Mekong River Commission

Financial analysis and risk assessment of selected aquaculture and fishery activities in the Mekong Basin

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Editor: Ann Bishop

P.O. Box 1112, 364 M.V. Preah Monivong Boulevard
Phnom Penh, Cambodia
Telephone: (855-23) 720-979 Fax: (855-23) 720-972
E-mail: mrcs@mrcmekong.org
Website: www.mrcmekong.org

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Don Griffiths, READ Viet Nam, Cambodia
John Sollows, MRF Dak Lak
Wolf Hartmann, MRF Lao PDR
Pham Cu Thien, READ Viet Nam
Chweng Touch, READ Cambodia
Kaing Khim DoF Cambodia
Chhor Bunly, MRC READ Cambodia
Hav Viseth, AIT AARM Cambodia
Ouk Vibol, Aquaculture of Indigenous Mekong Fish Species, Cambodia
Truong Ha Phuong, MRF Dak Lak, Viet Nam
Vo The Dung, MRF Dak Lak
Nguyen Thi Nhung, MRF Dak Lak
Son Dak Lak Aquatic Products Hatchery No. 2, Viet Nam
Phoui Siksidao, MRF Lao PDR
Saleumphone Chanthavony, MRF Lao PDR
Mr. Somboon, LARReC
Sommano Phounsavath, LARReC, Lao PDR
Sola Simmalavong, LARReC, Lao PDR
Niklas Mattson, MRF/AIMS
Eric Meusch, AIT AARM
Daouieng; Souamh, Nam Ngum Reservoir

Most commonly-used acronyms

MRC	Mekong River Commission
READ	Rural Extension for Aquaculture Development Project
MRF	Management of Reservoir Fisheries project
AIMS	Aquaculture of indigenous species in the Mekong
OFT	On-farm trials
A-system	Pond aquaculture without the use of animal manure
VAC	'Vuon-Ao-Chuong' or Garden-Pond-Pigsty
LARReC	Lao PDR Aquatic Resources Research Centre

Contents

Summary 1

1.1 Overview

The objectives of this study were:

- An assessment of the financial feasibility and risks for low income target groups of interventions in aquatic resource development; interventions in resource/habitat protection and the enhancement produced or proposed under the MRC fisheries programme; and
- Increased capacity of the implementing agencies in the monitoring of short/medium term financial and economic feasibility of aquatic resource development interventions and related risks for target groups.

Section 2 of the report describes the approach taken to financial and risk analysis in this study, and serves as a simple guide for undertaking such analyses more generally. Section 3 provides a brief overview and critique of previous financial data collection and analysis. Sections 4 to 7 provide examples of financial and risk analysis related to the MRC Rural Extension for Aquaculture Development (READ) project, and the MRC Management of Reservoir Fisheries (MRF) projects in the Lao People's Democratic Republic (Lao PDR), Cambodia and Viet Nam. Section 8 provides a detailed technical summary of the report, and a comprehensive set of conclusions and recommendations. The appendices provide various supporting information, including a possible approach to financial appraisal of new aquaculture candidates (requested by the AIMS project). A comprehensive spreadsheet incorporating all financial models used in the analysis is available separately.

The study concludes that several different forms of pond and cage aquaculture are very financially attractive, with acceptable levels of risk, and offer significant potential for poverty alleviation.

A major recommendation is to use financial analysis and risk assessment early on in the project cycle to help identify and refine useful interventions, and provide essential information for those who may wish to diversify into new activities in aquatic resource development and management.

1.2 Applications

The information and analysis will be useful to those engaged in aquaculture development and extension, whether government, aid agencies, development banks, NGOs or commercial enterprises. It provides simple, but vital, information on key financial and risk characteristics of different activities, and especially aquaculture. It emphasises, however, that these characteristics may change significantly according to local conditions, and should be treated as examples.

Section 2, on approach and methodology, provides concise and simple advice on how to undertake financial and risk analyses in support of research, extension or development projects.

1.3 Conclusions

1. Aquaculture in ponds and cages has high potential in Lao PDR, Cambodia and Viet Nam, in terms of both commercial development and small-scale family enterprises directed at poverty alleviation. From a financial perspective, aquaculture compares well with alternative traditional enterprises such as rice and fishing, and other new enterprises such as fruit and coffee production. Risk levels are necessarily somewhat higher than traditional activities, but generally similar to, or lower, than other new enterprise types.

2. The high levels of variation in performance found in baseline surveys suggest both the opportunity and the need to identify and extend a range of financially attractive production systems suited to different household or enterprise types.

3. There are significant differences in the returns from similar enterprises in different countries. This suggests the need for a broader economic study to examine price and cost differences between countries, and their implications for trade and future price trends.

4. Stocking of small reservoirs generates very high returns, and can be organised as a managed "enterprise" relatively easily. The financial benefits of stocking larger reservoirs are less clear, and the social and economic issues, including resource access and allocation, are complex, requiring much broader social and economic analysis than was possible in this study.

5. Socio-economic surveys, and especially baseline surveys, have been ambitious and detailed, but have not been used effectively as tools for identifying or refining interventions, especially extension recommendations.

1.4 Recommendations

1. Financial appraisal requires a thorough knowledge of both technologies and the development context. Where possible it should be undertaken by local technical staff trained in the basics of financial analysis appropriate to small-scale enterprises.

2. Baseline surveys should be less detailed. They should be analysed prior to extension or advisory interventions; followed up with more focused survey or case studies; used as the basis for financial and production models; and linked to an evolving extension programme.

3. Communicating the financial and risk profile of alternative enterprises and technologies should be a key part of project and extension activity.

4. Histograms and scatter graphs, rather than summary statistics, should be used to explore and present the nature of variation in financial performance, and this should provide pointers for further analysis and research, indications of levels of risk, and important information for extension advice.

5. Where possible, returns to the enterprise or household, to land, to labour and to capital should all be calculated, since these different returns are of greater or lesser importance, depending on local conditions and individual needs and perspectives. An estimation of minimum start-up investment and risk of failure should also be key components in the analysis, especially when assessing the potential for poverty alleviation.

6. Labour is a key resource and input to any new enterprise, and must be carefully accounted for in financial analysis. Care must be taken to distinguish between actual labour input and minimum necessary labour input; the latter is the critical measure in financial appraisal.

7. Financial analysis, ideally undertaken by the same analyst and based on similar assumptions, should be undertaken in respect to existing or possible alternatives to any proposed intervention.

Approach and methodology 2

2.1 Logistics and focus

The consultant visited four Mekong River Commission (MRC) Fisheries Programme Field Stations over a period of one month. These were the Rural Extension for Aquaculture Development (READ) project in Phnom Penh, Cambodia; the READ project in Cai Be, Viet Nam; the Management of Reservoir Fisheries (MRF) project in Ban Me Thuot, Viet Nam; and, the MRF project in Vientiane, Lao People's Democratic Republic (Lao PDR). Three short (1/2 to 1 day) field trips were undertaken to gain a better understanding of some of the key issues. These included visits to a hatchery in Dak Lak province in Viet Nam; to government fishery staff, and a village on the Nam Ngum reservoir in Lao PDR; and to farmers participating in the READ project in Cambodia.

Time was severely constrained, with four to six days spent at each field office. During this time the nature of the MRC interventions, and the local development context were discussed; relevant reports and papers reviewed; the nature and quality of data in project databases was explored; and, in close collaboration with local staff, financial, economic, and risk analyses were undertaken.

In all cases, the production and financial performance of fishing, aquaculture, and alternative activities were explored using the information available, supplemented with minor additions from field visits or targeted phone calls. Financial assessment was made of the following activities:

1. Small scale integrated pond culture, Tien Giang Province, Viet Nam
2. Rice-fish culture, Tien Giang Province
3. Rice cultivation, Tien Giang Province
4. Fruit cultivation, Tien Giang Province
5. Cage culture of grass carp in reservoirs, Dak Lak Province, Viet Nam
6. Small scale reservoir fishing, Dak Lak Province
7. Large scale reservoir management for fisheries, Dak Lak Province
8. Rice cultivation, Dak Lak Province
9. Coffee cultivation, Dak Lak Province
10. Cage culture of snakehead, Nam Ngum reservoir, Lao PDR
11. Cage culture of Tilapia in the Mekong River, Lao PDR
12. Pen culture of mixed species, Lao PDR
13. Small scale fishing, Nam Ngum reservoir, Lao PDR
14. Small scale integrated pond culture, Kandal, and Prey Veng Provinces, Cambodia
15. Rice cultivation, Takeo Province, Cambodia

In many cases, significant financial analysis had already been carried out, and this was developed and built on where possible. However, the information available varied greatly, and some of the assessments were much more detailed and thorough than others. This made comparisons between enterprises difficult.

The data analysis was followed up with one or two short informal workshops on “risks and returns” with project staff and other interested professionals. Subjective scores related to financial structure and performance, risk exposure and risk incidence were derived for project-related activities (such as aquaculture and fishing) and actual or potential alternatives, such as rice cultivation, or vegetable production. This not only supplemented the more formal analysis, but provided a tremendous amount of information and understanding related to financial performance and the risk profile of alternative activities.

2.2. Measures of financial performance

Where possible, the following performance measures and financial characteristics were assessed for each of the interventions:

- the profit or cash return to the enterprise or household (sometimes referred to as net revenue or net income);
- the cash return on the factors of production (capital; land/water; labour); and the sensitivity of these returns to changes in production parameters, input prices and product value;
- the variation in these returns between farmers/fishermen (related to location, management practices etc.);
- the variation in returns for an individual farmer/fisherman, related to production risks (such as crop loss) or market risk (e.g. falling price of product);
- the profit margin [(profit/sales revenue)*100 percent], which measures vulnerability to a fall in product value or an increase in production costs.

The relative importance of simple measures of return on labour ($/person day[1]), land (profit/ha) and capital (profit/capital investment) depend on the value or scarcity of these resources to different households and the intensity of their use in the production process. This varies significantly both within and between countries. For poor people engaged in relatively labour intensive activities, return to the household or enterprise, return on land, and return on labour are commonly more relevant than return on investment. The latter is, however, of concern to those who may lend money for modest investments. Where possible, therefore, all of these measures were used when comparing activities, and their relative importance discussed according to the local context.

There is some confusion surrounding the term "internal rate of return" (IRR) as a measure of return on investment capital. Correctly speaking, IRR is the discount rate that reduces net present value (NPV) to 0 in a discounted cash flow (DCF) analysis. Such analyses are appropriate for investment appraisal of major projects requiring a series of investments over several years and generating a varied income stream and erratic cash flow. The term is misused in several MRC reports as meaning the simple ratio of profit/total investment for relatively short-term investments of the kind considered here. This ratio is more properly termed Return on Investment (RoI).

A complete list of financial measures and ratios, with details of their meaning and derivation, is provided in Annex 1.

2.3 Sources of variation in financial estimates

Figures quoted for actual and potential financial returns from farm level activities are tremendously variable. This variation reflects both real and apparent variations in performance. Real variation may reflect differences attributable to:

- natural conditions such as soil and water quality, climate – through time and space;
- variations in production technology and intensity;
- knowledge, skill and management capacity;
- scale of enterprise;
- variations in market price related to variable marketing infrastructure;
- losses caused by disease or theft.

[1] All figures given in dollars are US dollars

Some of this variation in performance is predictable in theory; some (such as that related to disease or catastrophic events such as flooding) may be more difficult to predict or analyse.

False variations relate to:

- Data inaccuracies arising from misinterpretations of farmer/fisher questionnaire responses and/or subsequent errors in data handling (especially in large data sets);
- Different assumptions or methods of calculating financial ratios;
- Technical optimism, where figures are generated by technical specialists from production parameter based financial models, typically based on best trial results, rather than on commercially-realistic estimates.

In this study particular attention was paid to the presentation and analysis of variation in performance between different households. Where possible, selected information was plotted in the form of scatter graphs and histograms to provide an overview of the nature and distribution of financial performance. These plots, rather than simple performance averages (which can be seriously misleading) were also used, where possible, to compare different kinds of enterprise. They provide a sound basis for the analysis of real and false variations of the kind described above. They also serve as a key starting point for the assessment of risk.

2.4 Capital costs and opportunity costs

In calculating return to labour, the capital costs related to land preparation and pond digging, and opportunity costs of using on-farm inputs, may or may not be included. Similarly, when calculating return to land (e.g. profit/ha) and profit margin, these costs - and also those relating to the opportunity cost of on-farm labour – are sometimes excluded explicitly or implicitly from analyses.

If these costs are excluded, wholly or partially, it becomes impossible to make sensible comparisons between different kinds of enterprise; and different analysts are likely to generate very different results. Previous analyses of MRC interventions varied greatly in the extent to which information on these costs had been collected, and in the way that they were accounted. This has been a significant constraint on the analysis presented here.

In the following analysis, we have included all such costs where relevant, and where information was readily available, except for initial land clearance and field creation for rice cultivation. This is because, in most cases, the paddies are "given" in the sense that they have been existence for many years and their creation no longer represents a real cost to target beneficiary farmers. Where this is not the case, as in areas where land is being settled and cleared for agriculture, it should of course be included. In some cases, where it was appropriate to exclude some costs to inform the discussion, this is explicitly stated.

2.5 Surveys, case studies and models

Where available, survey data were used as a starting point for financial analysis. Where performance was near normally distributed, average values, and some measure of variation, were used to describe financial performance and generate an empirical financial model. This was used, for example, for rice production, where management practices and seed types are relatively consistent and standardised. This empirical model could, in some cases, be transformed into a corresponding parameter-driven production-financial model, allowing for the exploration the production system's sensitivity to changes in costs, prices, and production parameters.

Where performance was highly variable (as for example in the baseline survey of pond culture in Tien Giang Province) an attempt was made to identify and analyse sub-types, or at least to explain the wide variation in terms of different stocking and management practices. Unfortunately, shortage of time limited the extent to which this was possible.

In some cases, survey data were not available, and simple models were generated based on one or more examples or case studies.

2.6 Risk assessment

Risk assessment requires a *consideration* of both exposure to risk and the likelihood of certain risk events occurring.

Estimating risk exposure

Risk exposure has two components: the level of investment, and the time period over which the investment is outstanding. The longer the lead time and the production cycle, and the higher the investment, the greater the exposure to risk. In this study, several indicators of risk exposure were used:

- the total investment required before achieving a return;
- the time delay or "lead time" before the return occurs;
- the length of the cropping cycle;
- the working capital required for each cycle.

These also serve as indicators of the extent to which opportunities are available to the poor, since both the amount of financing and the period over which it is available are limited for poor people.

Profit margin measures exposure to a fall in product price or an increase in input costs, and is therefore also an index of risk exposure.

Risk exposure may be converted into an overall compounded index of exposure such as:

1. Lead time x enterprise investment/profit margin
2. Crop working capital x cropping cycle length/profit margin

Risks to the individual farmer/fisher over time

The probability of certain risk events taking place, and the financial consequences of such events (e.g. complete crop loss), can sometimes be calculated. For example, climatic records may allow for a rough estimate of the probability of flooding (e.g once in five years or 20 percent) and both overall returns, and the frequency of particular levels of loss, may be calculated. Time and/or data were inadequate to undertake such a rigorous analysis in this study.

It was particularly difficult to make rigorous assessments of the risk from disease, which tends to be highly erratic and potentially catastrophic. In this study assessment of disease risk was largely subjective and based on limited expert consultation. A more thorough study is required which would compare disease and predation risks across different kinds of enterprise.

Risks in terms of overall performance of individual farmers/fishers

Performance of fishers and farmers varies tremendously related to scale, local conditions, skills etc. This was analysed as described above using histograms and scatter graphs. Specific measures and indicators were then derived, including:

- Proportion of farmers making a loss;
- Proportion of farmers achieving return on labour lower than the agricultural (casual) wage rate.

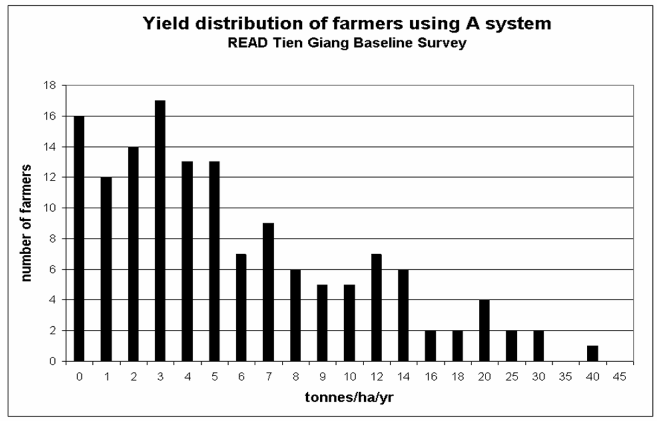
In practice, this was only possible on the basis of variation between farmers in any one year. Ideally the variation in performance of individual farmers through time should also be examined.

Sensitivity analysis and switching values

The sensitivity of a production enterprise to changes in input costs, market price, and production parameters (relationships between inputs and outputs) is sometimes used to assess the risks or likelihood of financial failure. It provides more specific and strategically useful information than profit margin. Sensitivity can most easily be measured as the percentage change in a cost, value or parameter required to reduce net revenue to zero, or reduce returns to land, labour and capital to unacceptable levels. The likelihood or risk of such changes taking place can then be assessed.

In practice, this type of analysis is more usually applied to well-established systems with clear relationships between inputs and outputs. Most of the systems studied here were not clearly defined, and inputs were dominated by labour. Only very simple forms of sensitivity analysis were therefore used. Wherever possible simple *switching values* were estimated. These were critical values of prices, costs or production parameters that would reduce returns to zero, or to below acceptable levels generated by alternative activities such as rice production.

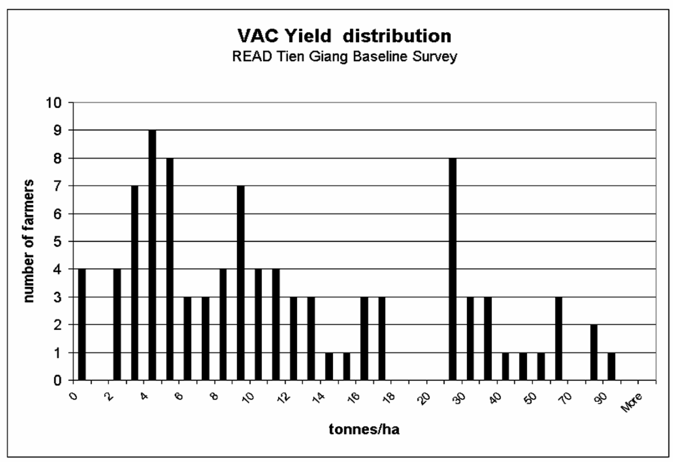
Figure 1



Other measures of risk

The coefficient of variation (standard deviation/mean) was used as a measure of risk in the READ Tien Giang baseline survey report. This measure is not particularly meaningful when applied to returns that are in any case highly variable for a variety of reasons. While risk implies variation in performance, variation in performance does not necessarily imply high risk. In the case of the baseline data, variation was mainly attributable to the use of different species, different stocking rates etc. In any case, great care must be exercised when comparing variation. In the baseline survey, the data were separated into three intensity categories based on production/ha, and the coefficient of variation was calculated for each of these. An examination of the frequency distribution of production shows no clumping of data corresponding to these categories (Figures 1 and 2), but rather a continuum of production related to a wide range of factors. The definition of the groupings was therefore arbitrary, and the corresponding variation therefore also arbitrary. In any case, the three groups are non-comparable from a statistical perspective, since the first includes zero values, and the third (intensive) group is unbounded (i.e. could theoretically rise to infinity). We would therefore expect a higher coefficient of variation in the lower (extensive) group and the higher (intensive group), with less variation in the intermediate (semi-intensive) group. Unsurprisingly, this is what was found.

Figure 2



In practice, such an approach would be useful and meaningful if the categories being compared were defined in terms of the production system (e.g. species, stocking density, or feed intensity) rather than the production rate. The variation in production for each of these technically-defined systems could then be compared, so long as production variation was near normally distributed, and the data were not bounded in any way.

2.7 Subjective risk assessment

It is often not possible to quantify the risks, or the measures used may not allow for comparison between activities. In such cases, a more subjective form of risk assessment can be undertaken closely related to multi-criteria decision analysis (MCDA). This was done at each of the field stations visited, with the help and involvement of technical staff. Ideally farmers, fishermen (as appropriate) and technical specialists from different fields should be included.

Firstly, the major risks were identified and listed on a matrix against alternative development options. The vulnerability of each option to each risk was then discussed, and scored on a scale of 1 to 5 or 1 to 10, as agreed. The completed matrix provided an overview of the risk characteristics of different options, and provided a basis and framework for overall comparison discussion, and organisation of information. Scores were summed in some cases to summarise the results and to further stimulate discussion, although this must be done with great care since the nature of risks may differ significantly. This problem can be addressed to some extent by weighting the risks and applying the weighting to the score. Any aggregate score of this kind is questionable, however, and should be used as a tool to stimulate discussion rather than as a firm criterion for decision-making.

This vulnerability to external risk factors was then compared with financial risk exposure as described above. High vulnerability, coupled with high financial exposure implies high risk.

Aggregated indices of risk

This process can be taken a step further by actually multiplying a score related to vulnerability by the score derived for financial exposure described above. However, as noted elsewhere, such aggregate scores are generally more useful as tools for discussion rather than as absolute criteria for decision-making and strategy development, and they have not been used in this study.

Previous data collection and analysis 3

In all cases financial and economic data had been collected, analysed and reported to a greater or lesser degree over several years. In the case of READ, substantial socio-economic studies had been undertaken, including a major base-line study in Cai Be and a Master's research study in Phnom Penh.

Most of this work is thorough and of high quality. However, there are some limitations and problems with the analyses. It should be emphasised that these inadequacies are common to the great majority of development programmes:

1. Where comprehensive financial and socio-economic analyses have been undertaken, this has generally been too late to be of much strategic value to the projects. Financial and risk analysis should be a key tool for analysing performance in practical terms, and for identifying appropriate interventions and recommendations. Furthermore, the communication of simple financial and risk profiles of alternative activities should be a key part of any extension activity – not an end-of-project exercise.
2. The financial returns from enterprises are typically described and compared using a single average figure (in some cases a range, or other measure of variation) derived from surveys, which does not adequately address the nature of the variation in the returns, and the implications of this variation to new entrants;
3. Much of the information related to variation in performance (typically the "project database") is compounded with *apparent* variation related to the nature of farmer responses and interviewer interpretation. In some, possibly most, cases this "false" variation may swamp real variations;
4. There has been inadequate attention paid to identifying and analysing different "types" of enterprise or management system (another major source of variation in the survey data), and then exploring in more detail, the strengths and weaknesses of these using case studies and production/financial models. Such analysis should be used to inform the adaptation and refinement of extension strategies;
5. While return on land (e.g. net revenue or profit/ha) and capital (percent return on investment) are almost always calculated, return on labour, which is often of particular concern to small enterprises, is less often reported. Also conventions for its calculation that are appropriate to small-scale rural enterprises, are not well established.
6. Approaches to accounting (or not) family labour and certain kinds of capital expenditure are varied, and assumptions are not always clear in reported figures or database calculations. Variation in approach between projects and field offices makes cross-regional comparisons difficult, and in some cases, impossible;
7. Thorough risk assessment is rarely undertaken, and there is no widely-adopted format or framework for risk assessment which would allow for comparison between different kinds of intervention and existing farmer/fisher activities;

8. Financial performance is often reported for a particular intervention, without comprehensive comparison with existing or possible alternative activities. Lacking any local reference point, these figures may be meaningless. This is a particular problem where interventions imply changes in resource use patterns;

The first of these is probably the most serious. A great deal of work has been undertaken by MRC staff and others to provide information on socio-economic and financial issues related to aquatic resources development. The focus of this work has been on collecting data and setting up databases. The analysis has not been linked directly to extension activity, and has had limited strategic impact. A less ambitious preliminary survey, analysed prior to extension or advisory interventions, followed up with more focused surveys or case studies, and linked to an evolving extension programme, would be far more effective.

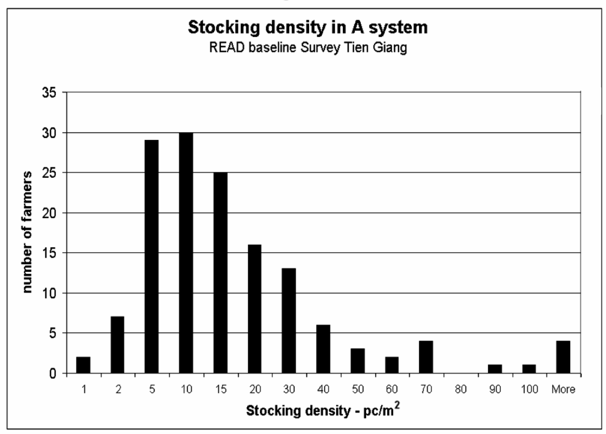
Pond aquaculture and alternative activities in Tien Giang Province, Viet Nam

4

4.1 Financial returns - baseline survey

READ undertook a comprehensive baseline survey of 361 households engaged in pond fish culture (integrated with animal husbandry (VAC[2]); not integrated with animal husbandry (A-system); rice-fish cultivation; and seed production/nursing. A report based on this survey has recently been produced (Sethboonsarng *et al*. 1999). The analysis here seeks to build on that work, and extend it with examples of analysis of variation in performance, risk and comparison with other activities.

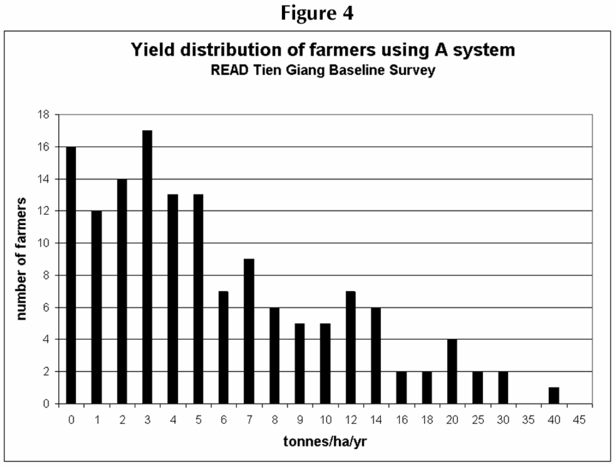
Figure 3



A-system

Pond culture is relatively new in the province, and a wide variety of species, stocking rates (Figure 3) and feeding and fertilising strategies are practiced. This variation in production systems is reflected in huge variation in yield (Figure 4). The yield histogram shows significant numbers of farmers failed to achieve any significant production. The reasons for this were unclear, but warrant further investigation. It also shows that many farmers achieved very high rates of production, although some of the more extreme figures may be unreliable.

Figure 4

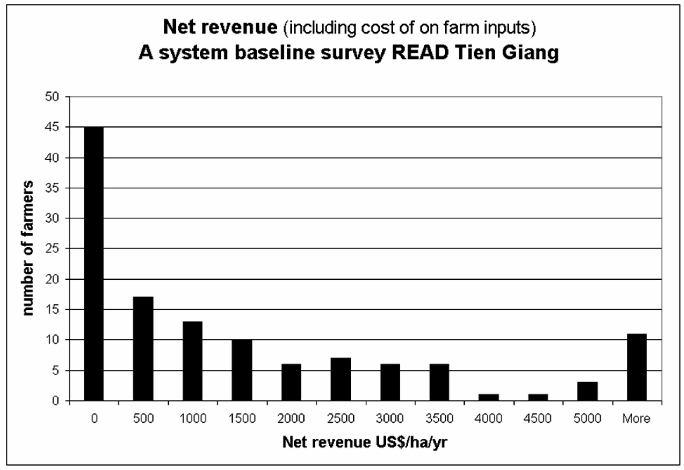


Financial performance in terms of *net revenue per hectare* was estimated, including a charge for the value of on-farm feed and fertiliser inputs, but excluding capital costs for pond construction, which were not included in the

[2] `Vuon-Ao-Chuong' or Garden-Pond-Pigsty

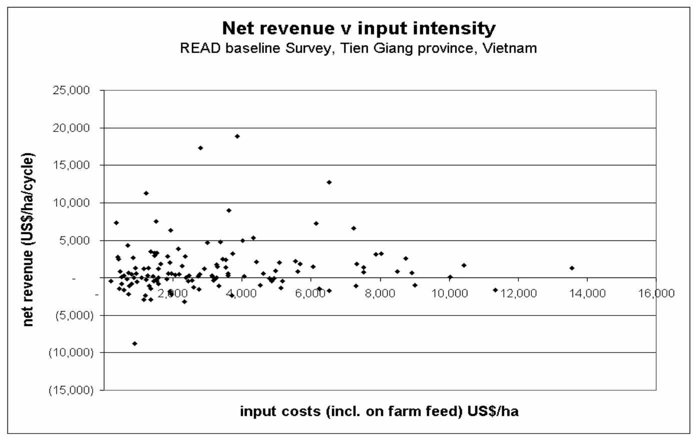
database (Figure 5). Performance was correspondingly varied and rather poor in many cases. A total of 36 percent of farmers made a loss in real terms. These figures would be significantly worse if a charge were to be made relating to the capital costs of pond construction.[3] On the other hand, 50 percent made in excess of $500/ha/yr, which is roughly the return from rice farming (double crop – see below).

Figure 5



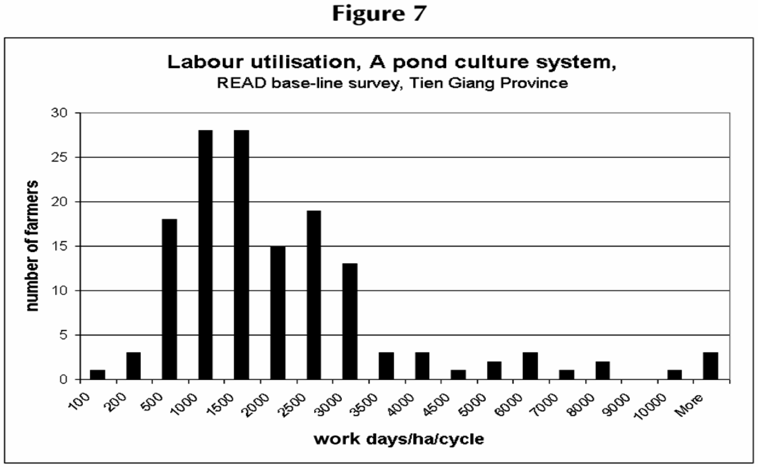
In order to explore the nature of the variation and to provide some insights into factors generating higher returns, the relationship between net revenue and intensity (measured in terms of total seed, feed and fertiliser economic costs) is plotted in Figure 6. It is clear from this chart that input intensity is not the main factor delivering higher returns – indeed it is clear that very high returns can be generated with very modest inputs. This suggests great potential for extension interventions building upon existing best practice. The nature of this best practice should be revealed by studying the farms corresponding to the data points in the upper left corner of the "data cloud". It is also notable that the proportion of farmers suffering a loss (in real terms) does not appear to increase with increasing intensity. Again, this finding warrants further investigation.

Figure 6



Return on labour was not calculated for the baseline A-system because of doubts about the accuracy and utility of the data. The figures for labour utilisation are very varied and generally very high (Figure 7). This variation will have real and false components. Information on labour use on family farms is notoriously inaccurate, and very broad comprehensive surveys are unlikely to allow for an accurate and thorough appraisal. It is probably best approached using a few detailed case study explorations of different types of enterprise. This would also allow for an estimate of the *minimum* labour requirement for a particular type or scale of enterprise – the key parameter for financial analysis.

Figure 7



[3] Pond construction costs were not included in any of the previous analyses, on the basis that many already existed (dug out to provide material for house building, or paid for by development).

Baseline VAC

The VAC systems used similar (high) stocking densities to the A system (Figure 8), but generated somewhat higher yield (Figure 9), with a significant group of farmers producing in excess of 25t/ha/cycle. While the data for some of the higher yields may be questionable, there are sufficient data points to suggest that very high yields are indeed possible, probably where significant quantities of animal manure are used.

Figure 8

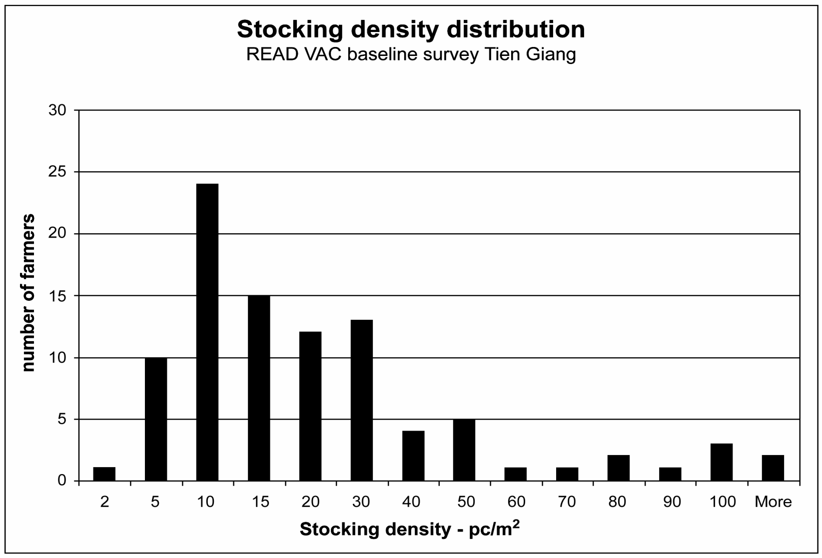
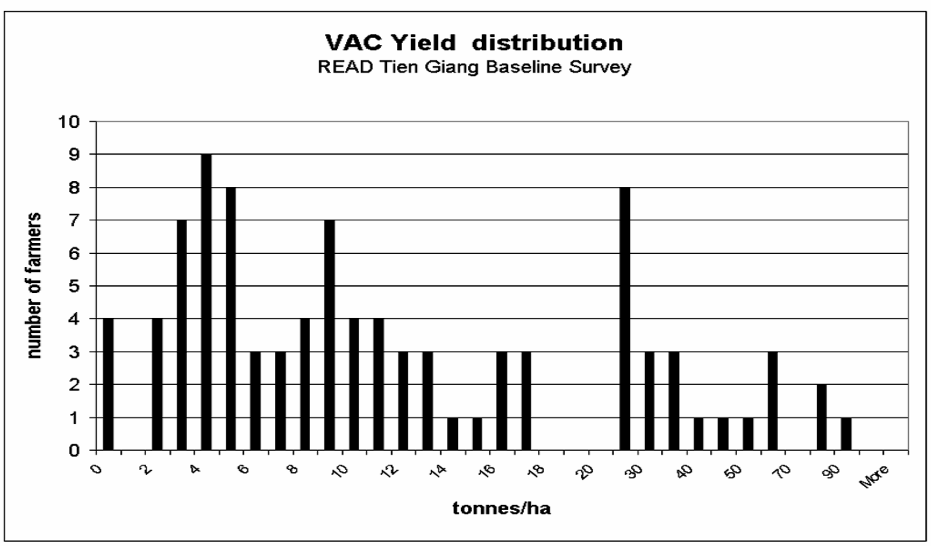


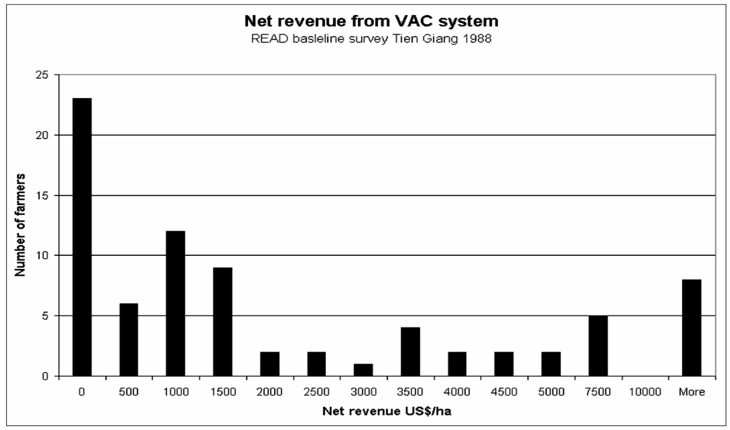
Figure 9



Note the change in the scale on the x axis compresses the data for higher levels of production and disguises the very long tail.

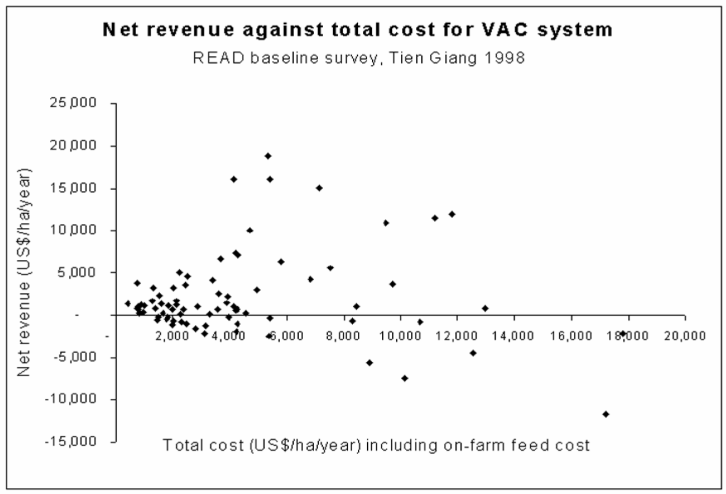
Corresponding to the variation in yield and the variation in the use of inputs, there is tremendous variation in net revenue per hectare (Fig 10), with similar performance to that achieved in the A system. Significant numbers of farmers (30 percent) made a loss, when the market equivalent costs of on-farm feeds are included. On the other hand, 64 percent achieved more than $500/ha/yr – which might be made from rice production – and 32 percent made more than $2,000/ha/yr, corresponding to a very healthy income

Figure 10



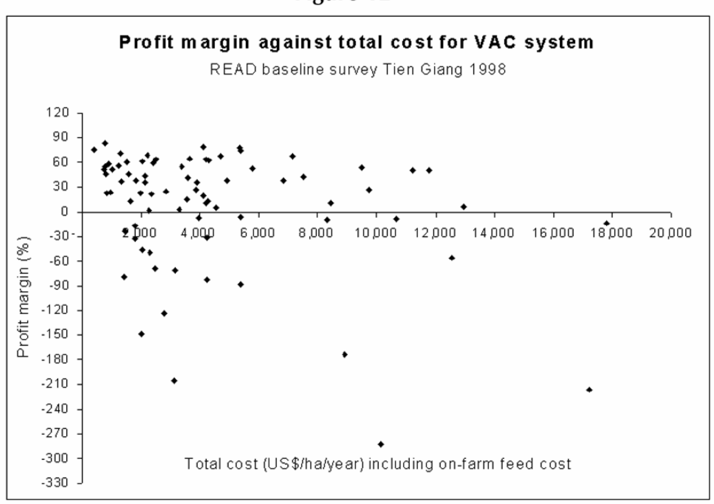
Where such high variation exists, an understanding of the relationships between the intensity of use of inputs, yield and return is of particular concern to farmers and extensionists. This is vital if projects are to learn from practical experience, and if sensible extension advice is to be given. The relationships are shown in Figures 11 and 12. The total value of on- and off-farm food and fertiliser inputs is used as a measure of input intensity and plotted against net revenue and profit margin.

Figure 11



Although there is substantial residual variation, net revenue appears to increase significantly with increasing inputs up to around $5,000/ha/yr, but beyond this, there is no clear relationship, and some farmers suffer significant losses. There is no clear relationship between profit margin and input costs. Together these suggest that medium intensity systems perform best, and the nature of these systems and their input strategies deserve further exploration in the field. Of particular interest are those farms generating $15-20,000/ha/yr with input costs of $4-5,000.

Figure 12



The reasons for farmers making a loss are also worth exploring. A total of 29 percent of the farmers in the baseline survey made a loss when on-farm inputs are included. Losses would be even more significant if capital costs for pond construction were to be included. Even where the cost of on-farm inputs is excluded, 15 percent of farmers still made a loss. The reasons behind these losses could not be explored in this study, but warrant further investigation.

4.2 On-farm trials

Only data for 2000 were seriously explored in this study.

The most conspicuous difference between the trial farmer performance and that of baseline survey farmers is the consistency of results. This is directly related to the fact that farmers were obliged to follow recommendations (Annex 2). Farmers kept close to the recommended stocking rate of five per square metre (average 5; max 8; min 2). As a result, yields and returns are also far more consistent (Figures 13 and 14). This also tends to confirm the view that variation in baseline data is not associated with risk, but with varied management practice.

Figure 13

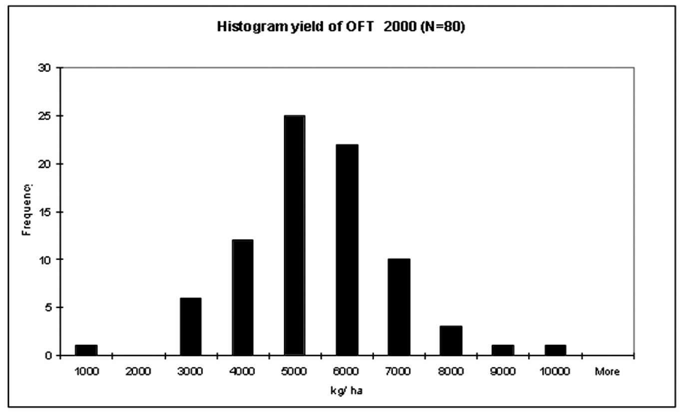
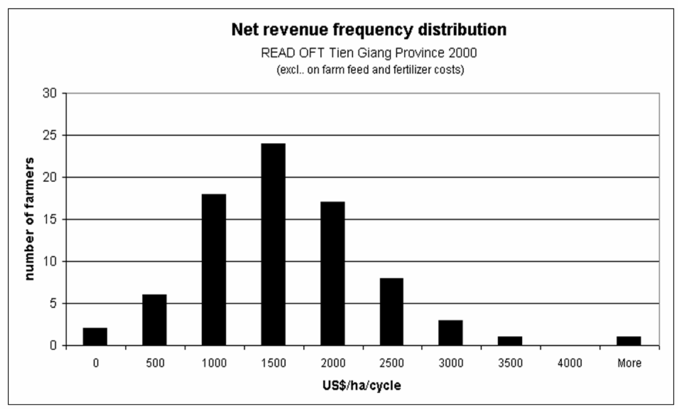
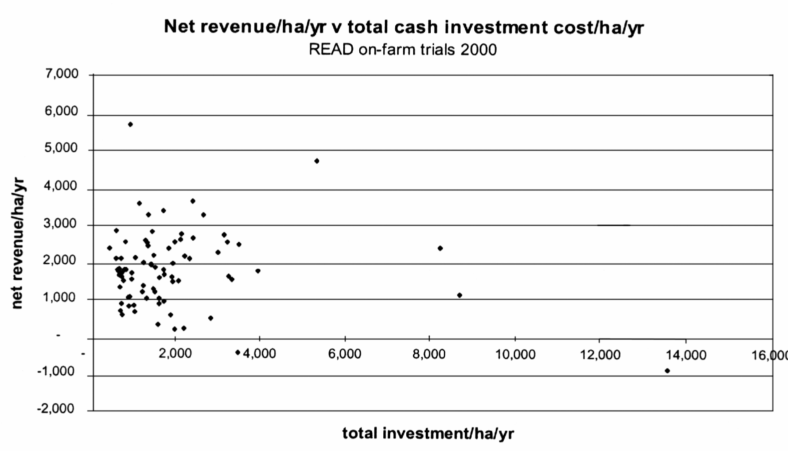


Figure 14



Unfortunately, the on-farm trial net revenue data presented here is not directly comparable with the baseline data, since on-farm input costs have been excluded from the former. Rough comparisons can, however, be made. Fewer farmers performed badly compared with the baseline survey. Only two farmers out of 80 made a cash loss, and roughly 5 percent made a real economic loss when the value of on-farm inputs is taken into consideration. On the other hand, rather few farmers made returns comparable with the better farmers in the baseline survey, with less than 16 percent achieving more than $2,000/ha, compared with 32 percent in the baseline survey. However, most farmers (more than 80 percent) achieved returns to land (net revenue per ha) substantially higher than that possible from rice production.

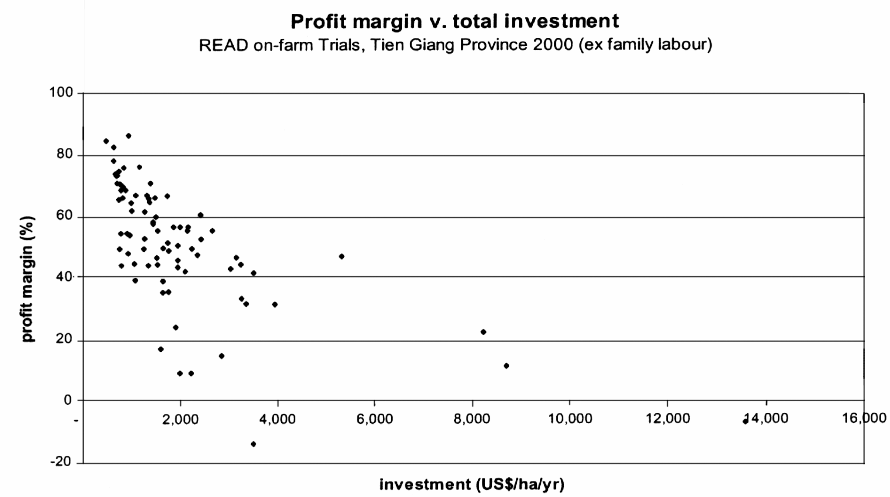
Figure 15



As with the baseline data, it is informative to plot returns against investment costs. There appears to be only limited relationship between investment in feed and fertiliser and return on land (Figure 15). This might be expected since production is constrained by recommended stocking rates, and marginal increases in production and revenue will therefore decline as inputs increase. Related to this, there is a clear decline in profit margin with increasing intensity (Figure 16).

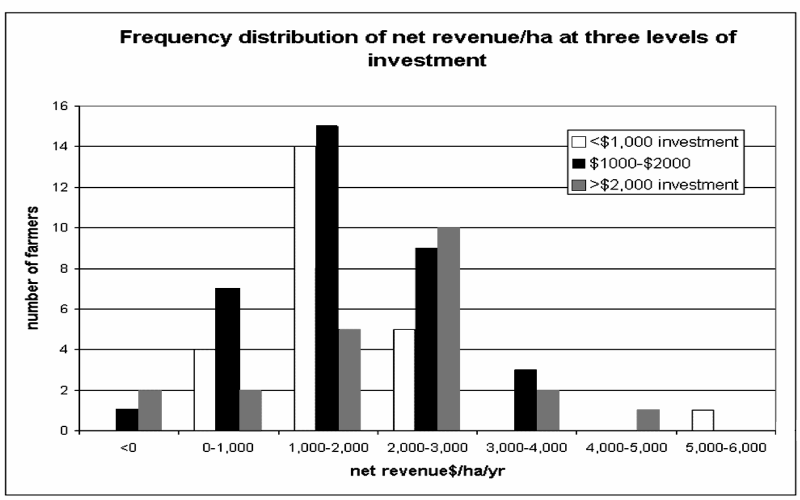
Although variation in performance is much lower than that in the baseline survey, it is nonetheless high when compared with well-established activities such as rice cultivation. It is particularly notable that many farmers are achieving high cash returns (>$2,000/ha/yr) using very modest cash inputs. While part of this is probably due to the availability of on-farm inputs, the actual practices used by the best farmers (in terms of financial performance rather than production) should be studied.

Figure 16



The relationships can be further explored using multiple histograms The data were sorted and divided into three classes according to the total expenditure on crop inputs (seed, feed, fertiliser, pumping, but excluding on-farm labour and capital costs associated with pond digging). Distribution frequencies of net revenue were then generated (Figure 17) to explore differences between the groups, and the possible benefits, or otherwise, of higher input investment.

Figure 17



The chart shows little difference between the first two groups but higher returns generated from the highest levels of investment. There is one important outlier, where a farmer with low apparent investment generated very high returns. This case is clearly worthy of investigation.

Unfortunately data on labour utilisation were not available for the on-farm trials in Tien Giang, and return on labour could not be calculated. However, data are available from comparable sources and "typical" return on labour can be estimated (see below).

4.3 Comparison with alternative activities

Given the nature of the variation in performance described above, it is difficult to compare pond aquaculture with other better-established activities, or indeed to make general analyses of its financial desirability. As noted elsewhere, average figures have limited meaning. The problem is compounded when different data sources present different kinds of financial information that may not be comparable. Notwithstanding these limitations, simple models were developed based on average performance. This was done for the various groups studied in the baseline survey and in the on-farm trial data. Missing parameters and other information (such as the costs of pond construction, use of labour etc.) were estimated from other sources or from first principles, as appropriate. These models also allow for the estimation of sensitivity to changes in input costs, market price, and production parameters.

Financial models for other activities were developed in a similar way, though based on more limited information. A summary of data derived from a survey of rice farmers in Tien Giang was available from the local government offices, and this was used to develop a simple financial model of single and double cropping of rice. Limited data were also available on returns from fruit tree production.

Details of all models used in this study can be found in Annex 3, and in the accompanying spreadsheet.

The results are summarised in Figures 18 and 19 and in Table 1. It should be noted that returns are generally lower than those shown above since all economic costs (including capital (pond) costs and the value (opportunity cost) of on-farm inputs) have been included to allow for realistic comparison.

Most striking is the very high average performance of the baseline survey VAC system, compared with the A system and the on-farm trials. However, the on-farm trials and the A-system (baseline) compare well with rice double cropping when labour and capital are excluded. However, the high cost of pond construction results in negative return when both are included. While returns from the A system (baseline) and OFT appear similar, it should be remembered that the A system generates far more variable returns.

Return on labour shows a corresponding pattern, with significant returns well above the agricultural labour rate ($1.5-2/day) for the VAC baseline data. Return on labour is also relatively high for the OFT and A system where pond construction costs are excluded, but falls close to zero when included. However, much depends on the assumptions used for labour requirements. Because of the questionable nature of the data on labour, I have used a standard rate of one person/ha/year, which is typical for commercial labour requirements on semi-intensive pond fish farms in Asia.

Rice-fish, especially in the on-farm trials, generates low net revenue per hectare, but is not strictly comparable because this is an additive rather than an alternative enterprise. The nature of labour inputs, capital (refuge ponds) and management issues would all need to be explored in depth before useful conclusions could be drawn.

Figure 18

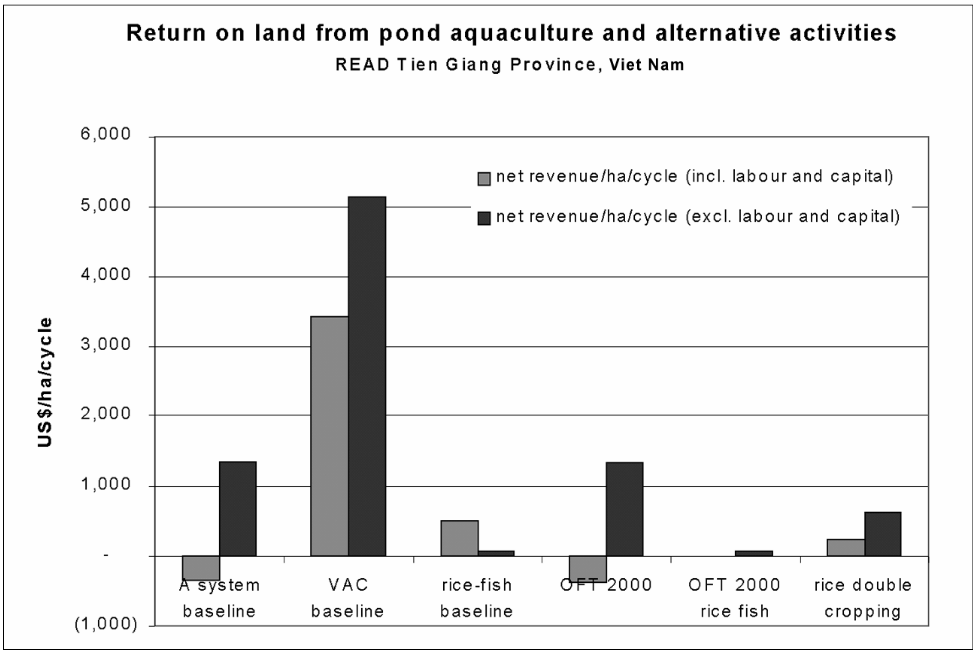


Figure 19

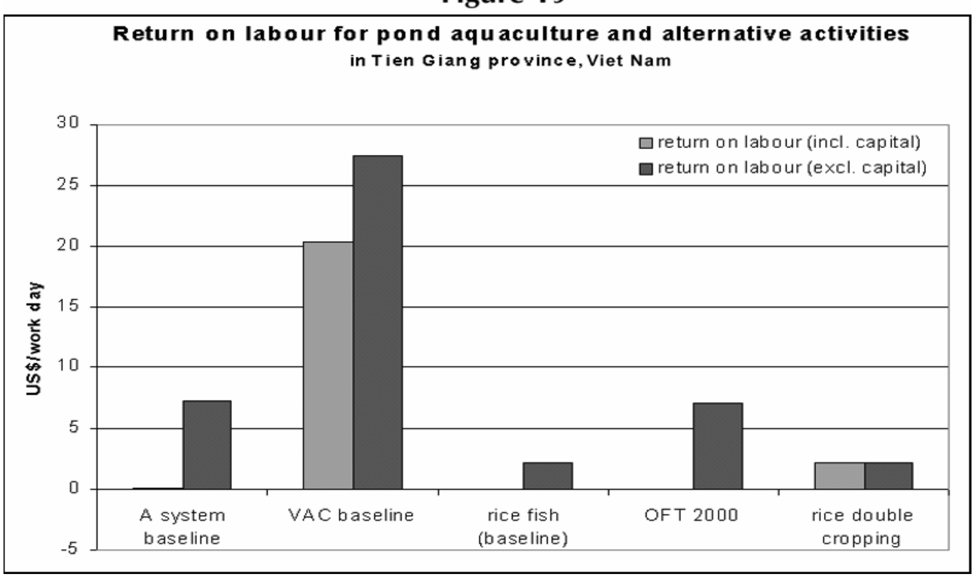


Table 1 Comparison between different economic activities in Tien Giang Province, Viet Nam

Currency values in $	Net revenue /ha/cycle (incl. labour and capital)	Net revenue /ha/cycle (excl. labour and capital)	Return on labour (incl. capital)	Return on labour (excl. capital)	Profit margin (incl. labour and capital)	Profit margin (excl. labour and capital)	Return on investment (strict)	Return on investment (1st crop)	Minimum start up investment	Payback
A system baseline	(355)	1,353	0.11	7.22	-12%	45%	-3%	-2%	150	-37.6
VAC baseline	3,429	5,137	20.29	27.40	49%	73%	26%	22%	152	3.9
Rice-fish baseline	58	505	NA	2.3	6%	42%	NA		3	0.0
OFT 2000	(377)	1,331	(0.01)	7.10	-15%	45%	-3%	-3%	145	-35.3
OFT 2000 rice fish	-	62	NA	NA						
Rice double cropping	236	627	2.14	2.14	25%	65%	NA	41%	2	NA
Fruit (orange)		14,955			94%	100%	NA	1742%	0	NA

Note: Figures are based on average performance; Brackets indicate negative values.

4.4 Comparative evaluation of risk

Risk exposure

Profit margin

Profit margin is generally high (40-70 percent) for all enterprises (Figure 20). However, if labour is factored in, the margin falls significantly for rice. If both labour and pond construction costs are added in, both the baseline A system and the OFT incur losses. Any fall in price would seriously undermine capacity to repay a loan on pond construction.

Minimum startup investment requirements

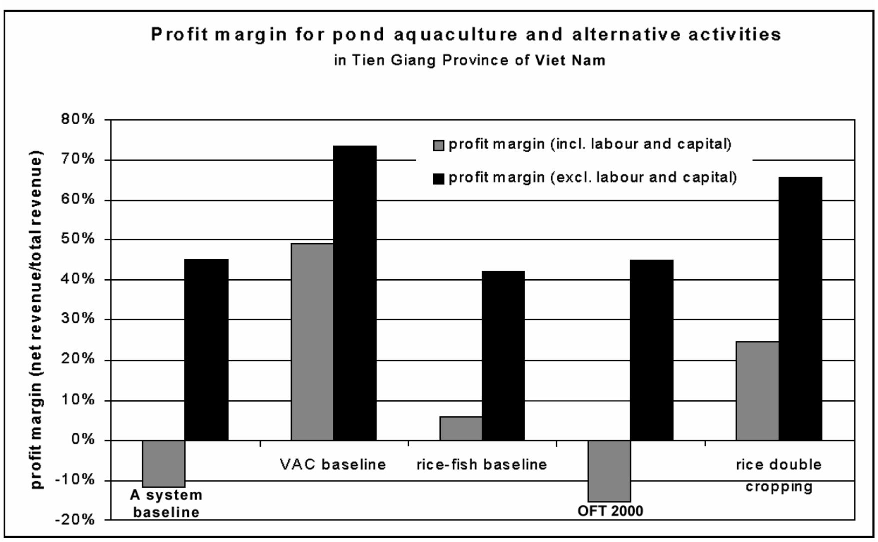
Minimum startup investment is calculated as capital investment + input investment in the first crop (excluding labour). As with the other calculations, the cost of land clearance/flattening/irrigation etc. for rice is not included. However, the costs for pond construction are included.

Minimum startup investment cannot be defined without first defining the minimum scale of activity. In the following, it is assumed that the minimum size of pond is 100 square metres and the minimum plot of rice is 500 square metres. Clearly such scale of activity would only be feasible where family labour is used.

On this basis, the startup investment for all enterprises is very modest. The baseline A system, VAC, and on-farm trials all require roughly $133 for pond construction. Additional investment in each crop amounts to between $11 for the OFT and $19 for the VAC baseline. The extensive, semi-intensive and intensive models used in the baseline report, correspond to crop investments of $15, $21 and $51, respectively. These crop investment costs rise by a further $3-10 if all inputs have to be purchased off farm. By way of comparison, investment in annual inputs for 500 square metres of rice (double crop) or fruit trees, would be similar at around $17.

Overall, there is little difference between aquaculture and rice production, in terms of investment in the crop. The risk exposure is related mainly to pond construction, especially where non-family labour is used.

Figure 20

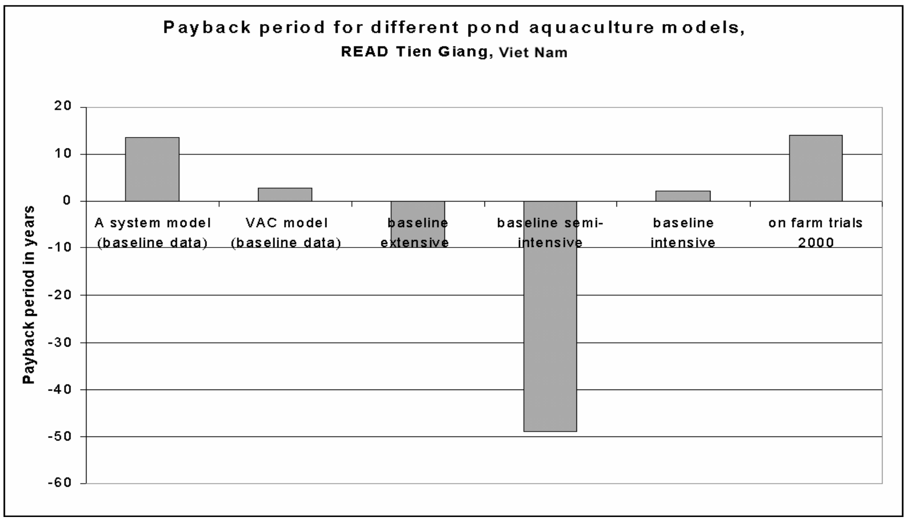


Note: rice and rice fish do not include a capital charge

Payback period

The payback period was calculated for the model A and VAC systems, the OFT 2000 data, and for the three intensity-level models described in the baseline report (Figure 21). Only the VAC baseline model and the intensive baseline farms generated sufficient return to pay off capital in a reasonable time (two years and three years, respectively). The A system model and the on-farm trials both had payback periods of 14 years, and the extensive and semi-intensive models described in the baseline report (Sethboonsong *et al.* 1999) did not generate sufficient income to pay off any capital costs. This suggests that lending money for pond construction to be managed under the OFT recommendations, would not be economic, and there would be a high risk of hardship and/or default. Rather more intensive systems would be required to reduce the investment risk.

Figure 21



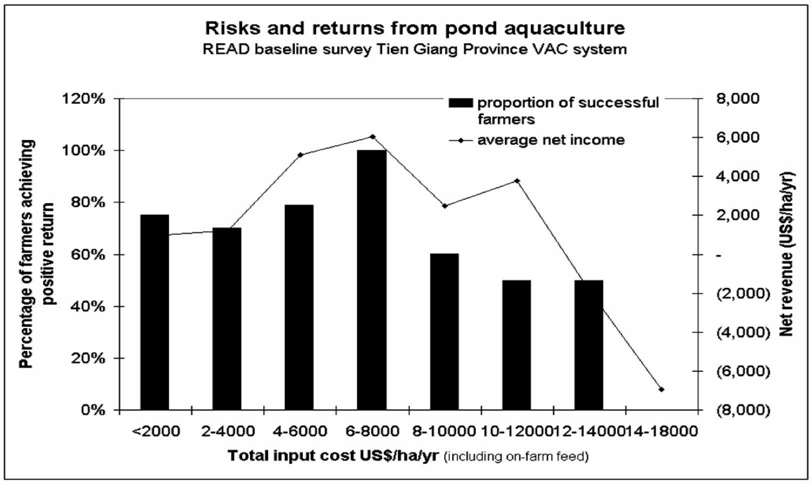
Production risk

It was not possible to analyse effectively the risk of not achieving an expected rate of production, as a result of factors such as disease, water quality, seed quality etc. To do this would require either data on individual farm performance over time, or, less satisfactorily, data showing variation in performance between farmers using some standard production technology package. Although the OFT farmers used a fairly standard package, there was nonetheless wide variation in the species used, size at stocking, and the ratio between different types of feed and fertiliser input. These differences were far greater in the baseline survey, and almost certainly swamp any variation related to production risk and uncertainty. As noted in the methodology section, using measures such as the coefficient of variation is largely meaningless in these circumstances.

However, it is clear from the distribution frequency of net revenue, that the performance of OFT farmers is far more consistent than that of baseline farmers, with a lower proportion of loss-making farms. In this sense, READ recommendations have reduced risk, presumably by excluding the worst or most-risky production practices.

The scatter graphs of net revenue versus input intensity, are intended, in part, to assess the degree to which returns and risk change with changes in intensity. While there is no clear relationship in the case of the A system, and the on-farm trials, the baseline VAC data suggested a significant increase in risk, and no significant increase in return, when the total economic cost of inputs exceeds $6,000/ha/yr. This analysis is taken a step further in Figure 22 by comparing the proportion of farmers failing to achieve positive returns with average net returns at increasing levels of intensity. Although the sample is limited for levels of input intensity greater than $6,000/ha/yr, the chart suggests that input levels between $4,000 and $8,000, generate very high average returns with relatively low rates of failure. Above $8,000/ha/yr, both returns and success rates decline rapidly. It is notable that the input costs under READ OFT recommendations, correspond to less than $2,000/ha/yr. It appears that these levels may be sub-optimal from a financial and risk perspective, although the relationships would need to be explored more fully in the field.

Figure 22



Vulnerability to external risk factors

In a short workshop, a group of staff from the Cai Be field station helped identify risks, and the vulnerability of different activities to these risks. Each selected activity was scored on a scale of 1 (low risk) to 5 (high risk), in relation to each risk factor. The results are presented in Table 2.

Table 2 Workshop-generated risk assessment matrix

	Theft	*Market price*	*Input price*	*Flooding*	*Temp. extremes*	*Disease*	*Acid water*	*Water shortage*	*Pollution*	*Seed quality*	*Total*
VAC	3	2	2	3	1	1	3	1	2	1	***19***
Pig	1	4	4	1	1	3	1	1	1	3	***20***
Rice	1	3	3	2	2	3	3	2	1	1	***21***
Rice-fish	5	2	1	4	1	1	3	3	2	1	***23***
Cage	1	1	5	1	3	5	1	1	3	3	***24***
Fruit	3	4	2	5	3	3	3	1	1	3	***28***
Sum	***14***	***16***	***17***	***16***	***11***	***16***	***14***	***9***	***10***	***12***	

Rice-fish, fruit farming, and cage aquaculture showed the highest overall scores, and these were the only activities to score 5 against any single risk criteria. The VAC system was rated lowest risk overall.

This exercise was undertaken by technical staff with an interest in aquaculture, and, while every attempt was made to be objective, the results may be somewhat biased. Ideally the exercise should be undertaken with technical specialists from other disciplines (agriculture, arboriculture), with extension officers and with farmers themselves.

4.5 Overall conclusions

Small-scale pond aquaculture is extremely diverse in terms of both financial return and risk. The baseline survey suggested that returns can be very high, and well above those generated by rice cultivation and other alternative activities. Risks from external factors appear to be relatively low compared with alternative activities.

However, many farmers in the baseline survey (VAC and A system), and especially those using very high levels of inputs, made losses in real terms (29 percent), and significant numbers made losses in purely cash terms (14 percent). On the other hand, of those farmers participating in the READ on-farm trials, very few (2.5 percent in 2000) made losses in cash terms.

Unfortunately, this reduced failure rate was achieved at a significant cost, with substantially lower average returns from the on-farm trials compared with the VAC baseline farmers, and with the negative average returns in the OFT, if all costs, including capital costs, are taken into account.

The analysis of risk and performance of VAC baseline farmers suggests that higher returns (well in excess of total economic costs) can be achieved with relatively low risk of failure. This requires that inputs be used more intensively than those recommended in the trials, but at less than the extreme levels used by some baseline farmers. The management practices of the successful existing farmers operating at these levels deserve further investigation, and the possibility of testing modestly-increased inputs in future on-farm trials should be explored.

Rice-fish culture appears to generate modest additional income in the baseline survey (cash net revenue $58/ha per cycle or $505, including and excluding labour and capital respectively); and $62/ha/cycle (excluding labour and capital) in the on-farm trials.

Pond aquaculture and alternative activities in Cambodia

5

5.1 Financial returns – baseline survey

No original analysis was undertaken of the Cambodian baseline survey data for this study. In the report of the baseline survey (Setboonsarng *et al.* 2000), no financial analysis was undertaken of existing pond aquaculture and alternative systems. It is notable that this report was completed in April 2001 – too late to have any significant influence on the evolving extension recommendations.

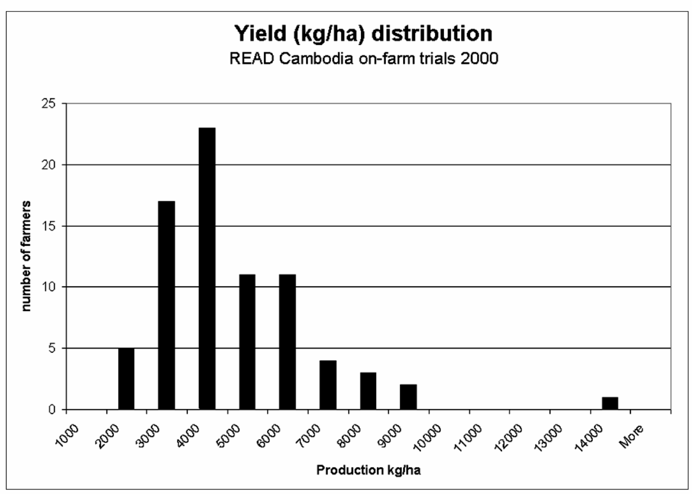
5.2 Financial returns – on-farm trials

Very limited time was available to gain a full understanding of the farming systems and database. The following analysis is therefore selective, designed to illustrate specific issues.

Production rates

Production rates were somewhat lower in the Cambodia READ trials, compared with those achieved in Viet Nam, with production rates around 4t/ha/cycle being most commonly achieved. The average in 2000 and 2001 was around 4.3 tonnes/ha per eight-month cycle. As with Viet Nam, however, significant numbers achieved higher rates – up to 9t/ha (Figure 23).

Figure 23



Return on land

Net revenue per hectare (based on cash costs) in the on-farm trials averaged around $3,600/ha/cycle in both 2000 and 2001. This is almost double the returns achieved in Viet Nam, despite the slightly lower rates of production. This is due mainly to the significantly higher farm-gate value of fish in Cambodia (around $0.8/kg) and Viet Nam ($0.5/kg). Given the proximity of the two study areas, and the increasing quality of transportation infrastructure, it is unlikely that such a differential will be maintained in the medium term.

These returns are much higher than those achieved in rice farming, which are very low, especially in the study area (around $110/ha/yr). As a result of poor quality soil, farmers can produce only one crop of rice per year.

Scale issues

When considering the suitability of any enterprise as a tool for poverty alleviation, the issue of economies of scale arises. Can very small-scale producers compete with larger enterprises? This issue is explored in Figure 25 by plotting cash net revenue/ha against pond size. The overall impression is of tremendous variation in performance irrespective of pond size. It is also clear that many small-scale farmers with ponds less than 200 square metres achieve good returns, comparable and sometimes better than those received by larger-scale farmers. However, the failure rate (when defined as negative net revenue, inclusive of a labour charge) is higher for farms with less than 200 square meters (roughly 20 percent) compared with farms of more than 200 square meters (around 7 percent). The causes of this failure would need to be explored before final conclusions on this issue could be drawn.

Figure 24

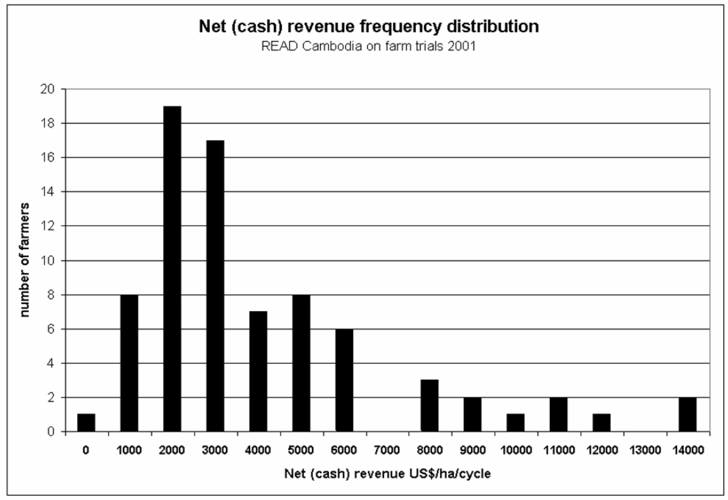


Figure 25

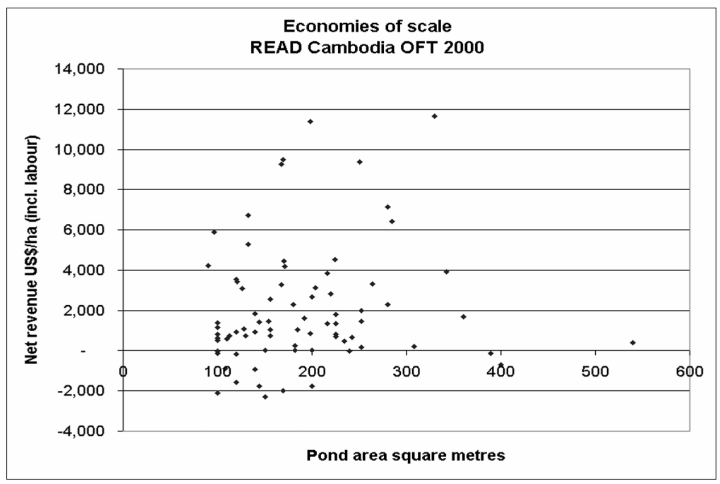
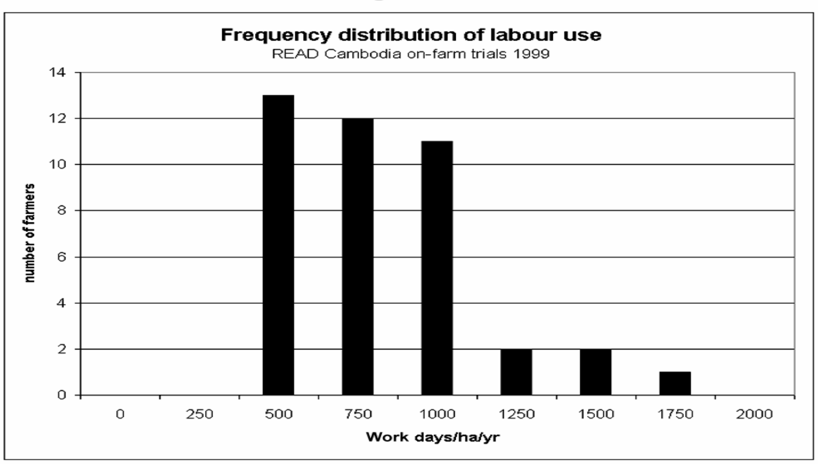


Figure 26

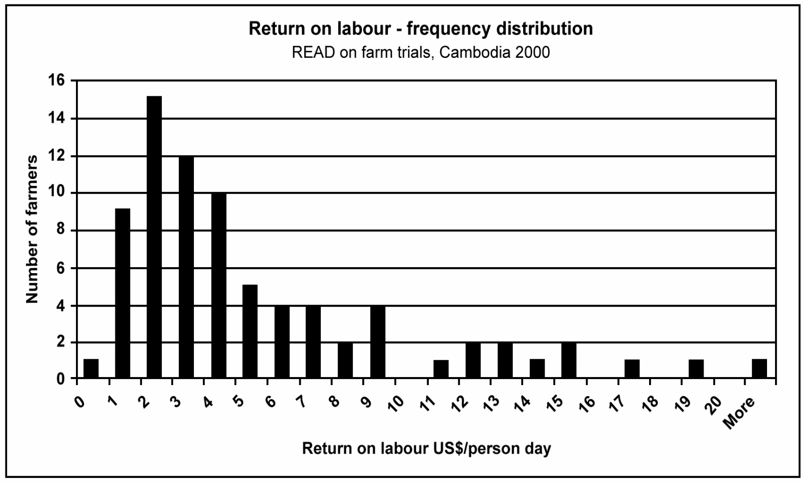


Return on labour

The use of labour in the on farm trials in Cambodia is very intensive, and highly variable (Figure 26) although less so than that collected for the baseline survey in Viet Nam. This is related to the generally small size of ponds, the proximity to the house, the use of family labour, and the use, or otherwise, of on-farm feeds which need collection.

Figure 27 shows the frequency distribution of return on labour for the Cambodia farm trials in 2000. Returns generally compare well with the standard agricultural rate and those generated by rice cultivation ($1-1.5). In a significant number of cases, returns are very much higher. In practice, labour inputs could probably be reduced significantly, and return on labour increased correspondingly. However, any labour savings would have to be offset against the costs associated with increased use of off-farm feeds.

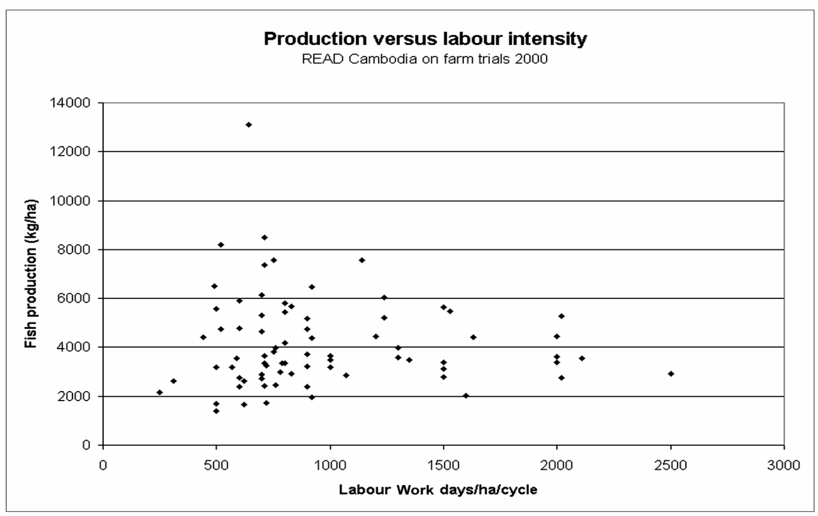
Figure 27



The use of labour, and the value or opportunity cost of on-farm labour, are important issues in financial analysis, and are rarely effectively addressed. Although the project has collected much data on labour, it has not analysed and used this data to revise its extension programme. It is common to discount the importance or costs of family labour. This is dangerous. Time is a key issue for all households, whether it is allocated to income-earning activities or to social and cultural activities. In either case, it has significant value that must be accounted. It is essential that farmers understand the labour implications of alternative production systems if they are to make rational and informed choices.

Labour use is plotted against production rate in Figure 28. While there is some indication of increasing production with increasing labour (up to around 750 person-days/ha/cycle), the trend is not sustained, and, if anything, production declines with increasing labour above this level. While this may be a random effect, it could indicate excessive use of on-farm feeds and manure associated with higher labour inputs.

Figure 28



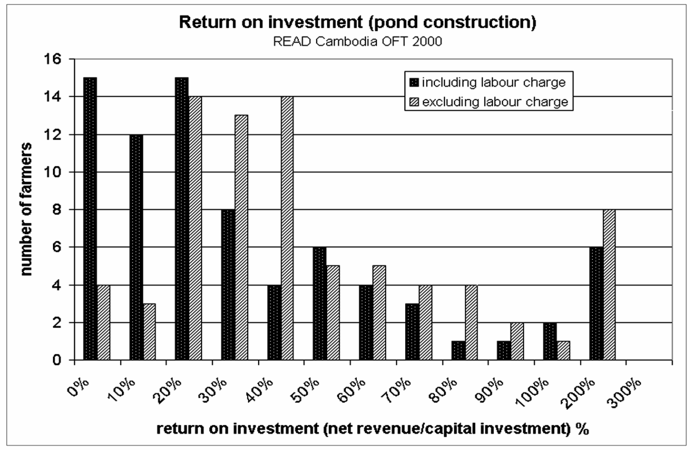
Note: the calculations used to generate the histogram included a charge for on-farm labour, rice bran, and broken rice at market rates

Return on investment

The cost of pond construction was estimated at around $0.7 per cubic metre. Assuming one cubic metre of earth must be removed to create one square meter of pond, the costs of construction can be added to the OFT performance data to generate return on investment for all farmers. This can be calculated using cash net revenue, but more realistically and usefully, economic costs (labour; on-farm inputs) should be included in the equation, as shown in Figure 29.

Where labour costs are excluded, returns are generally healthy, averaging 45 percent. When labour costs are included, returns average 30 percent, but significant numbers (20 percent) of farmers do not generate sufficient revenue to pay off investment costs.

Figure 29



5.3 Compa rison with alternative activities

Returns (to labour and land) from pond culture under the READ on-farm trials are much higher than returns from rice cultivation. Single crop rice farming in the study areas typically generates 1-2 tonnes per hectare only, corresponding to net revenue of $100 to $200/ha/yr. Returns from pond aquaculture are likely to be twenty times this. The return on labour from rice farming corresponds closely with the agricultural wage rate of $1-1.5 per day. Returns from pond culture are typically $2-$5/person day, but with significant numbers of farmers achieving much higher rates (around $15). It is probable that labour could be significantly rationalised and returns increased substantially.

5.4 Risk

Risk exposure

Profit margin

Profit margin, excluding pond digging and on-farm labour, averaged 67 percent for the on-farm trials in 2000. Data were not available to calculate real profit margin for individual farmers (including capital costs of pond digging and labour at market rates). However, the spreadsheet model, based on average performance and including these costs, generated a real profit margin of around 35 percent.

Minimum start-up investment

Assuming a realistic minimum size of pond ($100m^2$), the total start-up costs would be $70-$100, including the costs of pond digging.

Payback period

Average payback period (with on-farm labour charged at market rates) is very healthy, averaging 3.4 years for the 2000 trials. However, as with profit margin, there are significant numbers of farmers (20 percent) for whom it is infinite. If labour costs are excluded, the average payback period falls to 2.2 years and only 5 percent of farmers would be unable to pay off the capital.

Production risk

Only one farmer out of 77 made a financial loss in 2001, and most farmers earned significant returns with good margins. However, flooding has been a problem, as it has been for all activities, and this is discussed below.

Strengths and weaknesses of pond aquaculture and vulnerability to external risk fa ctors

A rather more comprehensive subjective assessment of financial and economic strengths and weaknesses, and vulnerability to external risk factors was carried out in Cambodia. Two mornings were devoted to developing a comprehensive assessment matrix with staff members and other interested parties. As noted previously, such workshops should be undertaken with a wide range of technical specialists and stakeholders, so this should be seen as illustrative only. In the following tables (Tables 3-5) a score of 5 means very strong or attractive, and a score of 1 means poor or weak

Some of the scores above were derived directly from actual objective figures (e.g crops per year); others were purely subjective assessment by the group. Where the criteria were not applicable (e.g. crops per year for fishing), a neutral score (*2.5*) distinguished by italics is entered.

On the basis of an un-weighted sum of scores, pond aquaculture ranks fourth behind fishing, wage labour and vegetables. The main reason for the relatively low ranking is the high start-up investment and correspondingly low return on investment. Clearly the rankings can be altered by weighting the criteria, and this might be done to stimulate discussion and information exchange in a broader workshop setting.

From this perspective, pond aquaculture scores rather better, although still behind fishing, which scores particularly well because of the strong local demand for wild fish, the very low investment and high labour generation, and the comparative advantage of Cambodia in fishery production.

No scores were entered for wage labour, although it is arguable that it is the least vulnerable to the various risks listed in the table. Scores for the other activities were rather similar, with rice and fishing leading the overall rankings.

Taking the three tables together, what is most striking is the similarity between the overall scores. All the enterprises have different strengths and weaknesses that tend to cancel out. The only major difference is the very poor rating of both rice production and cattle rearing in terms of financial return.

Table 3 Financial return and risk exposure

Activity	Return on investment ($/$)	Profit/ha ($/ha)	Return on labour ($/MD)	Minimum start-up investment	Time to first income	Crops per year	Un-weighted sum
Pond culture	3	4	5	2	3	3	***20***
Rice	2	2	2	3	4	4	***17***
Fishing	4	*2.5*	4	4	5	2.5	***22***
Vegetables	4	4	3	2	4.5	5	***22.5***
Cattle rearing	3	*2.5*	1	2	2	1	***11.5***
Wage labour	5	*2.5*	2	5	5	2.5	***22***

Table 4 Economic strengths and potential

	Labour per ha	Jobs per $ investment	Up-stream down-stream impacts	Domestic market	Regional & inter-national market	Site/land suitability and availability	Compar-ative advantage	Manage-ment & integration issues	Un-weighted sum
Pond culture	4	3	4	3	1	3	3	4	*25*
Rice	3	3	3	3	3	1	2	4	*22*
Fishing	2	5	2	4	4	1	5	3	*26*
Vegetables	4	4	3	3	1	2	2	3	*22*
Cattle rearing	4	3	2	4	3	2	3	3	*24*
Wage labour	2.5	2.5	1	3	3	2.5	4	2.5	*21*

Table 5 Vulnerability to external risks and shocks

Activity	Flood	Drought	Climate	Disease & pests	Theft or poison	Input costs	Input quality	Soil & water quality	Market price	Land tenure	Skills	Un-weighted sum
Pond culture	3	3	5	3	4	4	2	3	3	4	3	*37*
Rice	4	3	4	3	5	3	4	4	4	4	5	*43*
Fishing	5	1	5	4	4	4	5	4	3	3	5	*43*
Vegetables	2	2	4	3	5	3	4	4	3	4	4	*38*
Cattle rearing	4	3	3	3	3	4	4	4	4	5	4	*41*
Wage labour												

5.5 Overall conclusions – READ Cambodia

Pond aquaculture, as promoted under the READ project in Cambodia, appears to be very attractive from a financial perspective, generating much higher returns to land and labour than rice farming. The slightly higher risks compared with alternate activities derive mainly from the relatively high capital investment in ponds. However, this can be reduced by starting off with small ponds (good returns appear to be possible with ponds of 100-200m^2). Furthermore, the *cash* investment may be reduced if family labour is used to build the ponds, although the opportunity cost of this labour must be taken into account before allocating such labour. In practice, most farmers should be able to pay off the investment in a few years, and judging by the 2000 and 2001 trials, the failure rate is likely to be very low.

Significant numbers of farmers do exceptionally well, generating extremely high returns compared with any likely alternative. The project should examine these farmers in more detail in order to refine their recommendations to optimise financial return without significantly increased risk.

Cage aquaculture and fishing in Lao PDR 6

The data available in Lao PDR were different from those available under the READ project. Data were more limited, although some surveys of cage aquaculture had been undertaken.

6.1 Typology of cage aquaculture systems

It quickly became apparent that there was a range of cage culture systems that could be differentiated in terms of species, feeding technology, cage size and technology, scale of enterprise and type of business. The returns from these various systems are likely to be very different, and they need to be defined before meaningful analysis can be undertaken. This had not been done in some of the previous analyses, which generated average figures corresponding to no specific enterprise type. The first task therefore was to define these production systems, which could then be used as the basis for financial model development.

Project staff and aquaculture staff from LARReC participated in a workshop similar to those described above to discuss risks and returns, but with the added task of defining the most common and distinguishable aquaculture system types. They were as follows in Table 6:

Table 6 Typology of cage aquaculture systems in Lao PDR

Species	Production system/enterprise type	Comment
Tilapia, sex reversed, in river	Cages, family run but organised in credit groups, each family typically owning 3-4 cages. 2 or 3 cycles in a year	Roughly 90% of production is SRT
Tilapia, sex reversed, in cages in ponds	Cages in ponds operated by a large commercial company. Each pond 2-3 *rai* with ca 10 cages. 2-3 cycles per year.	The company also produces *Pangasius* (see below)
Filter feeders – mainly silver carp (contract) in cages in reservoir	Cages in a reservoir. Around 10 families each with 2-3 cages producing under contract. Usually only 1 cycle per year	
Filter feeders – mainly silver carp (family run) in cages in reservoir	Independent family run enterprises of 5 or more cages. Usually 1 cycle per year.	
Filter feeders (military company)	200 cages operated by a single military company	
Snakehead *Channa micropeltes; Channa striata* (90%)	Family enterprises in Nam Ngum reservoir, usually more than 3 cages; average 10? Number of cages varies according to seed availability	Seed of *C. micropeltes* in decline; now mostly *C. striata*
Pangasius	Cages in ponds, as above, for Tilapia. Total of around 50	

Information was then collected on some of these systems, from data and survey material from the aquaculture group, and from interviews during a one day field visit to Nam Ngum reservoir. This was used to develop illustrative models to explore financial characteristics. Systems analysed included:

1. Tilapia (family cage culture in the Mekong River);
2. Snakehead (cage culture in Nam Ngum reservoir);
3. Silver carp (cage culture in a reservoir)
4. Tilapia (cage culture in a reservoir)
5. Pen culture (mixed species in Nam Ngum reservoir)

Models were developed from limited empirical survey data for System 1. Survey data were used for System 2, supplemented by information collected on the field trip. Data on System 3 could not be clearly separated from other forms of cage culture in the survey data. A model was therefore developed from a mixture of partial empirical data and first principles. System 4 does not currently exist, but represents an interesting development possibility. A simple financial model was therefore developed from information about cage culture in rivers, modified according to the data on cage culture in reservoirs. A model for System 5 was developed based on information collected during a field visit to Nam Ngum reservoir. Complete model summaries are presented in Annex 3, and in the associated spreadsheet.

6.2 Culture of snakehead in cages in Nam Ngum Reservoir

Snakehead are typically grown in small bamboo cages (typically 5-6 cubic metres of water), which are cheap, but last one or two years at most. They are also grown in net and wood cages, which are more expensive, but last longer. Survey data were available on four examples of the former, and technical information was sufficient to generate a model of the latter.

Seed are collected from the wild, and can be purchased for around 200 *kip* (2 cents) each. The price is rising. They are stocked at between 250 and 1000 per cage, with the (limited) survey data suggesting that the former is more common – although this may be related to shortage of seed.

The fish are fed mainly *Pa Keo* (*Clupeichthys aesarnensis)* and this is usually caught by family members and fed in a fresh or semi-dried form. This fish has a market value (1000k/kg [10 cents] fresh; 1500/kg semi-dried). FCR using fresh fish is estimated at 6, and 3.5 for semi-dried.

Labour costs are estimated at one hour per cage/day, including the time required to catch *Pa Keo*, and 20 minutes per cage/day in cases where the feed is purchased. In practice, there will be significant economies of scale in the use of labour as the number of cages increases. Farmers suggested that one person could fish for *Pa Keo* and look after perhaps 5-8 cages.

The cropping cycle is 8-10 months, with fish typically held back until market price is high. Survival rates are high – typically 90 percent - and this was confirmed through back calculation of some of the survey production data.

Cash net revenue per cage (including a capital charge for the cage, but excluding labour) depends primarily on stocking rate. With rates at 250 per cage, cash net revenue is 500-600,000 kip or $50-$60/cage. With stocking rates of 1000/cage, cash net revenue is around 2 million kip or $200/cage. A family with five cages is therefore generating a significant $250-$1,000/cycle. Corresponding returns on labour are $3-7/day – significantly higher than the standard wage labour rate of around $1/day. Profit margins and return on investment (in cages) are also healthy at 50-80 percent, and 200-80 percent respectively. Payback on the investment in cages is achieved within a single production cycle. This is true for both the cheaper bamboo cages and for the more-expensive wood and net cages.

If the Pa Keo is purchased rather than caught, returns per cage are (necessarily) lower, since some of the economic benefits go to the fishermen. Returns range from negative (-$30-40/cage) where low stocking densities are used, to $50 to $70/cage at high stocking densities. Corresponding returns to labour range from negative, to $3-$6 for the higher stocking densities.

Minimum start-up costs are very modest. A small 12 cubic metre bamboo cage costs around $8, and if seed and feed are both caught, there is no significant additional cash expenditure. A larger (24 cubic metre) cage made from net and wood might cost around $80. At the other extreme, if seed and feed had to be purchased, and if labour were charged at market rates, the start-up investment would amount to $200. However, lower stocking rates would allow for lower start-up costs, although returns would be lower.

6.3 Culture of Tilapia in cages in the Mekong River

There has been a significant increase in intensive Tilapia production in cages in recent years in Thailand, and this technology has been introduced to Lao PDR, largely unchanged. For the following analysis, information on five examples was available from a recent survey.

Steel-framed net cages are used, varying in size from 10 to 50 cubic metres, and costing between $50 (home construction) and $200 (complete). These are stocked with commercially available sex-reversed Tilapia (costing 600 kip [6 cents]) each, and fed with commercial pellets (35-45 cents/kg). Food conversion rates are estimated at 1.5. Stocking rates varied from 30 to 145 per cubic metre. Fish are grown to 400-600 grams in a four-month cropping cycle, and sold for around $1/kg. Farmers claim survival rates of 90 percent, although back checking the production data suggests 80-90 percent. Smaller cages produce around 500kg/cycle, while the larger cages can produce more than two tonnes.

Labour use was recorded at between 70 and 160 person days per cage per cycle (equivalent to around one full-time person), and this requirement is related as much to guarding as to husbandry, and would therefore be significantly lower for groups of cages.

Cash net revenue (excluding labour costs) per cage per cycle is between $500 and $1,200 for the small cages, and $2,100 for the large cage. Annual returns will be double or treble this, depending on the number of crops. If labour is charged at standard rates ($1.2/day) this is reduced to $100-$800 (small cages) and $1,700 (large cage). The high variation for the smaller cages is related to highly variable labour inputs. For an enterprise that uses labour efficiently, the higher figure is probably more realistic.

Return on labour varied between $1.7 and $4 per person day on the smaller cages; and was around $6 on the large cage. Profit margin (including labour charge) was 5-35 percent on the smaller cages, and 50 percent on the larger. Return on investment is very high (from 100 percent to several thousand percent). This results in rapid payback periods of less than a year in all cases, and less than one cropping cycle in all cases except one.

Start-up costs (excluding labour) for these systems are relatively high at 4.5 to 6 million kip ($500-600) for the current typical enterprise. Adding one full-time labourer for four months would increase these costs by a further $100. However, costs could be reduced by self-assembly of a cage (approximately $50 for a cage), use of smaller cages, and/or use of lower stocking densities (and correspondingly reduced feed and seed costs). By way of illustration, one full-time job paid at $1.5/day, could be generated by stocking around 250 tilapia in one cage. Capital investment would still be paid off within a year (three crops). Total maximum outstanding investment would be around $270 until the first crop is harvested, reducing to zero before the end of the year. Where sites are available near houses, and where part-time and family labour is available, the use of even smaller cages is worthy of exploration in order to provide opportunities for poor people. Such small cage systems have been successfully used in Bangladesh (Hambry et al. 2001).

6.4 Cage culture of silver carp

No data were available which specifically separated cage culture of herbivores such as silver carp, from mixed cage culture enterprises, including snakehead. Also insufficient time was available to discuss costs and returns with farmers in the field. Nonetheless it is possible to make rough estimates of costs and returns, using existing knowledge of cage culture costs, coupled with appropriate production parameters for silver carp. If reasonable growth rates can be achieved – dependent on the quality of natural feed available in the reservoir – returns appear to be very attractive. No feed costs are incurred, and far less labour is required. In other respects costs are similar, although the growth cycle is likely to be around one year.

6.5 Pen culture of mixed species in Nam Ngum reservoir.

This is a relatively new enterprise and reliable performance data is lacking. However, fourteen-month old silver carp of one kilogram in weight were observed in pens, and cost data were provided by local villagers. Investment costs are high. In the enterprise visited, the cost of constructing a fence across an arm of the reservoir amounted to around 40 million kip or $4,000, with an expected life of 3-4 years. Investment in seed amounted to a further 10 million kip ($1,000), and two full-time guards were employed, at an additional 10 million kip/yr. No feed inputs or fertiliser were used, although this might prove necessary to achieve optimal rates of production. Total start-up capital was therefore in the region of $6,000, and annual operating costs (including a capital charge) were around $3,500. However, at a modest 20 percent survival rate, a yield of 21 tonnes was anticipated, generating 166 million kip or $16,600. This corresponded to net revenue of around $13,000, and very high rates of return on both labour and investment.

While this is clearly not an enterprise for individual poor households, it may prove very attractive for village groups or community associations, and its success or otherwise should be monitored.

6.6 Fishing

The majority of the households living close to Nam Ngum reservoir are primarily dependent upon fishing. No detailed data were available on returns from the fishing, but local government officers and villagers provided some basic information. A typical fishing household owns a small boat with a "long-tail" engine and two or more sets of nets. Gill nets are the most common net type. Total investment is of the order of 8 million kip or $800, and life of the boat and gear was estimated at around six years, corresponding to an annual cost of $133, plus an appropriate amount for fuel, spares and maintenance (say a minimum of $5/week or $250). A minimum of two household members are usually involved. Local officials suggested that income was around 25,000 kip per day for a typical household, corresponding to around $850/year. Maximum net cash revenue is therefore unlikely to exceed $500, corresponding to return on labour of less than a dollar a day, and negative return on investment, if labour is charged at market rates.

Data from a recent study (Mattson et al. 2000) suggest a catch per unit effort for gill nets of a little less than 1 kg per set, and that annual household gross income from gill netting averaged four million *kip*, corresponding at that time (1999) to $671. Unfortunately the authors provide only percentage costs so that crosschecking with the above figures is difficult. They also provide return on investment estimates (22 percent for gill nets), but it is not clear what charge for labour was used in these estimates, and what was included in the investment. As noted elsewhere in this report, more detailed representative case studies would be of much greater value for the purposes of comparisons between enterprises. In either case, it is clear that fishing requires high investment (typically using a high interest loan from the fish purchasing company) and generates a poor and unpredictable return.

6.7 Overall conclusions – cage aquaculture and fishing in Lao PDR

As with other aquaculture systems, it is very difficult to give indicative returns because the technology is new and varied, and standard management practices are not established in most cases. At a small scale,

scale factors, especially in relation to labour use and return on labour are very significant. Also in this case only limited data were available. Of the systems examined, the most consistent was for intensive Tilapia where a standard semi-commercial package is now available.

Table 7 presents a rough approximation and summary of the main financial features of the various systems examined. In general, the cage aquaculture systems score well against a range of criteria, and appear to be more attractive than most available alternatives, including fishing and rice cultivation. One great attraction of the aquaculture systems is their flexibility in terms of scale, intensity of inputs, collection or purchase of inputs, and range of species from mainly herbivorous to carnivorous. Start-up costs are modest, especially if captured seed and feed is available, or where herbivores/planktivores are reared. The Tilapia systems require more investment, but returns are more predictable, and operations can be set up in locations where wild seed and trash fish are not readily available.

Table 7 Summary financial profile of selected alternative economic activities in Lao PDR

	Snakehead (purchased seed and feed)	**Snakehead (captured seed and feed)**	**Intensive cage culture of Tilapia**	**Silver carp**	**Pen culture**	**Fishing (gill net, using small boat)**
Minimum start-up capital $	100-200	8-100	500-700	90	6,000	800
Length of crop cycle (years)	0.7	0.7	0.33	1	1-2	-
Payback period (years)	<1	<1	<1	<1	<2	6+
Net revenue (cash) per cage or enterprise $	Negative to+70	50-200	300-6300	500?	13,000	<500
Return on labour $/person day	Negative to 6	3-7	2-6	-	-	<1
Profit margin % (labour charged)	<20%	50%-80%	5%-40%	-	-	-
Return on investment %	Negative to 500%	200% +	100%+	-	-	-

Reservoir fisheries, cage culture of grass carp, and alternative enterprises in Dak Lak, Viet Nam 7

The emphasis of work in Dak Lak was again different. More effort went into understanding the broader economic context for fisheries and aquaculture development, and their role within the local economy. This should always be a key starting point for more detailed financial analysis.

In addition to analysing returns from rice cultivation, coffee cultivation, cage culture of grass carp, and fish seed production, the consultant and local counterparts spent much time and effort examining the less easily defined returns associated with fishing at various levels of organisation. We also explored returns from stocking, and discussed the ways in which returns associated with improved reservoir management might be assessed.

7.1 The role and importance of reservoir fisheries in the Provincial economy

The relative importance of fisheries and the other major sectors of the economy in Dak Lak are shown in Table 8.

Table 8 Income and employment in fisheries and other selected activities Dak Lak Province 1999.

	Production (tonnes)	Income $	Employment (FTE)	Area (ha)
Fisheries	3,815	3,309,463	287	3,328
Coffee	262,365	96,846,107	135,000	250,830
Rice	228,671	19,951,141	26,964	59,180
Manufacturing		48,000,336	17,611	

Notes:
- Average labour cost per person-day (PD) is equal to 25,000 Viet Namese Dong (VND).
- Rate varies from 20,000-30,000VND/PD.
- Average labour spent for 1 ha of coffee per year is calculated 140 PD, based on Ea Soup.
- Average labour spent for 1 ha of rice field is calculated 120 PD, based on Ea Soup.
- Average time spent for fisheries per year is calculated 90 PD/person (2 hr/PD).
- For coffee and rice, employment is calculated from person-days divided by 260 days/yr, for FTE's.
- Coffee price for 1999 estimated at 5,500 VND/Kg; for rice 1300 VND/Kg.

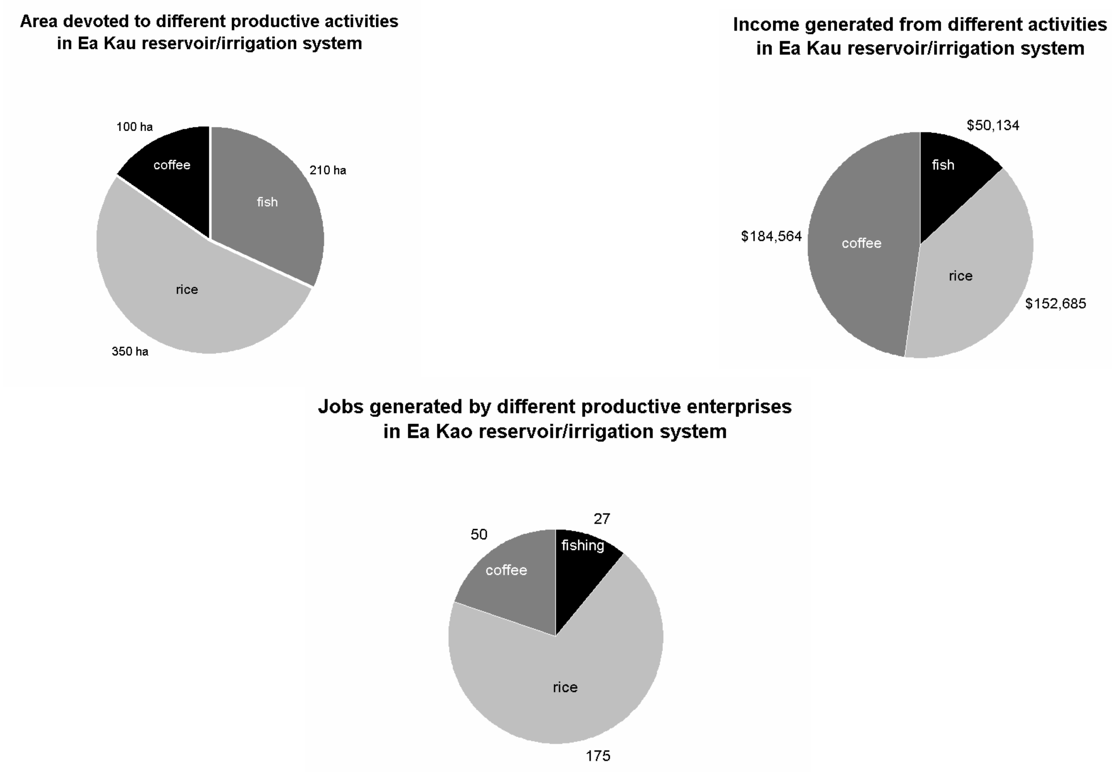
Provincial statistics do not distinguish between aquaculture and fisheries. Phuc and Sollows (2001) estimated that around 5,000 tonnes of fish could be produced from the reservoirs of Dak Lak, corresponding to roughly 25 billion VND ($1.7 millon). With stocking and improved management, the figure could be substantially higher. This compares with VND1,443 billion ($97 million) for coffee production, and VND297 billion ($20 million) for rice. Although this is a modest proportion of Provincial GDP, fish is very important in household nutrition.

7.2 The role and importance of reservoir fisheries in the local economy

The impact of reservoir fisheries locally is higher. Communities close to the reservoirs are often highly dependent on them, and reservoir fisheries can be an important safety net for the poorest people, especially new migrants.

It is important to gauge the relative importance of fisheries in the "reservoir-irrigation" system. Ea Kau reservoir covers 210ha and is used to irrigate 100ha of coffee and 350ha of rice. It yielded 150 tonnes of fish in 1996/7 valued at VND747 million ($50,000) and generated 27 full time equivalent jobs; although both production and employment have declined by more than 50 percent since that time. Based on the area of land/water allocated to different activities within the reservoir/irrigation system, and estimates of employment and income generated per hectare from rice and coffee production,[4] the relative importance of the different activities within the system can be estimated roughly.

Figure 30 Relative importance of fisheries in the reservoir/irrigation system of Ea Kau



[4] Data on productivity and income generation for rice and coffee are derived from a recent (2001) survey. The value of coffee has declined rapidly in recent years, and income in the past would have been much higher.

Ea Soup reservoir covers an area of 240 ha and provides irrigation for 450 ha of rice. The associated fishery generates roughly $22,000, and 26 FTE jobs, while rice cultivation generates $140,000 and 225 FTE jobs.

While fishing is not the dominant sector in the economics of the reservoir, it is significant, and deserves a corresponding weighting in reservoir management decision-making.

7.3 Economic returns and employment in reservoir fisheries

Broad technical and economic profiles of selected reservoirs in Dak Lak

The MRC data on reservoir fishing in Dak Lak is limited to six reservoirs varying in location, size, natural fertility, and management system. It is therefore not possible to undertake detailed analysis or draw firm conclusions with regard to the returns from different management interventions (stocking; effort regulation). In any case, detailed information was not available relating to management costs, although some "ball park" figures have been estimated for the purposes of illustration. Despite these limitations, some broad preliminary conclusions may be drawn.

The size and major economic characteristics of the six reservoirs are shown in Table 9.

Table 9 Broad technical and economic profiles of selected reservoirs in Dak Lak

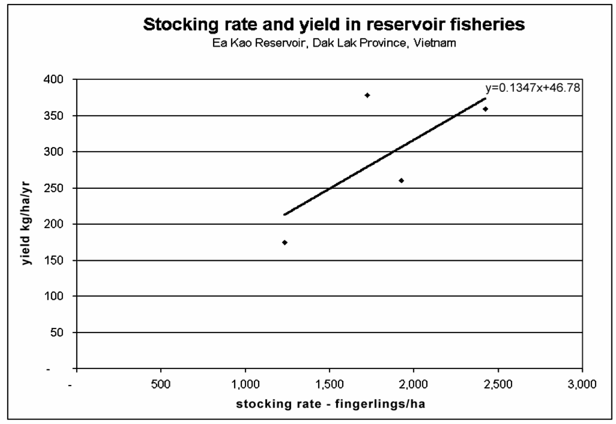
Reservoir	Size (Ha)	Management system	Yield kg/ha mean (range)	Gross income $/ha mean (range)	Gross income/ha less stocking costs	Employment individuals/ha (mostly part time*?) fishers and management
Ea Kao (Average over 4 yrs)	210	Stocked. DAPCO employee seconded to manage	576 (264-719)	195 (91-242)	186	0.2
Ea Kar (average over 3 yrs)	141	Stocked. contracted; very restricted access	355 (265-462)	179 (156-223)	162	0.1
Yang Re (average over 3 yrs)	56	Stocked. 4 local contractors license fishers and participate	550 (153-832)	232 (70-336)	218	0.3
Ho 31 (average over 4 yrs)	5	Stocked. Owned and managed by co-operative;	876(310-1307)	273 (99-414)	202	0.2
Lak (average over 3 yrs)	658	Un-stocked. Government agencies regulate; Union started	171 (126-256)	79 (57-113)	79	0.3
Ea Soup (average over 3 years)	240	Un-stocked. Union since 1999	264 (221-312)	126 (91-168)	126	0.5

Note: Ea Kao: Fishing costs per hectare do not include many gears, notably integrated net and seines. * This is an under-estimate.

The data suggest that stocking is cost effective. Stocked reservoirs generated gross income ranging from $153/ha/yr to $1,307, with much the highest yield from the smallest and most heavily stocked water body (Ho 31). This compared with $61 to $168/ha/yr for the un-stocked reservoirs. However, this difference might also be attributable to the larger size of the un-stocked reservoirs, which are typically less productive than smaller reservoirs.

Data on the relationship between stocking rate and yield for individual reservoirs is very limited, but also suggests that stocking is effective (Figure 31). Data over several more years, and with a range of stocking densities, would be required to generate a reliable economic relationship. Such a relationship would convert the quantities in the axes of a graph such as Figure 31, to cash values, providing an estimate of the marginal benefit of stocking. For example, with silver carp stock costing $2.5/1000, and an average value of the catch amounting to $0.5/kg, the relationship below would convert to *yield = 27 x stocking costs + 23*. In other words, spending $1 on stock would yield $27 in terms of harvested fish value. Clearly, improved data of this kind would be very valuable.

Figure 31



Returns and potential returns to the reservoir enterprise

Table 10 shows the overall returns to "the fishery enterprise" for three of the reservoirs. Estimates for labour use are approximate.

Table 10 Costs and returns to reservoir fisheries

	Year	Stock cost/ha ($)	Fishing cost/ha ($)	Fishing cost/ha (excl. labour)	Manage-ment cost/ha ($)	Total labour FTE/ ha (incl. management)	Total income/ha ($)	Net income/ha (incl. labour)	Return on labour
Ea Kao	96-97	9	19	4	0.14	0.13	239	211	6
	97-98	9	24	4	0.14	0.13	242	209	6
	98-99	7	38	6	0.14	0.10	206	161	7
	99-00	10	24	24	0.14	0.06	91	57	3
Ea Soup	97-98	0	181	25	0	0.08	91	(90)	3
	98-99	0	234	27		0.08	118	(115)	4
	99-00	0	246	32	5.3	0.09	169	(83)	5
Ho 31	96-97	604	188	0	134	0.20	1,249	323	9
	97-98	404	188	0	134	0.20	2,224	1,498	28
	98-99	262	188	0	134	0.20	1,861	1,276	24
	99-00	264	188	0	134	0.20	530	(57)	2

It is notable that the stocked fisheries (Ea Kau and Ho 31) show much higher net income, although yields in Ea Kau appear to be declining. Data for Ho 31 in 1999-2000, are misleading as flood problems prevented complete harvest. Overall, return on labour is high relative to average wage rates, especially for the stocked fisheries. This "return" to labour is potential income only, and in practice is distributed more widely (to the government, the commune, the company) and does not correspond to individual fishermen's income (see below). In the case of Ea Kau, for example, the company takes a tax corresponding to roughly 50 percent of the total revenue.

Unsurprisingly, the management costs for the small intensively managed fishery are much higher than those for more extensive fisheries.

Returns to individual fishermen

Calculations were made on financial returns to selected fishing enterprises (one or more fishermen operating a net, with or without a boat) and to the fishermen operating these gears. Complete data were only available in respect to lift net and gill net fisheries in Ea Kao and Ea Soup reservoirs. The data were not specifically collected for this kind of analysis, and the results should be considered as indicative only. Investment in boat and gear is significant even when divided amongst two or more fishers ($54 to $315).

Total net revenue for lift nets in Ea Kao (a stocked reservoir) was high, at more than $1,000 in 1997-1999. Returns to labour were around $6/person-day, return on capital investment was high, and profit margin healthy at 66 percent. Unfortunately, productivity declined significantly in 1999-2000, with net revenue becoming negative (-$427), and return on labour declining to close to zero.

Table 11 Returns to gears and fishermen

Reservoir	Gear type	Capital cost $ per fisher	[5]Capital cost allocation $/yr	Labour (person - day)[6]	labour cost @$1.7/pd	Total revenue in dollars	Net revenue in $ (excl. labour)	Net revenue in $ (incl. labour)	Return on labour $/pd	return on capital	Profit margin (incl. labour charge)
Ea Kao 97-8	Lift net	315	110	263	441	1638	1528	1,086	5.81	345%	66%
	Gill net	54	85	150	252	412	326	75	2.17	137%	18%
Ea Kao 98-9	Lift net	315	110	263	441	1624	1514	1,073	5.76	340%	66%
	Gill net	54	85	150	252	371	286	34	1.91	63%	9%
Ea Kao 99-00	Lift net	315	110	263	441	125	15	-427	0.06	-135%	-342%
	Gill net	54	85	150	252	336	250	-2	1.67	-3%	0%
Ea soup 98/9, 99-00	Gill net	121	310	234	393	345	34	-359	0.15	-297%	-104%
	Gill net	121	310	234	393	293	-17	-410	- 0.07	-340%	-140%

Net revenue for gill nets in Ea Kao was lower, generating returns on labour around $2/person-day in 1996-7 and 1997-8. Net revenue declined in 1999-2000, but not to the same extent as that for lift nets, and return on labour remained at a modest $1.7 (equivalent to the agricultural labour rate). It would appear, therefore, that gill nets are less susceptible to the recent fall in productivity. This is because they catch a greater variety of species, and rely more heavily on naturally-recruited species than lift nets.

Returns from Ea Soup, which is not stocked, were poor for gill nets. While total revenue was only a little lower, net revenue was negative, related to the higher capital costs (boat + engine), and return on labour was very low at 0.07-0.15$/person day. Clearly, this is not financially viable.

Broader economic issues

Data were not readily available to examine the variation in returns to different fishermen with different gears, although with modest additional effort this information could be generated. Catch-effort information, which has been collected, is closely related to financial return.

Some analysis was also undertaken relating to the allocation/partition of the income generated by reservoir fisheries to different fishers, to management and to government. Such information is important for an economic assessment of the strengths and weaknesses of alternative management systems, and the possible benefits related to co-management systems. However, an informed assessment of these issues was beyond the scope of this study, and the preliminary analysis is not presented here.

7.4 Cage culture of grass carp

The data for the following analysis was derived from a report produced by Michael Phillips (1988), supplemented by other information generated by the MRF project (Vinh *et al.* 1999).

[5] Capital cost of net/life+boat/life+engine/life + annual maintenance charge
[6] Working days, rather than hours, were used to estimate person days

The culture of grass carp in wooden slatted cages in reservoirs developed rapidly in the mid 1990s, but declined following serious disease outbreaks after 1996. Survey data is available for the period prior to the crash, and data is also available relating to three trial cages promoted by the MRF project in Ea Soup. Traditionally, floating cages, 15-25 cubic metres in volume, were made of heavy wooden slats, with a small shelter built above. In the trial, the use of less wood, but with net liners was used to try to improve water quality and extend the life of the cages (from three to four or more years).

Seed are stocked at 500 to 1000/cage and grown for eight months to a year, achieving a weight of 0.5-1kg. The fish are fed limited amounts of rice bran, and soy cake. The main inputs are cassava leaves, young grass and water weeds. Substantial quantities are required, corresponding to labour requirements for food collection and feeding of around one hour per feed, twice a day.

Survival rates were typically 70-80 percent prior to the disease problems. In the trial, survival rates in three cages were 24 percent, 54 percent and 72 percent, with losses probably due to both disease (shortly after stocking) and escapes.

Table 12 Key financial characteristics and ratios

	Minimum start-up investment (1 cage)	Investment in single crop (per cage)	Total revenue per cage	Cash net revenue per cage (excl. labour; incl. capital)	Net revenue (incl. labour and capital)	Return on labour $/person day	Profit margin (incl. labour)	Return on investment	Payback period (years)
grass carp culture, pre-disease *	137	57	231	159	9	2.3	4%	11%	1.8
grass carp culture, data adapted from MRF trial	195	49	95	18	-118	0.3	-125%	-81%	-1.6

Note: ***** Data adapted from Phillips 1998.

Although cash net revenue per cage was reasonably high (around $169) before disease struck, if labour costs are fully accounted, net revenue is very low. Return on labour is correspondingly low – just a little higher than agricultural wage rates. Profit margin is very slim (indicating sensitivity to increased cost and/or reduced price) and return on investment is low. Payback period was satisfactory at less than two years (when using the cheaper cages.)

The trial farmers' performance suffered from higher capital costs associated with the improved cage and lower survival and growth, resulting in very low cash net revenue ($18) and very low return on labour (well below market rates). If labour is costed at market rates, profit margin and return on investment are negative.

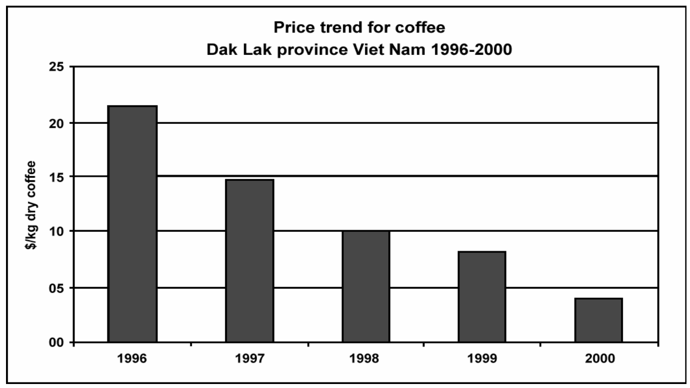
Using similar cost and labour utilisation data, the survival and growth rates required to achieve desirable returns (i.e. returns to labour higher than the market rates) can be estimated. Assuming growth to 700g (as was typically achieved in a production cycle prior to disease), and a market price of VND10,000 (price varies between VND8,000 and 10,000) a survival rate of more than 75 percent is required for return on labour to exceed the market rate of 30,000VND. If the price fell to 8000/kg, the survival rate would need to be more than 90 percent. Reducing only the cost of the cage has limited impact – the main problem here is the relatively low value of the product and the high labour requirements. These results explain why most farmers have abandoned grass carp culture and are reluctant to re-start: the returns do not adequately compensate for the effort, and risks remain high.

7.5 Coffee production

Coffee production was a booming business in Dak Lak until recent years, but prices have declined rapidly (Figure 32) and returns are now marginal. The main problem with coffee production, especially for the small-scale producer, is the long lead-time (five years before significant revenues are realised), with a corresponding high outstanding investment, and vulnerability to local and global over-production. Because the lead-time is long, production cannot adapt rapidly to market conditions, and there is significant potential for indebtedness.

The MRF team undertook a survey of coffee and rice producers in the areas adjacent to Ea Soup reservoir. For the seven coffee farmers surveyed in 2001, net revenue per hectare (excluding labour costs) ranged from $54 to $362 (average $184). If labour is charged at standard market rates, returns fall to between $-134 and + $160 (average $11). Profit margin and return on investment were correspondingly poor, averaging –28 percent and –2 percent, respectively. Four farmers generated return on labour between $1 and $3/person day, and three farmers generated between $5 and $6. It is clear that although some farmers continue to do reasonably, the days of high returns have passed, and the risk of losses are substantial. The start-up costs for coffee production are in excess of $500/ha, and returns do not begin for four or five years.

Figure 32



7.6 Rice production

Net revenue per hectare per crop for rice (excluding labour costs) ranged from $57 to $257 (average $172). If labour is charged at market rates, returns are reduced to between $-91 and $+90 (average $19). Profit margin ranged between –100 percent to +41 percent (average –4 percent). and –2 percent respectively. Five farmers generated return on labour between $2 and $4/person day, and three farmers generated between $5 and $7. At the present time, therefore, rice farming appears rather more attractive than coffee production, requires less investment, and prices are more stable.

7.7 Risk

As with the other projects, project staff were asked in a mini workshop to provide a subjective assessment of risk associated with selected activities. The results are presented in Table 13.

7.8 Overview: rice, coffee, fishing and cage culture

A summary of the financial characteristics of some of the activities studied in Dak Lak Province is presented in Table 14. The most attractive enterprises are the small stocked reservoir (Ho 31) and the lift net fishing in Ea Kau, a medium sized stocked reservoir. Prior to disease, cage culture grass carp generated consistent returns to labour that were a little above market rates, but profit margins were very slender, and this, coupled with increased risk of failure has led to its demise. Any resurgence would be dependent upon very high growth and survival rates, coupled with a ready supply of feed requiring lower labour input.

Coffee production used to generate high returns but is now marginal, and investment is unlikely to be recouped unless the price recovers significantly.

Coffee is a classic example of a high-risk activity, with significant investment, and long lead time. It is very difficult and painful for such an industry to adapt to falling world prices. It is therefore essential that the more general economic issues of comparative advantage, economies of scale, and the nature of world markets are examined thoroughly before encouraging small-holders to enter.

These figures suggest that stocked reservoir fisheries are relatively attractive from a financial perspective, and can generate returns higher than those available from other enterprises. However, a key issue is the management and distribution of income from such enterprises. Much more detailed studies are required to explore these issues, building on financial analysis to develop broader economic studies, which could inform strategy for future interventions in reservoir fisheries management. This will require a focused programme of economic research, rather than ad hoc and exploratory analyses of the kind undertaken here.

Table 13 Subjective comparative assessment of risk and potential, MRF project staff, Dak Lak

Activity	**Production risks**				**Prices and Market**				**Economic Potential**			**Livelihood**
	Flood	Drought	Theft	Disease	Price seasonality	Price trend	Local market	Intern. market	Comparative advantage	Labour per ha	Potential expansion (sites etc.)	Job quality
stocked, co-managed	1-3	1	2-3	2	20%	+	3-4	1	4-5		3-4	3-4
stocked, company managed	1-3	1	2-3	2	20%	+	3-4	1	4-5	0.1-0.2	3-4	2-3
un-stocked co-managed	1-4	1	1-3	2	20%	+	4-5	1	3-4		3-4	3
un-stocked, un-managed	1-4	1		1	20%	+	4-5	1	3-4	0.3-0.5	1-3	1-2
cage culture	1-2	1	3-5	2-5	20%	+	3-4	1	1-2[7]		1-2	2-3
rice	2-5	2 -5	1-4	1-3	35%	+	4-5	5	1-2[8]	3-5	2-3	3-4
coffee	1	3 -5	2-4	1-3	20%	-	1-2	5	4-5	4-5	1-2	1-5
pond culture	2-5	2-4	1-4	2-4	20%	+	3-4	1-3	2-3	4-4	3-4	5-6

Table 14 Summary financial profile of selected activities in Dak Lak Province

	Capital investment per ha or unit	**Annual costs (including labour)**	**Net revenue[9] per ha/yr; gear/ yr; cage/yr**	**Return on labour**	**Return on investment**	**Profit margin**
Small stocked reservoir (Ho 31)[10]	-	584-926	323 to1,498	9-28	NR	26-68%
Gill net fishing Ea Kao reservoir	54[11]	327	-2 to 75	1.7 to 2.2	-3% to 137%	0-18%
Gill net fishing Ea Soup reservoir	121	703	-359 to -410	.1 to 0.2	-297% to 340%	-104% to 140%
Lift net fishing Ea Kao	315	551	-427 to+1,086	0.1 to 5.8	-135% to+345%	-342% to + 66%
Cage culture of grass carp (pre-disease)	137	207	9	2.3	11%	4%
Coffee production (2001)	455-721 (547)	191-394 (276)	-134 to +160 (-11)	0.5-2.4 (1.3)	-22% to +32% (-2%)	-111% to 32% (-28%)
Rice production-1 crop 2001	NR	181-347 (232)	-91 to +90 (19)	0.5 to 2.5 (1.6)	NR	-100% to + 41% (-4%)

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7 Lack of river; skill, seed, trash fish
8 Lack of river; skill, seed, trash fish
9 Labour charged at market rates
10 The figures for 2000 were excluded since flooding prevented full harvest.
11 Capital costs divided by the number of fishers in the team.

Summary, conclusions and recommendations 8

8.1 Key elements of financial feasibility assessment

1. Financial feasibility assessment should encompass analysis relating to:

   - the cash return to the household or enterprise
   - the cash return on the factors of production (capital; land/water; labour)
   - the variation in these returns between farmers/fishers (related to location, management practices etc.)
   - the variation in returns for an individual farmer/fisher, related to production risks (such as crop loss) or market risk (e.g. falling price of product)
   - the profit margin (which measures exposure to increased costs or decreased product value)

2. In practice, most financial analysis generates simple summary statistics and ratios relating to the first two of these only. While this is appropriate and useful for well-established enterprises and technologies, it is of limited value for new activities and enterprises where both technology and performance are highly variable. It is the exploration of variation in returns to different factors of production which is the key to developing improved recommendations and interventions in aquatic resources management; and tailoring these recommendations to the resource profiles and needs of different client or beneficiary groups.

3. Unfortunately a great deal of "false" variation is generated in large-scale socio-economic surveys as a result of misinterpretation of questions and responses, and errors in data handling and analysis. The nature of the "real" variation can be more usefully explored through detailed case studies and enterprise modelling.

4. The relative importance of simple measures of return on labour ($/person day), land (profit, or net revenue/ha), and capital (profit/capital investment), will depend on the value or scarcity of these resources to different households. This will vary significantly both within and between countries. It is therefore important that all these measures (or related variants) are calculated.

5. It is common to discount or ignore family labour as a cost for small-scale enterprises. This is a mistake. In most of the locations visited, casual wage labour was available, and there is a real opportunity cost in using family labour. In any case, time itself has value in all societies, and (especially where adequate food is available) people will invest time in proportion to the financial or social rewards with which it is associated. The calculation of return on labour, though difficult, is therefore an essential component in financial analysis for small-scale family enterprises.

6. Summary financial ratios and indicators can only be derived by making many, often questionable, assumptions. It is essential that these assumptions are both understood and communicated if the ratios are to have value for informing development strategies.

8.2 Analytical risk assessment

1. Risk assessment requires a consideration of both exposure to risk and the likelihood of certain risk events occurring. Risk exposure has two components: the level of investment, and the time period over which the investment is outstanding. Indicators of risk exposure include: the total investment required before achieving a return; the time delay or "lead time" before the return occurs; the length of the cropping cycle; and the working capital required for each cycle. These also serve as indicators of accessibility to the poor, since both the amount of finance and the period over which it is available are limited for poor people.

2. Profit margin measures exposure to a fall in product price, or an increase in input costs, and is therefore also an index of risk exposure.

3. Price and cost sensitivity provide more specific and strategically-useful information than profit margin. It can be estimated as the percentage change in price or percentage increase in costs, which would lead to zero profit, or an unacceptable level of return to land, labour or capital. The likelihood or risk of such a change taking place can then be assessed.

4. The probability of certain risk events taking place, and the financial consequences of such events (e.g. flooding, low temperatures, disease) can sometimes be calculated. Unfortunately risk data in respect to disease is very limited.

5. Analysis of variation of current financial performance, as described above, offers important insights into both exposure to risk and the frequency of risk events. The proportion of farmers making a loss is a key general indicator of financial risk. Ideally, farmers/fishers should be classified into different enterprise types - in terms of scale, intensity, technology (including species) - and failure rates examined for each type. The reasons for failure, and the nature of the risks, can then be explored more thoroughly through case studies.

6. Analysis of variation in performance of individual farmers over time provides further information on the nature of risk, and allows for an assessment of the extent to which skill and/or specific management practices can reduce variation in financial performance.

7. The coefficient of variation (standard deviation/mean) has been used as a measure of risk by READ Viet Nam. This measure is not particularly meaningful when applied to financial returns whose variation mainly reflects variation in technology and management practice. While risk implies variation in performance, variation in performance does not necessarily imply risk. The measure is more useful once variation related to differing technologies has been removed; i.e. once the data has been classified according to production system.

8. The coefficient of variation is only statistically valid when applied to groups whose performance is distributed normally around a mean.

8.3 Subjective risk assessment

1. It is often not possible to quantify the risks, or the measures used may not allow for comparison between activities. In such cases, a more subjective form of risk assessment can be undertaken, which is closely related to multi-criteria decision analysis. A representative group of stakeholders, including farmers and technical specialists, is brought together to undertake the analysis. Major risks are identified and listed on a matrix against alternative development options. The vulnerability of each option to each risk is then discussed, and scored on a scale of 1 to 5 or 1 to 10, as agreed. The completed matrix provides an overview of the risk characteristics of different options, and provides a basis and framework for overall comparison, discussion, and further analysis.

2. Although the exercise was conducted at each field station with technical specialists, lack of time prevented the involvement of a wide range of stakeholders, and the results presented in the body of the report should be seen as illustrative only.

8.4 Accessibility to the poor

1. Key measures of the financial accessibility of an enterprise include the total minimum investment required before acceptable income is generated, and the total time over which such finance is required.

2. Much depends upon what is deemed to be a minimum scale of activity. This can be empirically assessed where a range of data is available related to differing scale of operation. This was done in Cambodia, where the data suggested that those producing from ponds of less than $200m^2$ generated very variable returns, but a significant proportion did very well. Where survey data is absent, production/financial models can be developed to assess the minimum realistic scale of operation, given known production parameters, local resource constraints, income expectations and other factors.

8.5 Previous data collection and analysis

1. All projects had collected, analysed and reported financial and economic data over several years. In the case of READ, substantial socio-economic studies had been undertaken, including a major base-line study in Cai Be and a Master's research study in Phnom Penh. There was no shortage of material to draw on. However, none of the existing analyses had seriously addressed the issues of risk, of variation in performance between target beneficiaries, or the strengths and weaknesses of project intervention, compared with alternative activities.

2. There are several problems in the way in which financial performance is currently analysed and reported:

3. Analyses are usually undertaken too late to be of use in developing improved interventions, and are rarely used to inform overall development strategies;
4. The financial returns from enterprises are typically described and compared using a single average figure (in some cases a range, or other measure of variation) that does not adequately address the nature of the variation in the returns, and the implications of this variation to new entrants.
5. Much of the information related to variation in performance (typically the “project database”) is compounded with *apparent* variation related to the nature of farmer responses and interviewer interpretation. In some cases, this “false” variation may swamp real variations.
6. Approaches to accounting (or not), family labour and certain kinds of capital expenditure are varied, and assumptions are not always clear in reported figures or database calculations. Variation in approach between projects and field offices makes cross-regional comparisons difficult, and in some cases impossible.

7. While return on land (e.g. net revenue or profit/ha) and capital (profit/capital investment) are almost always calculated, return on labour, which is a key concern to small enterprises, is less often reported, and the conventions for its calculation appropriate to small-scale rural enterprise are not well established.
8. Thorough risk assessment is rarely undertaken, and there is no widely adopted format or framework for risk assessment which would allow for comparison between different kinds of intervention and existing farmer/fisher activities.
9. Financial performance is often reported for a particular intervention, without thorough comparison with existing or possible alternative activities. Lacking any local reference point, these figures may be meaningless. This is a particular problem where interventions imply changes in resource use patterns.

8.6 Examples from READ Viet Nam: pond aquaculture and alternative activities in Tien Giang Province, Mekong Delta

1. Small-scale pond aquaculture in Tien Giang Province, is extremely diverse in terms of both financial return and risk. The baseline survey suggested that returns can be very high, and well above those generated by rice cultivation and other alternative activities. Risks from external factors appear to be relatively low compared with those affecting alternative activities.

2. However, many farmers in the baseline survey, and especially those using very high levels of inputs, made losses in real[12] terms (29 percent), and significant numbers made losses in purely cash terms (14 percent). On the other hand, of those farmers participating in the READ on-farm trials, very few (2.5 percent in 2000) made losses in cash terms.

3. Unfortunately, this reduced failure rate was achieved at a significant cost, with substantially lower average returns from the on-farm trials compared with the VAC baseline farmers; and with negative average returns in the on-farm trials if all costs, including capital costs, are accounted.

4. The analysis of risk and performance of VAC baseline farmers suggests that higher returns with relatively low risks of failure could be achieved. This would require using rather more intensive inputs than those recommended in the trials, but less than the extreme input levels used by some farmers. The management practices of the successful existing farmers operating at these levels deserve further investigation, and the possibility of testing modestly-increased inputs in future on-farm trials should be explored.

8.7 Examples from READ Cambodia – pond aquaculture and alternative activities in three provinces

1. Pond aquaculture, as promoted under the READ project in Cambodia, appears to be very attractive from a financial perspective, generating much higher returns to land and labour than rice farming.

2. The slightly higher risks compared with alternate activities derive mainly from the relatively high capital investment in ponds. However, the survey data suggest that good returns are possible with ponds of 200m^2 or less, so that would-be aquaculturists can begin with relatively-modest investment of perhaps $200. In practice, most farmers should be able to pay off the investment in a few years, and judging by the 2000 and 2001 trials, the failure rate is likely to be very low. Furthermore, the *cash* investment may be reduced if family labour is used to build the ponds, although the local opportunity cost of this labour must be taken into account before allocating such labour

[12] Including family labour charged at market rates and opportunity costs of on-farm inputs.

3. Significant numbers of farmers do exceptionally well, generating extremely high returns compared with any likely alternative. The project should examine these farmers in more detail in order to refine their recommendations to optimise financial return without significantly increased risk.

4. In general, financial returns to pond aquaculture were higher in Cambodia than in Viet Nam, even in the lower-input systems. This is related to slightly lower labour costs in Cambodia and significantly higher farm-gate prices. These differences deserve further analysis and may have important implications for the future development of aquaculture in the two countries.

8.8 Examples from MRF Lao PDR – cage culture of Tilapia, snakehead and silver carp; reservoir fishing

1. The analysis of cage culture and fishing in Lao PDR was based on more limited data than that available for the READ project, and greater reliance was placed on case studies and small-scale surveys, rather than on comprehensive survey data.

2. Cage culture technology is new and varied, and standard management practices are not established in most cases. It was therefore difficult to generate "typical" returns. At a small scale, scale factors, especially in relation to labour use, are highly significant, resulting in widely divergent financial profiles. Of the systems examined, the most consistent was for intensive Tilapia where a standard semi-commercial package is now available.

3. In general the cage aquaculture systems score well against a range of financial and risk criteria, and appear to be more attractive than most available alternatives, including fishing and rice cultivation. A great strength of the aquaculture systems is their flexibility in terms of scale, intensity of inputs, collection or purchase of inputs, and range of species from mainly herbivorous to carnivorous.

4. Start-up costs are highly variable ($8-$700) but can be kept to very modest levels, especially if captured seed and feed is available, or where herbivorous/planktivorous species are reared. The rearing of species such a silver carp, while apparently highly profitable and requiring only limited inputs, is only possible in very fertile reservoirs.

5. The Tilapia systems currently in use require more investment, but returns are more predictable, and production can take place in many more locations – in rivers, ponds and reservoirs – irrespective of local food and seed availability. The use of rather smaller cages, or low stocking densities would allow for initial low cost entry.

8.9 Examples from MRF Project, Dak Lak, Central Highlands of Viet Nam – reservoir fisheries; cage culture of grass carp; coffee and rice

1. Of the enterprise systems studied, the most financially attractive were a small (5 ha) stocked reservoir (Ho 31) and the lift net fishing in a medium-sized stocked reservoir (Ea Kau). However, the small reservoir suffered from harvesting problems related to flooding last year, resulting in greatly reduced returns; and the lift net fishing declined radically in 1999-2000. In contrast, although the gill net fishing in Ea Kau had previously generated rather poor returns (close to the market wage), the downturn last year was much less severe, and it significantly outperformed lift net fishing.

2. This illustrates the dangers of using financial performance indicators in isolation to assess the strengths and weaknesses of different enterprises or technologies. They must be used in combination with a thorough understanding of the nature of the systems being exploited, broader economic trends, and possible changes over time.

3. Prior to disease outbreaks in the mid 1990s, cage culture of grass carp generated consistent returns to labour a little above market labour rates, but profit margins were very slender, and this, coupled with increased risk of failure led to its demise. Analysis of data from MRF trials on cage culture of grass carp using improved cages to promote higher water quality, suggests that returns would be marginal without exceptional growth and survival rates. The low returns are related mainly to the high labour requirements involved in feed collection and feeding, as well as the relatively low price of grass carp in Viet Nam ($0.5-0.6).

4. Coffee production generated very high returns in the past but is now marginal, and investment is unlikely to be recouped unless the price recovers significantly. Using average values from a small survey to develop a spreadsheet model, it is shown that prices of raw coffee would need to rise by around 30 percent to restore return on labour to market rates, and closer to 100 percent to generate returns sufficient to make up for the high investment and long lead time.

5. Overall, the figures suggest that stocked reservoir fisheries, analysed as a single enterprise, are relatively attractive from a financial perspective, and can generate returns higher than those available from other enterprises. This is especially the case with the smaller water bodies. However, a key issue is the management and distribution of income from such enterprises. Much more detailed studies are required to explore these issues, building on financial analysis to develop broader economic studies, which could inform strategies for future interventions in reservoir fisheries management. This will require a focused programme of economic research, rather than ad hoc and exploratory analyses of the kind undertaken here.

8.10 Major conclusions

1. Socio-economic surveys, and especially baseline surveys, have been ambitious and detailed, but have not been used effectively as tools for identifying or refining interventions, especially extension recommendations. Less ambitious preliminary surveys, analysed prior to extension or advisory interventions, followed up with more focused surveys or case studies, and linked to an evolving extension programme, would be far more effective.

2. The study suggests that the varied forms of aquaculture in ponds and cages have high potential throughout the region, in terms of both commercial development and small-scale family enterprise directed at poverty alleviation. In general they compare well, and in some cases very well, with alternative traditional enterprises such as rice and fishing, and other new enterprises such as fruit and coffee production.

3. The very high levels of variation in performance found in the READ baseline surveys in Viet Nam and Cambodia, with some farmers doing badly, and others very well, suggests high potential and need for identifying and extending a range of financially-attractive production systems suited to different household or enterprise types.

4. The analysis of risk and performance of VAC baseline farmers in Tien Giang Province suggests that higher returns with relatively low risks of failure could be achieved with rather more intensive use of inputs than those recommended in the on-farm trials.

5. Stocking of small reservoirs appears to generate very high returns, and can be organised as a managed "enterprise" relatively easily. The financial benefits of stocking larger reservoirs are more ambiguous, and the social and economic issues, including resource access and allocation, are complex, requiring much broader social and economic analysis than was possible in this study.

6. Some interesting differences have been highlighted between countries (for example lower returns from pond culture in Viet Nam compared with Cambodia) that suggest the need for a broader economic study to examine price and cost differences between countries, and their implications for trade and future price trends.

8.11 Recommendations

1. Useful financial appraisal requires relatively simple forms of analysis coupled with a thorough knowledge of the technologies and the (often changing) development context. It should therefore be undertaken by local technical staff trained in the basics of financial analysis appropriate to small-scale enterprises.

2. Financial analysis should be undertaken throughout the project or programme cycle to inform resource allocation decisions, and to guide and refine interventions and extension recommendations.

3. Baseline studies should be completed and analysed prior to initiation of on-farm trials, and prior to the development of extension packages. Indeed, communicating the financial and risk profile of alternative enterprises and technologies should be a key part of project and extension activity.

4. Comprehensive baseline surveys and detailed monitoring exercises may be counter-productive, in so far as analysis may become too complex, too time consuming, and too divorced from the realities and trends on the ground. A day in the field may be more informative than many days of database analysis.

5. Relatively simple but broad-ranging preliminary surveys, followed up with detailed case studies of representative enterprise types, are likely to be most effective. These case studies should then be used to analyse production parameters, and develop corresponding production/financial models that can be used to explore the financial consequences of modified relationships or input/output values. These are likely to be of more use for informing strategy than empirical "average" models derived from large data sets.

6. Survey responses should be cross-checked in the field at the time of interview. For example, information may be solicited on production, on product value, on total income, on stocking rates and on survival. A simple on-the-spot calculation will highlight discrepancies that can then be explored with the respondent. It is in the exploration of such discrepancies that insights into the nature of technologies, and the financial realities of these to the farmer, can be gained.

7. Once data has been collected it should be explored and analysed immediately, either by the field team or in close consultation with them. Particular attention should be paid to "outliers": data that lie at the extremes of performance. These may represent false data, or important differences in the kind of enterprise.

8. Histograms and scatter graphs rather than summary statistics should be used to explore and present the nature of variation in financial performance, and this should provide pointers for further analysis and research, and important information for extension advice. These charts will also provide important insights into the variation in performance between different beneficiary groups, and the risks of poor performance or failure associated with particular types of enterprise.

9. Where possible, returns to the enterprise or household, to land, to labour and to capital should all be calculated, since these different returns are more or less important depending on local conditions and individual needs and perspectives. An estimation of minimum start-up investment and risk of failure should also be key components in the analysis, especially when assessing the potential for poverty alleviation.

10. Labour is a key resource and input to any new enterprise, and must be carefully quantified and accounted in financial analysis. Care must be taken to distinguish between actual labour input and minimum necessary labour input. Where labour is plentiful, the former is likely to be high and variable. The latter is technology dependent, and is the key parameter for input to financial analysis. It should be explored through in-depth case studies.

11. Financial analysis, ideally undertaken by the same analyst and based on similar assumptions, should be undertaken in respect to existing or possible alternatives to any proposed intervention. Without some such "baseline", development potential is almost impossible to assess, and rational allocation of resources by projects and by farmers or fishers themselves is unlikely.

12. Financial analysis and risk assessment should as far as possible follow the framework and approach outlined in more detail in the methodology sections (2.2 to 2.7) of this report.

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Measures and indicators of financial performance

Annex 1

Steady state analysis (annual costs and earnings)

This is a relatively simple approach to financial appraisal and adequate for most purposes. In particular it is useful for comparing the performance of already established, and relatively un-intensive (low investment) activities. The only complexity or subjectivity relates to the manner in which the cost of capital (the money tied up in capital assets - land, buildings, plant, equipment) is accounted. Normally a ***capital charge*** is included in the operating costs. This charge may include any or all of the following:

- an ***interest charge*** against capital tied up in land, buildings, plant and machinery/equipment;
- a ***depreciation charge*** to allow for the establishment of a replacement fund for deteriorating or ageing buildings, plant and equipment;
- a ***maintenance charge*** against buildings, plant and machinery;
- an ***insurance charge*** related to the value of capital assets (e.g. buildings, plant and machinery or equipment;

The **interest charge** may be related to the current opportunity cost of capital (e.g. commercial rates of interest on invested cash) or the borrowing cost of capital (bank lending rates). It may be charged on all or any of land, buildings, plant and machinery. By convention (with little obvious justification) it is often not charged against land value. The values chosen for the various interest rates can have a major impact on the analysis.

There are a variety of conventions for estimating **depreciation**, but for the purposes of project appraisal, the ***straight line*** method is adequate. Cost is divided by the expected life to give a simple average annual charge.

The cost of **maintenance** is highly variable and difficult to estimate on an actual cost basis. It is conventional to assume that maintenance can be estimated as a simple percentage of capital cost (usually between 5 and 15 percent).

If information is not available on actual **insurance** premiums related to buildings, plant and equipment (if any), a percentage rate may be assumed.

Other annual operating costs are relatively straightforward, and should normally be broken down into labour, raw materials (food, fertiliser, chemicals), energy (electricity, fuel oil etc.), communications etc. as appropriate to the enterprise.

Variable costs are those operating costs that vary in direct proportion to output (e.g. food, casual labour). **Fixed costs** are those costs that are independent of output or production rate (e.g. capital charges related to land, ponds, major items of equipment, labour associated with routine management). It may be useful to sum these up as separate sub-totals, especially for *existing* enterprises with significant overhead costs. However, many operating costs cannot easily be classified as fixed or variable and may be termed ***semi-variable***. *In practice there is often little point in making the distinction when the purpose of the analysis is investment appraisal or feasibility. In this case most costs may be varied (on paper) according to a range of possible outputs (e.g. numbers of ponds or tanks).*

Table A1.1 Static financial/resource model of a hatchery

Capital costs					
Item	***Quantity***	***Unit cost***	***Total cost $***	***Life***	***Units***
Land	1	5000	5000		ha
Building	200	150	30,000	20	m2
Plant and machinery			5,000	10	
Vehicle	1	15,000	15,000	6	
Tanks	12	200	2,400	8	
Tanks	8	400	3,200	8	
Pipework			2,800	6	
Lab equip			2,000	5	
total			***60,400***		

Operating Costs				
Fixed costs				
Item	***Quantity***	***Rate/cost***	***Total cost $***	***Units***
Interest		10%	6,040	
Depreciation		see above	6,067	
Maintenance		10%	6,040	
Labour skilled	100	20	2,000	MD
Total fixed costs			***20,147***	
Variable costs				
Casual labour	*75*	*15*	*1,125*	*MD*
Fuel	*300*	*4*	*1,200*	*l*
Artemia	*3*	*100*	*300*	*kg*
Feed	*5*	*80*	*360*	*kg*
Fertiliser	*30*	*5*	*150*	*kg*
Chemicals	*30*	*30*	*900*	*l*
Broodstock	*6*	*50*	*300*	*each*
Total variable costs			***4,335***	
Total operating costs			***24,482***	

	Production	***Unit price***	***Sales***
Total revenue (income)	**5,000,000**	0.01	***50,000***

Indicators of financial viability

Given information on production, and product value, a range of simple indicators of financial viability can be calculated:

Profit (also often referred to as net revenue or net income). *Income minus all operating costs, including interest, depreciation, maintenance, labour, inputs etc*. If tax is deducted this is called net profit, or profit net of taxes.

Profit/ha/crop or profit/ha/yr is a simple measure of return on land, or land productivity, and can be calculated for a single production cycle or for a year, whichever is appropriate. This should always be made clear.

Return on Labour (RoL/PD). *(Profit + labour costs)/total labour* used *(in person days)*. RoL corresponds to the average wage that would reduce profit to zero, or the maximum average wage that could be paid. Note that if labour has not been included in total costs when calculating profit, then there is no need to add labour costs back in.

Return on Investment (static). *(Profit/total capital investment)x100 percent*. A simple measure of attractiveness for investment. This is sometimes confused with the more complex measure *internal rate of return* (see below).

Profit Margin. *(Profit/total income)x100 percent.* A measure of vulnerability to product price change or increased costs. A useful indicator of financial risk.

Pay-back (PB). *Total investment/(annual profit+depreciation).* The time required to pay off capital invested in a project. While payback periods of 10 or more years may be acceptable to some very large corporations, most small businesses, including farmers, would hesitate to invest where payback periods exceed two or three years.

Unit Production Cost. *Total operating costs/total units or quantity produced.* Useful for assessing competitive position or comparative advantage compared with other actual or possible producers.

Total start-up investment/ha. *The cost (per hectare or per enterprise) of purchasing land, building/establishing ponds, tanks, buildings etc., and investing in inputs for the first crop*. The total outgoing costs before any return is generated. Essential information for people with limited access to funds.

[13]**Gross margin (GM).** *Gross income (sales revenue) minus variable costs*. If a farmer engages in several different activities, it may not be possible to allocate fixed costs to each of these, and gross margin may then be used as a partial measure of return for comparative purposes. Unfortunately, labour may be classified as a fixed cost or a variable cost, depending on circumstances, and this makes gross margin figures difficult to compare. It is useful therefore to distinguish two measures: gross margin excluding all labour (GMxl), and gross margin including all labour, so that confusion can be avoided and consistent comparisons made.

Measures relating to land use and land productivity. Several of the above can be divided by the area of land used in production to give an indication of the efficiency of land use – e.g. **gross income/ha; profit/ha; GM/ha; RoL/ha; MD or MY/ha** (or labour density). While gross income/ha is of importance to the economy as a whole, the other measures have more meaning for the individual land-user.

[13] In practice, there may be a range of measures of profitability which include/exclude different kinds of costs as appropriate to the analysis being undertaken. It is important to make clear what costs have or have not been included in profit/net revenue/gross margin figures.

Fish combination recommendations to farmers, READ on-farm trials, Tien Giang Province, Viet Nam

Annex 2

VAC:

1. For inland area (Chau Thanh, Cho Gao, Go Cong Tay):
   - ? Cai Lay: river catfish 50%, Tilapia, and kissing gourami.
   - ? Chau Thanh:
     + For sale: giant gourami 70%, kissing gourami, river catfish, and Tilapia.
     + For household consumption: Tilapia 70%, river catfish 30%.
   - ? Cho Gao: Tilapia 60%, kissing gourami 20%, grass carp and silver carp.
   - ? Go Cong Tay: Tilapia 70-80%, river catfish, and silver carp.
2. For flood prone area (Cai Be and Cai Lay): Tilapia >50%, river catfish 20-30%, kissing gourami, silver barb, and common carp.
3. For highly acid sulphate area (Tan Phuoc): Tilapia 50%, kissing gourami, river catfish, and hybrid catfish.
4. For slightly acid sulphate area (Tan Phuoc): Tilapia 40-50%, kissing gourami 20-30%, river catfish, hybrid catfish, snakeskin gourami.
5. For salinity intrusion area (limited water exchanged) (Go Cong Dong and Go Cong Tay): Tilapia 50%, river catfish, and common carp.

Rice-fish:

1. Flood prone Cai Be:

   + Rice field>5,000 m^2: Common carp 30%, Tilapia 30%, silver barb 30%, silver carp 5%, and Indian carp 5%.

   + Rice field<5,000 m^2: Common carp 30%, Tilapia 25%, silver barb 35%, silver carp 5%, and Indian carp 5%.
2. Low lying area in Go Cong Dong and Go Cong Tay:
   - ? Go Cong Dong: Tilapia 35%, common carp 35%, silver barb 20%, silver carp 5% and Indian carp 5%.
   - ? Go Cong Tay: Tilapia 40%, silver barb 30%, common carp 25% and silver carp 5%.

Spreadsheet models of selected enterprises

Annex 3

The (37) spreadsheet models used in this paper are too extensive to include in a standard A4 sheet, and most of the information is lost in printing. They can be downloaded from the Nautilus Website www.nautilus-consultants.co.uk or the MRC website www.mrcmekong.org or contact John Hambrey john@nautilus-consultants.co.uk

Economic approaches to assessing the aquaculture potential of indigenous species

Annex 4

Assessment of potential should be an evolving process, constantly updated and informed as new information and trial results are received.

There are typically three stages in aquaculture production: hatchery, nursery and grow-out. Grow-out is by far the most important in overall economic terms, and seed costs are usually a relatively small part of production costs. The assessment should therefore put greater weight *initially* on grow-out economics.

The same argument applies to actual research and production trials. Grow-out performance should be examined before expensive research on hatchery production is initiated, especially for the less well-known/understood species.

If growth rate and feeding habits are reasonably established, then the minimum production costs for different potential species can be established through comparison with established species. This can be done roughly, on the basis of a scoring system, or more accurately if local data on production economics are already available for a range of comparable species.

Rough scoring system for comparing economic potential of aquaculture candidate species – grow-out

The economic attractiveness of any new species for aquaculture will depend on the difference between market price and input costs. Where accurate information is not available, a scoring system, based on comparison with known species, can be used.

The fish is given a score on a range of 1 to 5 (or 1-10 if preferred). The range for each parameter is defined by reference to known species. For example, if it is agreed that silver carp involves the lowest input costs, then this species corresponds to 1 on the reference scale. If it is agreed that *Channa* involves the highest input costs, then this represents 5 on the reference scale. The new species is then assigned a score between 1 and 5 by comparison with these species. This will be relatively easy for some new species which are very similar to existing species, and for which good scientific information is available. For others, the scoring will be more difficult. To take account of this difference, an uncertainty score (estimated range for the parameter score e.g. + or – 1) should be assigned for each parameter.

Table 1 Scoring table for the assessment of species potential (economic)

Species e.g.	Fixed costs	Un-certainty: + or -	Variable input costs	Un-certainty: + or -	Market price	Un-certainty: + or -	Net revenue (net score)	Total un-certainty score
Anabas testudineus								
Osphronemus gourami								
Trichogaster pectoralis								
Barbodes gonionotus								
etc.								

Notes on scoring

Assigning scores should be done with care, taking account of the various components of cost.

Fixed costs

Fixed costs do not vary with production. They may be related to capital investment (pond, cage, dyke etc.) or to labour (e.g. for guarding). All else being equal, these costs will be lower per unit of production for faster growing species. For example, if growth is such that two crops per year might be feasible, then fixed costs will be roughly 50 percent of those for a species for which only one crop is possible. Assigned scores should reflect these differences.

Variable input costs

These include feed, seed, fertiliser, and variable labour (i.e. labour which varies with production). Growth rate should not be taken into account when assigning this score. Species should be compared in terms of expected input costs/kg of production. Although the expected cost of seed should be taken into account, it should be noted that seed is typically a relatively small component of input costs when compared with feed and labour.

Market price

In assigning a score for market price, potential demand should be taken into account as much as existing market price. Many unusual wild species have a very high market price locally, and the price is often related to scarcity. Significant aquaculture production is likely to cause a significant price fall for these species. The market price score should therefore be based on the price of similar species that are more widely available.

Using the scores

The scores for fixed costs and variable costs can then be added, and subtracted from the market price score to provide a "net revenue" score. The uncertainty scores can also be summed to provide an overall indication of the uncertainty associated with the net revenue score. The results can then be discussed, scores adjusted where appropriate, and a final score obtained. The species with the highest net revenue and lowest uncertainty score will be the most attractive as immediate candidate species. Those with high revenue and high uncertainty may deserve further investigation. Those with low net revenue scores should be given low priority.

Applying the same approach to hatchery economics

A similar approach can be taken to the costs and returns from hatchery production, although as noted above, this is probably less important than grow-out for overall species potential assessment.

When undertaking this exercise for hatcheries, a key issue is technical difficulty. In terms of financial return, technical difficulty will have an impact on both fixed costs (low survival implies more tanks/ponds/cages for broodstock, larvae and fry) and variable input costs (mainly labour).

It may be easier to simply classify seed production as low cost (cf. common carp, *Tilapia*) medium cost (cf. grass carp, *Pangasius*) and high cost (cf. seabass, *Macrobrachium*). These rough costs could then be included in the assessment of input costs for grow-out in Table 1.

Towards more detailed assessment

Rough estimates of financial return for different species can be made if the following information is available, or can be reasonably estimated through reference to other similar species:

- ✍ Seed cost
- ✍ Survival rate
- ✍ Growth rate
- ✍ Input costs
- ✍ Market price

Seed cost should be relatively easy to estimate through comparison with similar species.

Survival rate and growth rate may be known through trials, or again may be assessed in comparison to similar known species.

Other input costs (per kg of production) (mainly feed, fertiliser and labour) may be estimated from survey data of existing aquaculture operations, and are likely to fall into one of three classes: trash fish/formulated feed systems; fertilised ponds with supplementary feed; and fertilised only systems.

Market price has been discussed above. Likely demand should be taken account of as well as current price. It will probably be appropriate to adjust the current price downward to take account of the impact of increased aquaculture production. Similar species that are more widely available should provide an indication of what this adjusted price might be.

A table (preferably set up in a spreadsheet) can then be constructed which provides rough return data for different species, taking account of survival rate, growth rate, and market price. An example, based on current species grown in the Mekong Delta, is provided in Table 2.

Adjusted seed cost is the cost of seed required to produce one harvested fish, and takes account of mortality. It is calculated as the purchase price of one seed divided by survival rate. For example, if seed price is VND200/piece, and survival rate is 50 percent, then 2 seed are required to produce 1 fish, and the adjusted seed cost per fish harvested is 200/0.5 = VND400.

Allocation of input costs is the estimated input costs/kg (excluding seed) multiplied by the size of the fish in kilograms. These costs should include labour, feed, fertiliser etc.; and, if possible, an allocation for fixed costs (ponds, nets etc.), although these have not been included in the estimates made in Table 2.

Net return per fish harvested is simply the market value of the fish (column three) less the adjusted seed cost and input costs. Remember throughout that the calculation is based on one fish, not on 1 kg of production. This figure would represent the *maximum* return (there will be other less-easily defined costs) and is a useful financial performance index for comparing different species.

Table 2 Partial returns over nine months for different species grown in the Mekong Delta

Species	Size at ca 9 months	Farm gate price VND/kg	Fish value (VND/piece) at 9 months	Less adjusted seed cost	less allocation of input costs	Net return after 9 months/fish harvested
Common carp	320	8,000	2,560	167	504	1,889
River catfish	450	8,000	3,600	563	709	2,329
Tilapia	160	6,000	960	182	252	526
Kissing gourami	100	10,000	1,000	175	158	668
Giant gourami	150	11,000	1,650	500	236	914
Silver barb	110	7,000	770	300	173	297
Grass carp	320	6,000	1,920	143	504	1,273
Silver carp	350	6,000	2,100	71	551	1,477

Note: prices and costs in the table above are rough estimates only and should be adjusted according to local conditions/current knowledge.