one-way ANOVA test, we find that these farms have higher use of commercial feeds than all other farm types (significant at the 1%); have higher stocking densities of milkfish fry than all other farm types (significant at the 5% level); and have higher use of inorganic fertilizers than all other farm types (significant at at least the 5% level). Mean size **11.08 ha** (+/- 1.46).

## Sustainability Indicators

### *Introduction*

A number of key objectives were identified from Philippine government documentation and rhetoric as representing the relevant policy objectives that apply for aquaculture. The sector should earn profit, not expose operators to excessive risk, be technical efficient, produce protein for human consumption, generate employment, and not pollute the environment excessively. These desirable policy outcomes are not necessarily feasible, as there may be trade-offs between different objectives.

In order to study this possibility, specific farm-level indicators for each of these objectives were developed with aim of providing best quality of information within the constraints of the study. In some cases, this diverged from how the problem might be approached in an ideal world (see Table 1 below).

**Table 1: "Ideal-World" and "Feasible" Approaches to Studying the Objectives associated with Sustainable Aquaculture**

| Objective | Studied in isolation – Ideal-World | Comparative study – Feasible for this case |
|---|---|---|
| Maximise profit | Full economic profit | Gross margin |
| Minimise risk | Variation in output over time (panel data) | Variation in output on similar farms (cross-section) |
| Maximise technical efficiency | Stochastic multi-output distance function | Stochastic frontier with single output (i.e. revenue) |
| Maximise net protein production | Dietary protein balance | Dietary protein balance |
| Maximise regional employment | Social accounting matrix or full input-output analysis | Employment multiplier analysis |
| Minimise eutrophication potential | Full nutrient balance | Partial nutrient balance |

*Methods*

The specific calculation of each of these six indicators is detailed in Stevenson *et al.* (2005b). In each case, the raw data comes from the same farm-level survey that generated the data for the typology. A brief description of the methods used in each case is given as follows:

*Gross margin* (PhP/ha/hr) – Calculated using the mean price for the harvest achieved in a given production year for each farm:
(Total revenue – Variable costs inc. hired labour)/ Farm size
= Mean gross margin in PhP/ha/yr

*Risk indicator* – Calculated as the mean gross margin for a given farm type, divided by the standard deviation:
Gross margin / Std. Dev. = Risk indicator

*Technical efficiency* – Calculated using a stochastic frontier production function model, with technical efficiency effects, where output is measured in value terms, owing to multiple outputs. Technical efficiency indicator is bounded: 0 - 100% efficient.

*Net protein production* – Calculated using farm-level input-output data on feeds and production. Protein content determined by proximate analyses: some from secondary sources, some commissioned at SEAFDEC laboratories. Indicator unit is kg protein/ha/yr

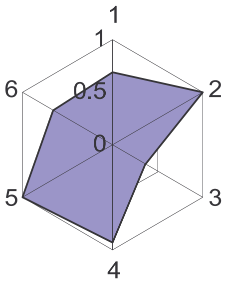
*Regional employment* – Interviews were held with upstream and downstream industries to determine labour use in relation to inputs to and outputs from aquaculture. Coefficients calculated and used to estimate labour multipliers by farm type, based on the farms' use of inputs and generation of outputs, as well as on-farm labour-use. Indicator unit is man days/ha/yr.

*Eutrophication potential* – Partial budget with nitrogen (N) as the currency. Estimated by summing all inputs to the production system and subtracting N embodied in harvests. Assumes that excess is discharged to watercourse. Proximate analyses of feeds, fertilisers and products as with protein production indicator – some secondary data, some commissioned at SEAFDEC laboratories. Indicator unit is kg N/ha/yr.

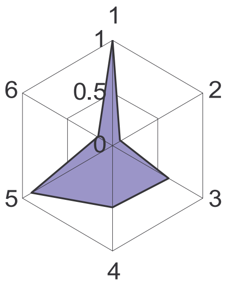
*Results*

Figure 8 - Plots of the indicator results by farming system. Each of the five points represents the maximal element of one of the five indicators (all indicators are to be maximised and all scores are expressed as ratios of the maximal element): 1=Profit, 2=Nutrient loss, 3=Employment, 4=Technical efficiency, 5=Risk, 6=Net protein production.

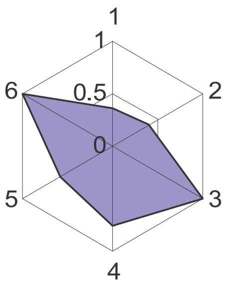
**Extensive polyculture**




**Semi-intensive prawn polyculture**




**Low-input, labour-intensive**




**Large, milkfish oriented farms**

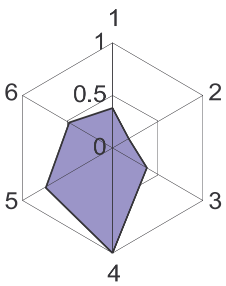
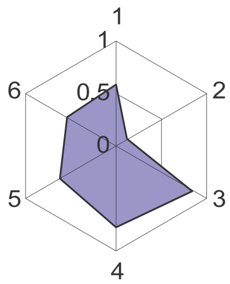



Figure 8 cont. –
1=Profit,
2=Nutrient loss,
3=Employment,
4=Technical efficiency,
5=Risk,
6=Net protein production

**Semi-intensive milkfish monoculture**




A quick visual check on these radar diagrams show that no single farming system dominates any other in the Paretian sense. The indicators are each expressed on a scale between 0 and 1 (a maximal element). Therefore, there are trade-offs between objectives that need to be resolved. The following section outlines the process of handling trade-offs among objectives using multi-criteria decision-making model

## Multi-Criteria Decision-Making (MCDM) Model

In this paper, we propose handling the trade-offs apparent in the sustainability indicator results by means of a multi-criteria decision-making model. In particular, the family of specific models that fall under the title Compromise Programming seem particularly suitable. These typically rely on the concept of an ideal, or “utopian”, point.

The utopian point in a given decision problem is an unfeasible but approachable point at which all relevant objectives are maximised which is unfeasible owing to the inherent conflicts between objectives. The rationale behind compromise programming is known as Zeleny’s axiom of choice: *“Alternatives that are closer to the ideal are preferred to those that are farther away. To be as close as possible to the perceived ideal is the rationale of human choice.”* (Zeleny, 1982, p. 156)

The particular form of compromise programming used in this paper is that outlined by van Huylenbroeck (1997). The best compromise solution is found by minimising the distance to a utopian point. This distance is defined as follows:

$$L_p(W) = \left[ \left( \sum_{j=1}^{n} W_j d_j \right)^p \right]^{1/p} \quad (1)$$

with

$$d_j = \frac{\left| Z_j^* - Z_j(x) \right|}{\left| Z_j^* - Z_{*j} \right|} \qquad (2)$$

where $Z^*_j$ and $Z_{*j}$ are the utopian and anti-ideal solutions respectively for indicator $j$; $W_j$ is the weight of criterion $j$ in the decision; and $p$ is the parameter of the $L_p$ metric (where $p = 2$ gives Euclidean distance and $p = \infty$ gives the Tchebycheff norm). The indicator results that correspond to the utopian and anti-ideal points are given in table 2 below. The anti-ideal is the opposite of the utopian point – the worst results for each indicator across all five farm types. The normalisation clause in the equation for $d_j$ means that all the distances in the model are bounded between 0 (the utopian point) and 1 (the anti-ideal point).

**Table 2: Utopian and Anti-Ideal Points in the Compromise Model**

| | Mean Profit (max) | N loss (min) | Employment multiplier effect (max) | Net protein production (max) | Risk index (min) | Technical efficiency (max) |
|---|---|---|---|---|---|---|
| Utopian | 74824 | 20.0 | 411.2 | 53.2 | 1.229 | 0.748 |
| Anti-ideal | 27845 | 231.9 | 150.7 | 8.6 | 2.152 | 0.437 |

The parameter *Wj*, the relative weight of indicator *j,* is particularly important in determining the optimal solution. The relative weights attached to each indicator in the decision problem can be derived in a number of ways and can emphasise consensus (e.g. Caffey *et al.* , 2001 and their use of a Delphi survey) or aim to highlight possible conflicts arising from the values held by different stakeholders (e.g. Brown *et al*., 2001). The latter approach is employed here, using data obtained during focus group exercises in two Philippine communities from the regions under study.

## Communities

Three focus groups were convened in *barangay* Sapang Kawayan (region 3), a community of almost 3,000 people and accessible only by boat owing to its position in the inter-tidal zone surrounded by fishponds. From a separate household survey in the *barangay* (Irz, Stevenson *et al*., 2005) it was estimated that 59% of the population are "poor" using the head-count index. One focus group was carried out with the *barangay* council (a locally elected administrative body), and one each with randomly selected groups of men and women with diverse sources of livelihood with the sexes separated to allow gender differences to emerge. Capture fishing and labouring on fishponds are the two most common sources of livelihood for men in the community.

Another focus group was convened in *barangay* Nanding Lopez (region 6), although unlike in Sapang Kawayan, this was only possible with the *barangay* council. The population of Nanding Lopez is around 1,400 individuals and the level of poverty is lower than in Sapang Kawayan at an estimated 44%. About 97% of the 797 hectares in Nanding Lopez are covered in fishponds, with fishing and aquaculture again the two most important sources of livelihood.

## Eliciting weights for the indicators

Each focus group followed the same formula. The participants (between 8 and 12 in number) were asked about aquaculture and how it impacted on their livelihood and those of the community in general, in both positive and negative terms. Following this discussion, the set of indicators were presented to the group and explained in as simple terms as possible. Once the group and facilitators were satisfied that the principles underlying the indicators were understood, the group were asked to pick the three that were most important to them. This was usually fairly clear cut for the first one or two indicators, with the final choice being debated at length in some cases.

Once the group were happy with their choice, twenty small stones (to be used as counters) were presented to the group. The group's final task was then to assign the stones to three piles that represented each chosen indicator. The rationale underlying this process was that each stone corresponds to a relative weight of 5%, with the stones summing to 100%. These weights were often debated vigorously (in one case, a show of hands on two possible was required in order to settle the vote) but the group always came to a consensus among themselves that they believed fairly represented their interests. The results of this process are shown in table 3, for each of the four focus groups.

**Table 3 – Weights used in the analysis gathered from participatory exercises as part of a number of focus group**

| | Barangay council – Sapang Kawayan | Group of men – Sapang Kawayan | Group of women – Sapang Kawayan | Barangay council – Nanding Lopez | AVERAGE WEIGHT |
|---|---|---|---|---|---|
| Profit | 0.4 | 0.35 | 0.35 | | 0.275 |
| N loss | | 0.5 | 0.3 | 0.3 | 0.275 |
| Employment | 0.25 | 0.15 | 0.35 | 0.45 | 0.3 |
| Protein production | | | | | 0 |
| Risk index | 0.35 | | | | 0.0875 |
| Technical efficiency | | | | 0.25 | 0.0625 |

**Table 4 – Scenario analysis using different weight sets. The first column gives the results when all indicators are valued equally and the last column uses the average weighting across all four focus groups. In all cases, the parameter p=2 (Euclidean distance)**

| | All weights equal | Sapang Kawayan council | Sapang Kawayan men | Sapang Kawayan women | Nanding Lopez council | AVERAGE WEIGHTS |
|---|---|---|---|---|---|---|
| Farm type | Distance (rank) | Distance (rank) | Distance (rank) | Distance (rank) | Distance (rank) | Distance (rank) |
| 1 – Extensive polyculture | 0.120 ($1^{st}$) | 0.174 ($2^{nd}$) | 0.118 ($1^{st}$) | 0.218 ($2^{nd}$) | 0.229 ($3^{rd}$) | 0.185 ($1^{st}$) |
| 2 – Semi-intensive prawn polyculture | 0.285 ($4^{th}$) | 0.055 ($1^{st}$) | 0.277 ($2^{nd}$) | 0.214 ($1^{st}$) | 0.357 ($5^{th}$) | 0.226 ($2^{nd}$) |
| 3 – Low-input, labour-intensive farms | 0.229 ($2^{nd}$) | 0.375 ($4^{th}$) | 0.282 ($3^{rd}$) | 0.239 ($4^{th}$) | 0.104 ($1^{st}$) | 0.250 ($4^{th}$) |
| 4 – Very large, milkfish farms | 0.293 ($5^{th}$) | 0.379 ($5^{th}$) | 0.451 ($5^{th}$) | 0.463 ($5^{th}$) | 0.340 ($4^{th}$) | 0.408 ($5^{th}$) |
| 5 – Milkfish monoculture | 0.235 ($3^{rd}$) | 0.236 ($3^{rd}$) | 0.314 ($4^{th}$) | 0.227 ($3^{rd}$) | 0.186 ($2^{nd}$) | 0.241 ($3^{rd}$) |

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## Implications for Management and Policy

In terms of the multiple perspectives that are relevant (social incommensurability of values – Munda, 2004), we consider the case of *barangay* Sapang Kawayan. The *barangay* council, a group of randomly selected men, and a group of randomly selected women all chose similar sets of indicators. In all three scenarios, profit and employment were chosen as important indicators. For the council, risk was included as the third indicator, whereas nutrient loss was more important for the groups of men and of women.

There were some slight differences in the weights attached to each indicator. The council chose a set of weights that make semi-intensive prawn polyculture the preferred option, whereas the choice by the group of men suggest that extensive polyculture is the preferred option. The weights chosen by the group of women give results that are equivocal for four possible production systems. Therefore, there is some heterogeneity with regards priorities and preferred solutions among different stakeholder groups.

However, some overall patterns emerged from the analysis. Very large milkfish-oriented systems, which dominate land-use in the study regions, rank bottom in almost every case, and often by some considerable distance. As well as these results, which suggest that very large farms are sub-optimal, there is an important issue with regards to the relationship between the communities and the operators of these farms. Some members of one of the focus groups mentioned community agitation by leftist activists, in addition to the widely-held knowledge that the New People's Army (a communist rebel group that operate throughout the country and extort money from businesses and politicians – their "revolutionary tax") are active in extorting money with the threat of violence from large-scale operators. The operators are targeted because of their wealth, but also because of perceived injustices with regards to the impacts of the fishponds on poor fisherfolk in the area. There is therefore significant potential for social unrest and conflict.

Documented elsewhere (Irz and Stevenson, 2004) is an in-depth analysis on the relationship between farm size and efficiency, for which there is only weak evidence of an inverse relationship – insufficient on its own to justify inclusion of aquaculture under agrarian reform legislation. However, when considered in combination with the high levels of poverty in aquaculture-dominated areas (Irz, Stevenson *et al*, 2005), the importance of aquaculture for livelihoods in these areas as a means to soften the decline of municipal fisheries yields, and the results of the current study, the case becomes more persuasive. While significant efforts of government extension and training would be required to unlock the potential of the break-up of large farms into smaller, more productive units with a greater emphasis on labour as a factor of production, this is a possibility that the Philippine government should seriously consider.

It would be naïve to think that agrarian reform in aquaculture would simply reduce the number of under-performing farms and produce large numbers of smaller farms (similar to farm types 1, 2 and 3 in particular) that perform well according to the objectives outlined here. For example, if one were to take a dynamic perspective, we might consider the characteristics of the individuals that would be involved in aquaculture under agrarian reform versus the *status quo* to differ significantly. The beneficiaries of agrarian reform would be likely to be both more risk averse and more capital-poor than the current cohort of operators. These factors may also have important impacts on productivity in either positive or negative directions. This particular topic, the personal objectives of operators and their attitudes to risk, is one that would benefit from further research.

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