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Extending low-cost fish farming in Thailand: an ACIAR–World Vision collaborative program

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Extending low-cost fish farming in Thailand: an ACIAR–World Vision collaborative program

David N. Harris

D.N. Harris & Associates



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Cover: Floating basket demonstration unit at the Ban Hnongwah Vocational Training Centre located in Udon Thani, North-East Thailand.

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Foreword

In 2001 the Australian Centre for International Agricultural Research (ACIAR) initiated a collaborative program of extension-related projects with a global non-government organisation—World Vision (WV). The aim was to extend the research and development (R&D) outcomes from selected ACIAR projects to low-income farming communities of Thailand, Lao PDR and Vietnam. Each project involved a combination of participatory research and extension training. A feature of the program was the opportunity for ACIAR to gain an entrée into World Vision's network of localised area-development programs.

Six projects were jointly selected by ACIAR and WV for inclusion in the program: training vegetable growers in southern Thailand on how to improve net returns by reducing pesticide and fertiliser use; encouraging farmers in the hill areas of northern Thailand to grow high-value, low-chill temperate fruits; training farmers in northern Thailand on fish farming with a low-cost feed; encouraging rice farmers in southern Vietnam to adopt rodent control systems to reduce crop losses; training peanut farmers in southern Vietnam on how to improve soil fertility and crop yields; and training farmers in southern Laos on how to improve crop yields in rainfed rice-farming systems.

A program review in 2003 and project completion reports found that each component had achieved important outcomes in terms of meeting or exceeding targets to train farmers. In each case the projects generated benefits in the form of improved food security and poverty alleviation from commercial sales of surplus output.

Evaluation of the net benefits of the entire collaborative program would require specific impact assessments of each project. It would be a substantial undertaking and ACIAR decided this was not feasible. Instead,

one component—the Thai fish-farming project—was initially selected for assessment as an indicator of the value of this type of R&D investment by ACIAR.

The impact of the selected project was assessed on the basis of the economic returns that accrue to farmers adopting the extension advice. This impact assessment report confirms that there were significant food security and poverty alleviation benefits for the farms that still operate a fish-farming enterprise. There were also human health benefits from improving the nutritional content of the family diet through increased consumption of fish.

The report has noted some issues for consideration that could improve the effectiveness and sustainability of outcomes from this type of project investment. However, the review found that the WV area-development programs were a highly effective way of reaching the target population of potential beneficiaries—poor farmers with limited land and food security concerns.



Nick Austin
Chief Executive Officer, ACIAR

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This assessment could not have been completed without the cooperation of staff from the World Vision Foundation of Thailand (WVFT). The high degree of cooperation was facilitated by Ms Chitra Thumborisuth, WVFT Executive Director, and her commitment to the exercise was greatly appreciated. Some other staff members have been noted in the list of contributors to the in-country impact assessment consultations (see Appendix 2). But there were others involved and their help during the course of the assessment was very much appreciated.

WVFT staff in the Area Development Program (ADP) districts collected the survey information for the assessment. This task involved face-to-face interviews with farmers. It required patience in explaining the questions to farmers and a commitment to ensure that survey responses were accurate. This task was diligently completed and was a key contribution to the impact assessment. The efforts of WVFT staff involved in this task were highly valued and much appreciated.

The assistance provided by Mr Anusorn Somsiri from WVFT requires special mention. He facilitated the field trips and acted as an interpreter during site visits to meet with farmers and local government officials. He supervised the survey activity and ensured that ADP staff were fully briefed on the detail of the questionnaire. Mr Somsiri was the key source of WVFT knowledge on the project and provided valuable background data. He was generous with his time, and his patience, advice and organisational efforts were greatly appreciated.

Executive summary

The Australian Centre for International Agricultural Research (ACIAR) invested in a collaborative program of extension projects with World Vision (WV) to enhance the adoption of results from several technical research projects. The program was composed of six projects located in Thailand, Lao PDR and Vietnam. They involved a combination of participatory research and extension training. The aim was to use WV field staff engaged in community development projects to direct the research and deliver the extension advice.

Each project was implemented by the in-country WV organisation. They were integrated into their Area Development Programs (ADPs) as a specific activity. ADPs typically operate for 10–12 years and they offered a highly effective way to engage with the target population of very poor farmers with limited land areas. The projects were jointly funded by ACIAR and the in-country WV organisation.

Content of the World Vision collaborative program

The program commenced in 2001. The completion dates for projects varied due to the granting of extensions. The portfolio of projects and target countries was jointly selected by ACIAR and WV. The six program components were:

- component 1 in southern Thailand—Agriculture reform preventing agrichemical pollution of water resources
- component 2 in northern Thailand—High-value low-chill temperate fruits for hill areas of northern Thailand
- component 3 in North-East Thailand—Profitable fish farming through utilisation of low-cost feeds
- component 4 in southern Vietnam—Rodent control in rice crops using integrated pest management techniques
- component 5 in southern Vietnam—Improvement of soil fertility in Binh Thuan province
- component 6 in central and southern Lao PDR—Improving crop yields in rainfed rice-based systems in central and southern lowlands of Lao PDR.

Total program expenditure was A\$1.799 million over the 2000–01 to 2007–08 period. ACIAR's contribution was A\$1.453 million, about 80% of the total expenditure.

Collaboration with WV meant that the extension efforts of each project would be targeted at a particular group of farmers within the project impact areas. WV focuses its efforts on the poorest of the poor members of local communities. The area of potential impact was limited to villages where an ADP was participating in the project.

- *Wealthy and higher income members of the community did not participate.*

Individual program components had varying objectives but the primary focus was to improve food security and farm income.

- In component 1 the aim was to encourage vegetable growers in selected areas of southern Thailand to reduce pesticide and fertiliser use.
- In component 2 the aim was to encourage farmers in selected areas of northern Thailand to grow low-chill, temperate fruits as an alternative to upland rice and opium poppies.

- In component 3 the aim was to encourage farmers in selected areas of northern Thailand to establish a fish-raising enterprise based on a low-cost fish feed.
- In component 4 the aim was to encourage farm communities in selected areas of southern Vietnam to implement a rodent control system to reduce the impact of rats on rice yields.
- In component 5 the aim was to encourage peanut farmers in selected areas of southern Vietnam to change fertiliser applications and peanut varieties in order to improve soil management and increase crop yields.
- In component 6 the aim was to encourage farmers in selected areas of southern Lao PDR to improve rice crop management by using new varieties and changing fertiliser practices.

In general the collaborative program achieved important outcomes in capacity building of farmers and extension officials. Targets for the number of farmers trained and the development of extension infrastructure were achieved and, in some cases, exceeded. Each component improved food security in the project impact areas. In many cases the sale of surplus output contributed to improvements in farm income.

The Thai fish-farming project

Impact assessment (IA) of all six components to judge the net benefits of the program was not feasible because there was insufficient information. An alternative approach was to select a project component for an IA as an indication of the value of this type of R&D investment. The Thai fish-farming project was selected for this purpose.

Freshwater fish farming is widespread in Thailand. Farmers living on low incomes have been reluctant, however, to raise fish as a formal farm enterprise because of high feed costs and low survival rates of fingerlings. Low-cost feed rations, improved feeding strategies and better management of fish were seen to be the key factors in encouraging these farmers to establish a fish-raising enterprise.

The project involved a combination of participatory research and extension activities. Demonstration

sites were established and selected farmers received training in the technical requirements of fish farming. In the first phase of the project two areas in North-East Thailand were selected to participate—Muang Udon district in Udon Thani province and the Prasart district ADP in Surin province. Two community-learning centres were established to facilitate the research and extension training.

A low-cost fish feed was developed as an alternative to commercial feed rations. Farmers were encouraged to establish a fish-raising enterprise. They received financial support for establishment costs and were provided with fingerlings and fish feed for their initial attempt.

The project was extended to a second phase in the same areas from June 2003. It also allowed WVFT to use the lessons learned from phase one to implement the project in another 14 ADPs across North-East, northern and central Thailand. ACIAR funding ceased in December 2006 but the WVFT investment continued until mid 2009.

Initial joint funding of the project was A\$388,000, with ACIAR contributing around 70%. WVFT then invested a further A\$1.7 million over a 3-year period beginning in 2006–07. Total project expenditure was close to A\$2.1 million and ACIAR's share of the total investment was 13%.

Impact of the Thai fish-farming project

The project impact was assessed by the economic returns that accrued to farmers adopting the extension advice. It was based on the net returns from establishing a fish-raising enterprise and the number of adopters. Regional differences in the impact were expected as the participating ADPs were dispersed across northern and central Thailand.

To develop estimates of current net returns, a survey of farmers in selected ADP districts was conducted. The sample covered a selection of ADP districts to allow for regional differences in enterprise performance. The first output from farmer application of the training in phase one of the project occurred in 2002–03. In phase two the initial output occurred mostly in 2005–06.

WV records of ADP members showed that there was a fall in adoption following the initial application of the training. In 2008–09 there were 977 active adopters across all project impact areas. The initial adoption level was 2,281.

Average net returns for fish-farming enterprises in five project impact areas were derived from the survey results. It was assumed that they reflected typical outcomes for the adopting farmers in the areas of impact. The total annual impact of the project reached a steady state of A\$714,000 in 2015–16. The impact was strongest in the lower North-East region, with an estimated steady-state annual effect of more than A\$438,000.

The estimated net returns were compared with a ‘no impact’ base case to determine the project benefits. Some participants had previous experience with fish raising. This was confirmed by the survey results. In many cases it involved a less-formal approach based on limited use of feed rations and raising small numbers of fish in rice paddies.

- *The non-discounted project benefits were valued at A\$17.1 million.*
- *The lower North-East region accounted for almost two-thirds of the benefits.*
- *The benefits were small in northern and central regions because of low adoption.*

Net benefits of the Thai fish-farming project

The present value of the net benefits of the project was A\$6.9 million for a 5% discount rate. The project had a benefit:cost ratio of 5.1:1. Attribution of the net benefits based on project expenditures indicates a net benefit of A\$0.9 million for the ACIAR investment.

The sensitivity of the estimated net benefits to assumptions on future adoption levels was examined. If adoption levels remain unchanged from their current levels, the project will still yield a positive net benefit. The sensitivity analysis showed a net benefit of A\$4.6 million in present value terms.

The project has had significant poverty alleviation and food security benefits for the adopting farm households.

Income gains varied according to the amount of fish retained for home use. Survey results showed that the annual income gains in 2008–09 varied between A\$158 in Prasart district to A\$31 in Muang Udon district.

These gains are significant in the context of average household incomes. Much larger benefits were obtained from improved food security. The human health benefits from improving the nutritional content of the family diet were not quantified in the study. This means that the net benefits of the project will be underestimated to some extent.

Lessons from the impact assessment

Using the ADP network for the extension of research results was a worthwhile exercise. It was an effective way to reach a target group of potential beneficiaries as defined by WVFT operating plans—very poor farmers with limited land. But it limited the impact as non-ADP members could benefit only by observing the experiences of adopters.

Investigating the reasons why a large number of initial adopters ceased fish farming would be worthwhile. It suggests that some refinements to the approach used in the extension training may be necessary. It also highlights the need to take care in making assumptions on adoption rates for low-income farmers with limited financial resources.

A lack of money to buy fingerlings and feed was a factor in non-adoption. Some farmers retained their entire fish harvest for home use then ceased production. This suggests that they were unaware of the need to sell a portion of each harvest to finance future output. Extension projects aimed at poor farmers should include, in addition to technical training, financial advice on enterprise performance.

The project successfully developed a low-cost fish feed but the uptake was limited. This was confirmed by the survey results. An inability to secure regular supplies of low-cost feed may have been the key factor in the fall in adoption. Extension activities to disperse the knowledge on fish feed production may increase the net benefits of the project.

1 Introduction

The Australian Centre for International Agricultural Research (ACIAR) makes substantial investments in scientific and technical research projects across a range of developing economies. The impact of these projects in part depends on the effectiveness of efforts to encourage potential beneficiaries to adopt the results. As a result, ACIAR has continually emphasised the importance of post-project extension in project designs.

One way to strengthen the practical impact of ACIAR's technical research is to invest in complementary extension projects. The projects could be implemented in partnership with in-country agencies and designed to make use of technologies and advice from ACIAR research projects. They could involve a combination of participatory research, capacity building of farm advisers, farmer training and the application of extension advice.

ACIAR has invested in an activity that followed this general approach. A collaborative program of extension projects was developed with World Vision (WV) Australia. The aim was to use WV field staff engaged in community development projects in selected countries to encourage the adoption of ACIAR research results.

WV is a non-government organisation (NGO) that is active in several countries where ACIAR invests funds in technical research projects. It has established close links with farming communities in locations where they have active development programs. They focus on poverty alleviation among the poorest members of the community and have staff based in their program development areas.

WV collaborates with government agencies to deliver health, education and other welfare programs to the poor. This work includes self-help extension advice aimed at improving the financial position of target

families in rural areas. Using regionally based WV staff and their infrastructure support is one way to enhance the adoption of ACIAR research. It offers an alternative to government-funded extension services, which are not always the most effective way to disseminate research results.

ACIAR funded the set of WV extension projects through an activity called 'Facilitating farmer uptake of ACIAR project results: World Vision collaborative program' (project PLIA/2000/165). The program has been selected for an impact assessment to provide an indicator of the value of this type of approach for enhancing the impact of ACIAR technical research projects.

This report does not provide an impact assessment of the entire program. That would be a substantial undertaking as it would require assessments of the net benefits of each project. Instead it assesses the impact of one of the major projects in the program as an indicator of the net benefits of this type of investment. Impact assessments of other projects may be undertaken at a later date to supplement the findings of this report.

The WV collaborative program was designed to make use of ACIAR research outcomes from specific technical projects in selected developing countries. Each component of the program involved participatory research and extension activities based on related ACIAR project investments in keeping with the organisation's mandate. One possible limitation with the collaboration is the mandate and reach of the partner organisation.

- *WV focuses its efforts on the poorest members of local communities.*
- *WV development programs do not cover all parts of the country.*

- *The ACIAR extension project may not be implemented in all the areas where WV has active development programs—participation decisions are decentralised.*

These factors mean that the extension efforts were targeted at a particular group of farmers in the local communities—there was a restricted number of potential direct beneficiaries. They also mean that the area of potential impact was limited to districts and villages where a WV development program was active and participating in the extension project. Community members who had incomes higher than those of the poorest did not participate in the project.

Adoption of the extension advice beyond the target group would depend on other farmers observing the outcomes for those participating in the WV development programs. It would also depend on other organisations such as government extension services applying the outcomes of the WV extension projects in their work programs.

The collaborative program was administered through WV Australia but the individual extension projects were implemented by the in-country WV organisation. The projects were integrated into the WV Area Development Programs (ADPs) in each country as a specific activity. ADPs typically operate for 10–12 years and, in some cases, have financial support from the Australian Agency for International Development. The extension projects were not funded solely by ACIAR—the in-country WV organisation also contributed some funds.

2 The ACIAR–World Vision collaborative program

The collaborative program was composed of six projects in three countries—Thailand, Vietnam and Lao PDR. The projects commenced in January 2001 and, due to the granting of extensions, had various completion dates. The portfolio of projects and target countries was jointly selected by ACIAR and WV Australia.

The six projects were designed to be integrated into existing WV development programs operating in the target countries. They were extension projects that used the results of current and recently completed ACIAR technical research. The WV ADPs involve targeted poverty alleviation activities in specific locations.

WV Australia was involved in the administration of the program. At a project level the interaction was between ACIAR's partners in related technical research and staff from the WV organisation in the target country. The in-country WV organisation implemented the projects. They used their local staff to direct the participatory research and develop extension advice, with support from ACIAR research partners as required.

Objectives and activities of program components

The objective of the ACIAR–WV collaborative program was to enhance through extension activities the impact of ACIAR technical research. For each program component the objective was to encourage application of technologies and research results from specific ACIAR project investments. The six program components were:

- component 1 in southern Thailand—Agriculture reform preventing agrichemical pollution of water resources
- component 2 in northern Thailand—High value low-chill temperate fruits for hill areas of northern Thailand
- component 3 in North-East Thailand—Profitable fish farming through utilisation of low-cost feeds
- component 4 in southern Vietnam—Rodent control in rice crops using integrated pest management techniques
- component 5 in southern Vietnam—Improvement of soil fertility in Binh Thuan province
- component 6 in central and southern Lao PDR—Improving crop yields in rainfed rice-based systems in central and southern lowlands of Lao PDR.

Total program expenditure by ACIAR and WV was A\$1.799 million over the 2000–01 to 2007–08 period (Table 1). ACIAR's contribution was A\$1.453 million, about 80% of the total expenditure. Funding for project management in Australia included payments to ACIAR project advisers as well as project monitoring and the participation of WV Australia staff in project reviews.

The program was initially designed to have each component run for 2–3 years with similar-size budgets. This reflected the experimental nature of the activities under the collaboration. In most cases the individual projects commenced in mid 2001.

Table 1. Expenditure on the ACIAR–World Vision (WV) collaborative program^a

	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	Total
	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000
Project management in Australia									
ACIAR	3.9	7.9	8.2	4.2	–	–	–	–	24.3
WV	9.7	19.8	20.5	10.7	–	–	–	–	60.8
Component 1—Chemical use and water pollution, Thailand									
ACIAR	30.0	99.4	52.3	27.2	15.3	–	–	–	224.1
WV	5.6	11.2	5.6	–	–	–	–	–	22.4
Component 2—Low-chill temperate fruits, Thailand									
ACIAR	55.4	34.8	47.0	24.6	43.0	–	–	–	204.8
WV	16.7	33.3	33.3	16.7	–	–	–	–	100.0
Component 3—Fish farming and low-cost fish feed, Thailand									
ACIAR	39.2	78.7	39.5	22.2	52.1	36.6	–	–	268.3
WV	27.6	59.8	32.3	–	–	–	–	–	119.7
Component 4—Rodent control in rice crops, Vietnam ^b									
ACIAR	30.4	32.3	20.3	26.1	–	–	–	–	109.1
WV	2.3	4.6	2.3	–	–	–	–	–	9.3
Component 5—Improvement of soil fertility, Vietnam ^b									
ACIAR	30.4	32.3	20.3	33.2	50.9	19.5	–	–	186.7
WV	2.3	4.6	2.3	–	–	–	–	–	9.3
Component 6—Improving rainfed rice yields, Lao PDR									
ACIAR	49.8	99.0	66.7	19.7	39.7	39.7	100.7	20.1	435.6
WV	6.2	12.3	6.2	–	–	–	–	–	24.6
Total project expenditure									
ACIAR	239.1	384.4	254.4	157.2	201.0	95.9	100.7	20.1	1,452.8
WV	70.4	145.7	102.5	27.4	–	–	–	–	346.0
<i>Total</i>	309.4	530.2	356.9	184.6	201.0	95.9	100.7	20.1	1,798.8

Source: ACIAR (pers. comm.)

^a Expenditure for project PLIA/2000/165 only. Collaborative projects with WV in Mozambique on vaccines for Newcastle disease and cassava cyanide toxicity were not funded under PLIA/2000/165. They have not been reviewed as part of this impact assessment. The projects were originally scheduled to terminate in December 2003 but were subsequently extended.

^b Components 4 and 5 were two activities in a World Vision rural development project in Binh Thuan province.

Component 1: Chemical use and water pollution, Thailand

The objective of this project was to encourage low-income vegetable growers in selected areas of two provinces of southern Thailand (Songkla and Nakhon Si Thammarat) to reduce their use of pesticides and fertilisers. Appropriate application rates would yield residue-free produce and reduce groundwater contamination. The project was designed to use the results of an ACIAR technical project that demonstrated that excessive use of chemicals had caused significant contamination of drinking water.

This component was a collaboration between the World Vision Foundation of Thailand (WVFT) and the Prince of Songkla University. WVFT directed the participatory research and extension activities with advice from the university's Faculty of Natural Resources. There was no involvement by Australian collaborators in the original technical project.

The project provided training for extension workers. It demonstrated that a large decrease in chemical use was possible without adversely affecting the viability of vegetable growers in the Songkla Basin. More than 1,500 family farms were targeted as direct beneficiaries of the training advice. There was expected to be a large number of indirect beneficiaries. Once the project was completed, the impact could be expanded through the involvement of government extension services.

Component 2: Low-chill temperate fruits, Thailand

The objective of component 2 was to encourage low-income farmers in high elevation areas of Chiang Rai province in northern Thailand to grow low-chill, temperate fruits. It was considered a viable alternative enterprise to upland rice and a replacement for growing opium. The nominated products were highly valued in the domestic market and may eventually support an export trade.

Component 2 was designed to extend the outcomes of some related ACIAR technical projects that had successfully introduced stone fruits such as plums, peaches and nectarines to other parts of northern Thailand. WVFT directed the participatory research and extension activities with advice from the Thai Department of Agriculture and the Royal Chiang Mai Agricultural Centre. There was very little involvement

of the Australian collaborators in the ACIAR technical projects.

The project targeted 200 family farms in a specified ADP area. Seedling trees were distributed to farmers and they were required to attend nursery management training programs at two community-learning centres established for the project. These centres set up demonstration plots to support the extension training.

In the early stages of the project there were difficulties with low-quality seedlings and the effectiveness of the training. Some farmers had problems in applying the training lessons. This may have reflected deficiencies in the approach used to implement the project. It affected the initial benefits of the project for farmer incomes and food security.

The project showed that low-chill fruits could be successfully grown in the region. There was strong interest in growing temperate fruits in the targeted communities. However, the benefits of the project were expected to take some time to materialise because of the long production lags in growing temperate fruits. In some locations poor growth rates of the seedlings would also affect the timing of the project impact.

Component 3: Fish farming and low-cost fish feed, Thailand

The objective of component 3 was to encourage fish farming in northern Thailand as a way to improve community health and nutrition, food security and farmer incomes. The use of commercial feed to raise fish reduced returns and discouraged low-income farmers from establishing a fish-raising enterprise. The project was designed to use the results of an ACIAR technical project that had developed a low-cost alternative to commercial feed rations, based on locally available materials.

This component involved collaboration between WVFT and the Thai Department of Fisheries. Initially WVFT directed the participatory research and extension activities through two learning centres in Surin and Udon Thani provinces. Advice from the Thai Department of Fisheries was used as required. There was little involvement of the Australian collaborators in the ACIAR technical project.

The project was extended in early 2004 with extra funding from ACIAR and a further investment by WVFT. The extra funds were used to widen the scope of the project by providing training in another 14 locations across nine provinces. The experiences and training practices from the original extension activities in Surin and Udon Thani were used to promote fish raising in other areas of northern Thailand.

The project showed that small-scale fish raising using low-cost fish feed could improve food security and increase farm incomes. More than 1,000 family farms were expected to be direct beneficiaries of the first phase of the project. The number of beneficiaries was expected to increase with the anticipated scope of the project. Encouraging the use of low-cost fish feed was considered to be the key factor in the level of adoption.

Component 4: Rodent control in rice crops, Vietnam

The objective of component 4 was to encourage farming communities in the Bac Binh province of southern Vietnam to implement a trap-barrier system to reduce the impact of rodents on rice crops. Crop damage by rats reduced rice yields, which had a negative impact on food security and farm income. The project was designed to use the results of ACIAR technical projects that looked at ways to manage the rodent problem.

This component involved collaboration between WV Vietnam and the National Institute of Plant Protection in Vietnam. WV directed the participatory research and extension activities with advice from institute staff. Involvement by the Australian collaborators in the ACIAR technical projects was limited.

The project showed that a community trapping system for rodents was effective and viable. In locations where community cooperation was reasonable, a user-pays approach could be used to establish and maintain the system. There was expected to be a large number of project beneficiaries if the system was adopted by all WV ADPs in Vietnam.

Component 5: Improvement of soil fertility, Vietnam

The objective of component 5 was to encourage peanut farmers in the Bac Binh province of southern Vietnam to improve their soil management by changing fertiliser application practices and the peanut varieties planted. Soil fertility management is a key factor for higher

yields and sustainable peanut production on the light, sandy soils of the province. The project was designed to use the results from an ACIAR technical project that investigated the role of phosphorus in crop production on acid upland soils.

Component 5 involved a collaboration between WV Vietnam and the National Institute of Soils and Fertiliser in Vietnam. WV Vietnam directed the participatory research and extension activities. Institute staff provided technical advice on soil fertility and fertiliser use. The involvement of Australian collaborators in the ACIAR technical project was limited to a small number of site visits.

The project showed that significant yield improvements were feasible by changing fertiliser practices and peanut variety selection. Farmers participated in field experiments in order to test alternative fertiliser rates and peanut varieties. Around 200 farmers were expected to be direct beneficiaries of the training. The number of beneficiaries was expected to rise if the soil fertility extension advice was eventually implemented in each of the ADPs operated by WV Vietnam.

Component 6: Improving rainfed rice yields, Lao PDR

The objective of component 6 was to encourage farmers in the Savannakhet province of central and southern Laos to improve rice crop management by using new varieties and changing fertiliser practices. On the sandy soils of this province these factors were lowering crop yields, which reduced food security and farm incomes. The project was designed to use results from ACIAR technical projects on plant-breeding strategies for lowland rice and productivity gains in rice-based cropping systems.

The project involved a collaboration between WV Laos, the International Rice Research Institute's Lao PDR project and staff from provincial research stations. WV Laos directed the participatory research and extension activities with advice from collaborating institutions. Involvement of the Australian collaborators in the ACIAR technical project was limited.

The project involved training government extension workers to work with farmer groups in 32 villages. They conducted on-farm trials of rice varieties and alternative fertiliser applications. The project showed

that significant increases in rice yield could be achieved through using better varieties and fertiliser practices.

The 157 family farms in village-based groups were expected to be the direct beneficiaries of the training advice. The number of beneficiaries was expected to rise if the training activities were expanded to include more villages in the region.

Outcomes of program components

In general the ACIAR–WV collaborative program has achieved significant outcomes in capacity building of extension officials and farmers. Targets for the number of farmers trained and the development of extension infrastructure were achieved and, in some cases, exceeded. Each component improved food security in the project impact areas. In many cases the increased output provided a surplus for commercial sale, which contributed to improvements in farm incomes.

Component 1: Chemical use and water pollution, Thailand

The project commenced in January 2001 and finished in December 2005. This period included an extension from the original completion date of June 2003. The first phase of the project was implemented in two WVFT ADPs. During the second phase WVFT extended the training to another 10 ADPs in southern Thailand. The project impact area and potential beneficiaries were limited to the ADP farmers living in extreme poverty in these locations.

The primary impact was a change in vegetable management practices by a group of very low income farmers in the ADP areas of southern Thailand. At the completion of the project over 1,300 farmers were direct beneficiaries. These farmers were growing chemical-free vegetables, and many were using alternatives to commercially made chemical fertilisers and pesticides. The farmers had reduced their growing costs and increased production. Many had higher incomes from larger sales of surplus produce.

WVFT staff reported environmental gains in the quality of soil and water resources. Each ADP purchased equipment to test water and soil quality. The test results

were used to advise farmers on the fertiliser application rates that would minimise the run-off into watercourses. The project also achieved some social benefits. Reduced chemical contamination and residues in vegetables had health benefits for farmers and consumers.

Component 2: Low-chill temperate fruits, Thailand

The project commenced in April 2001 and finished in June 2006 following an extension from the original completion date of June 2003. The primary aim of the project extension was to trial new fruit tree management systems and focus extension advice on growing the fruits that showed the most promise. It was also used to:

- develop more extensive nursery training on fertiliser use and tree pruning
- assess the suitability of other temperate fruit crops in the local microclimate
- conduct more market research analysis on the viability of fruit sales.

The project impact was limited to a group of low-income farmers assessed to be in extreme poverty in the ADP area of Chiang Rai province. The primary outcome was the adoption of low-chill fruit growing as a farm enterprise by some of these farmers. Production lags in fruit growing and project difficulties affected the sustainability of adoption of the extension advice.

At the completion of the project there were 36 direct beneficiaries from the target of 200 farms. These farmers adopted new methods of orchard management that increased yields, improved ripening times and raised fruit quality. They passed on their knowledge to other interested farmers in the area. This was expected to increase the impact of the project through adoption by other farmers in the region. There was no assessment of the extent of this flow-on effect on project adoption levels.

The impact on farm income was difficult to assess as the fruit trees had not reached maturity when the project finished. Seedlings were not distributed until 2003 and there is a 3-year lag before the first fruit set. Initial indications suggested income gains of A\$500 per season from an orchard of 200 fruit trees. This was based on a conservative low-yield assumption of 7 kg of fruit per tree. A more accurate assessment would not be possible until several years after the completion of the project.

Component 3: Fish farming and low-cost fish feed, Thailand

The project commenced in April 2001 and finished in December 2006. This period included an extension from the original completion date of June 2003. There was a further investment by WVFT to support the extension activities until mid 2009. During this time the training was implemented in 14 ADP areas. The project impact area and potential beneficiaries were limited to the ADP farmers living in extreme poverty in these locations.

The primary outcome of the project was the adoption of fish raising as a supplementary farm enterprise by low-income farmers in the ADP areas of northern and central Thailand. By mid 2009 almost 1,000 farmers were direct beneficiaries of the project. Fish raising had proven to be a viable supplementary enterprise to rice farming as land requirements were minimal.

There were gains in food security, and many of the adopting farmers had higher incomes from sales of surplus fish. Initial assessments showed that a typical small-scale fish-raising enterprise was producing around 200 kg of fish per year. Between 75 and 125 kg were used for home consumption, with the remainder sold in the local community. After accounting for feed costs, the net value of the fish harvest was around A\$200.

WV staff reported environmental gains through improvements in the way water resources were used. Regular refreshment of the water used for fish raising provided an input for growing more vegetables. The project also achieved some social benefits. In some cases local communities work together to prepare low-cost fish feeds. The larger supply of fresh fish in local communities has also had health and nutritional benefits.

Component 4: Rodent control in rice crops, Vietnam

The project commenced in January 2001 and finished in April 2005. This included an extension from the initial completion date of December 2002. The project was initially implemented in selected areas of the ADP in Binh Thuan province. Application of the rodent control system was expanded to other communities in the ADP through the project extension. The project impact area and potential beneficiaries were limited to the ADP farmers living in extreme poverty in these communities.

The primary outcome of the project was reduced pre- and postharvest rice losses through adoption of a 'community trap-barrier system'. At the end of the project WV staff reported that there was a significant decline in the rodent population in the project impact areas. However, this outcome may have partially reflected the drought that existed at the time.

The project had an impact in selected lowland rice areas of five districts in the province, but there were no estimates of the number of beneficiaries or the size of the benefits for individual farmers. The impact on farm income is difficult to assess because there was no valuation of the rice yield gains from reducing rodent infestation. A rodent control tool kit was published in March 2005. WV Vietnam planned to implement the project in other ADPs, which would increase the benefits of the project.

Component 5: Improvement of soil fertility, Vietnam

The project commenced in January 2001 and finished in December 2007 following an extension from an initial completion date of December 2003. It was implemented in a specified area of the ADP in Binh Thuan and extended to increase the number of farmers that received training in soil management. The area of impact and potential beneficiaries were limited to farmers living in extreme poverty in this location.

The project focused on field trials to demonstrate the crop yield and financial benefits of changing fertiliser use for crops such as maize and peanuts growing in highly acidic soils. The primary outcome was the adoption of improved soil management techniques by a group of low-income farmers in the project impact area.

WV staff reported significant improvements in soil fertility and crop yields from the use of organic manure in place of traditional fertiliser use. There were no estimates of the total number of beneficiaries as the project relied on a small group of adopting farmers to pass on their knowledge to other farmers.

The adopting farmers benefited from higher incomes and improved food security through yield gains and lower production costs. There was some variability in the size of these gains and it was difficult to judge the overall economic benefits. The project generated environmental benefits in reduced land degradation, reduced crop residue contamination and improvements in the quality of groundwater resources.

Component 6: Improving rainfed rice yields, Lao PDR

The project commenced in January 2001 and finished in December 2007. This included two project extensions after the initial planned completion date of December 2003. During the three phases of the project, training activities were implemented in six districts of the ADP in Savannakhet province. The project impact area and potential beneficiaries were limited to farmers living in extreme poverty in these districts.

The primary outcome of the project was improved food security and higher farm incomes from higher yields for wet-season rice production. This was achieved by introducing new rice varieties, changing fertiliser applications and adjusting the planting density. Around 200 farmers participated in the initial project training during the first two phases of the project. In addition, around 200 farmers participated in training to increase output from dry season vegetable plots through improved soil fertility.

At the completion of the project there were more than 800 direct beneficiaries following the inclusion of other districts in the ADP. There were also some indirect beneficiaries in each phase of the project. Other farmers were able to learn from the experiences of the farmers that participated in the project.

A key element of the project was to facilitate the adoption of new rice varieties developed by the Lao National Rice Research Program. By the time the project ended, new rice seed varieties had been distributed to around 11,660 farmers in the six districts targeted by the project. Adopting farmers benefited from higher incomes and improved food security, primarily through higher yields of rice.

3 The Thai fish-farming project

An assessment of the impact of the ACIAR–WV collaborative program would require the preparation of individual impact assessments (IAs) for each of the six components. This would be a sizeable task and require data on:

- the extent of the project impact area and the number of participants
- project adoption rates
- the costs and returns of adopting the extension advice.

A review of ACIAR project reports on the six components found that there was insufficient information to estimate the individual net benefits of each component. It would require surveys to obtain estimates of the variables that determine the project impacts. The cost of this requirement made the preparation of an IA for each component infeasible.

An alternative approach of selecting some components for an IA was used to obtain an indication of the value of this type of R&D investment by ACIAR. As a first step the Thai fish-farming project was selected for assessment. The project was implemented in a large number of WV ADPs in northern and central Thailand. Other program components may be reviewed as separate exercises.

Freshwater fish farming in Thailand

Freshwater fish farming is widespread in Thailand, and freshwater fish are an important source of protein in the national diet, especially in areas outside the major cities. The demand for freshwater fish has been expanding

in response to population and income growth. In 2006 the total annual catch in Thailand was around 740 kilotonnes (kt) (Table 2).

Two of the most popular species of freshwater fish are Nile tilapia and catfish. These two species account for more than half the total catch and are widely used by commercial fisheries. In rural areas farmers raise fish as a supplementary enterprise to growing crops. A portion of the output is retained for household consumption and the residual is sold in local markets to provide an additional source of income.

Commercial aquaculture accounts for most of the freshwater fish catch. The wild catch was less than 30% in 2006 (Table 3). Most fish-raising enterprises use earth- or plastic-lined ponds. A small number of enterprises use floating cages in rivers and dams. Some fish are also raised in irrigated paddy fields.

In 2006 around 490,000 farmers engaged in freshwater fish farming (Table 4). There has been a strong shift towards pond-based aquaculture. Fish farming in paddy fields has declined as farmers adopted a more formal approach to production.

One of the constraints to expanding freshwater aquaculture has been the availability and cost of fish feed. Fishmeal or 'trash fish' is the main source of protein in commercial feed, but declining supplies and rising prices have made feed expensive and have curtailed industry growth rates. Low net returns have tended to discourage the use of commercial fish feed, with the result that fish have slower growth rates.

Farmers living in poverty or on low incomes are often reluctant to raise fish as a formal farm enterprise because of high feed costs and a risk of low survival rates of fingerlings. This has implications for their food security as well as the nutrition content of their diet.

Table 2. Annual freshwater fish catch in Thailand^a

	Catfish ^b		Nile tilapia		Other fish		Total
	'000 t	% share	'000 t	% share	'000 t	% share	'000 t
2000	110.1	23.3	122.4	25.9	240.0	50.8	472.5
2001	107.7	22.3	127.6	26.5	246.9	51.2	482.2
2002	111.0	22.5	120.9	24.5	261.3	53.0	493.2
2003	141.4	25.3	123.6	22.1	294.5	52.6	559.5
2004	199.8	27.5	203.1	27.9	324.5	44.6	727.4
2005	186.2	25.2	244.3	33.1	307.7	41.7	738.2
2006	184.8	24.9	228.5	30.8	328.1	44.3	741.4

Sources: DOF (2008a) and OAE (2008)

^a Includes aquaculture and wild catch^b Includes walking catfish and striped catfish**Table 3.** Thai freshwater aquaculture production^a

Production site	Catfish ^b		Nile tilapia		Other fish		Total	
	'000 t	% share	'000 t	% share	'000 t	% share	'000 t	% share
Ponds	166.8	98.7	171.9	83.7	126.7	82.7	465.3	88.2
Paddy fields	0.1	0.1	6.6	3.2	22.5	14.7	29.2	5.5
Ditches	1.0	0.6	1.4	0.7	2.3	1.5	4.8	0.9
Cages	1.1	0.6	25.5	12.4	1.6	1.0	28.1	5.3
Total	169.0	100.0	205.3	100.0	153.1	100.0	527.4	100.0
Wild catch	15.8	–	23.2	–	175.0	–	214.0	–
Total catch ^c	184.8	–	228.5	–	328.1	–	741.4	–

Source: DOF (2008a)

^a Based on production for 2006—data unavailable for subsequent years^b Includes walking catfish and striped catfish^c Includes total aquaculture and wild catch

Table 4. Freshwater fish farming in Thailand^a

	Ponds		Paddy fields		Ditches		Cages		Total ^b	
	'000 farms	change	'000 farms	change	'000 farms	change	'000 farms	change	'000 farms	change
2000	239.1	10.0	11.4	1.6	4.7	0.4	0.9	0.2	256.1	12.2
2001	252.7	13.6	11.0	-0.4	4.1	-0.6	0.8	-0.1	268.6	12.5
2002	265.0	12.3	10.9	-0.1	4.1	0.0	1.2	0.3	281.2	12.6
2003	316.0	51.0	12.0	1.1	3.6	-0.5	1.9	0.7	333.5	52.3
2004	407.1	91.2	9.2	-2.8	3.4	-0.2	3.3	1.4	423.1	89.5
2005	452.9	45.7	7.5	-1.7	3.6	0.2	5.0	1.6	468.9	45.8
2006	471.5	18.6	8.0	0.5	3.6	0.0	5.1	0.1	488.2	19.2

Sources: OAE (2008) and DOF (2008b)

^a Farm households with freshwater aquaculture

^b Includes aquaculture in ditches

A cost-effective replacement for fishmeal in feed rations, improved feeding strategies and better management of fish are seen to be the key factors in encouraging low-income farmers to establish a fish-raising enterprise.

Extension activities in the fish-farming project

The aim the project was to develop the capacity of poor farmers in selected targeted communities to establish and maintain a freshwater fish enterprise. The project involved a combination of participatory research and extension training activities. Demonstration sites were established and selected farmers participated in formal training activities on the technical requirements of fish farming.

In the first phase of the project groups of farmers in two WVFT work areas in North-East Thailand were selected to participate in the project. They were located in:

- the Muang Udon district community group in Udon Thani province
- the Prasart district ADP in Surin province.

Two community-learning centres were established to facilitate the research and extension training. The project provided funds for building training facilities, equipment to produce fish feed, demonstration cages

and ponds for raising fish, fingerling hatching facilities and purchasing enterprise inputs. The learning centres were located at:

- Koksard subdistrict Centre for Promotion of Sustainable Economy in the Prasart district ADP
- Ban Hnongwah Vocational Training Centre in the Muang Udon district.

One of the major project activities was the development of a low-cost fish feed as an alternative to commercial feed rations. This involved the practical application of results from an ACIAR technical research project on alternative feed rations based on locally available inputs. Alternative formulas with different levels of protein content were tested. They used materials such as rice bran, maize bran and powdered fish.

Participating farmers became members of training centres and collectively worked to prepare a low-cost fish feed once the appropriate formula was identified. The aim was to promote community self-reliance in producing feed and fingerlings. Formal cooperative arrangements were established to facilitate collective production of enterprise inputs that were purchased by the members.

- *By the end of the project the community groups had become focused on producing the low-cost fish feed—there were difficulties with hatching fingerlings and this activity was discontinued.*

- *Community cooperative activities also involved producing processed fish products that provided an option for the use of surplus output.*

WVFT staff at the training centres directed the participatory research on developing the fish feed. Feed quality problems such as protein levels and floating properties were evident in the early stages of the project. These problems were solved and the feed ration was reported to be A\$0.12–A\$0.20/kg cheaper than commercial feed.

In the early stages of the project WVFT obtained advice from both local staff and a fish nutrition expert of the Thai Department of Fisheries. Advice covered various aspects of fish farming including production of feed rations and fingerlings. Australian collaborators in the related ACIAR technical project made some site visits and provided advice on how to resolve problems encountered by the community groups.

Extension activities provided training for two types of fish-raising enterprises. Training in pond-based aquaculture included the use of plastic-lined ponds for farmers with limited land (i.e. less than 1 ha) and larger dirt ponds for those with more land area. Training was also provided in cage-based aquaculture. It focused mainly on the ‘floating basket’ approach but also covered fish raising in cement pipes or large plant pots.

Farmers that participated in the first phase of the project were encouraged to establish a fish-raising enterprise once the feed ration formula was finalised. They received financial support for establishment costs and were provided with fingerlings and fish feed for their initial attempt. The beneficiaries received further training and shared their experiences with other farmers as they managed their own enterprise.

- *Funding for the project commenced in 2000–01 but the first output from farmer application of the WVFT training did not occur until 2002–03.*

The use of the low-cost fish feed was not the basis for judging the impact of the project. As the extension activities covered all aspects of fish raising, the impact was dependent on the number of farmers establishing and maintaining a fish-raising enterprise.

- *Most project participants had no experience in formal fish-farming techniques but some raised small numbers of fish in their rice paddies.*

- *The use of feed rations in these informal fish-raising activities was minimal.*

Participants in phase one of the project were the direct beneficiaries of the extension activities. It was expected that other farmers would observe the outcomes and experiences of the direct participants and adopt the training advice. Over time this could expand the impact of the project in the ADP target areas.

Adopting farmers benefited from improved food security and higher farm income. This was the primary impact of the project—fish produced for home consumption and commercial sales. The economic benefits of the project can therefore be assessed by the number of adopters and the net returns from raising fish.

An extra benefit may come from higher fish consumption improving the nutritional content of the family diet. Measuring the human health benefit is beyond the scope of this study. Higher vegetable production on the edges of ponds also occurred in some cases but there was no suitable basis to value this benefit. As the gain is likely to be small and was not a widespread feature of project outcomes, it was not included in the analysis.

The project was extended from the scheduled completion date of June 2003. This was to allow further monitoring and extension work in the phase one project impact area. It was also to facilitate WVFT plans to implement the project in other ADPs of northern and central Thailand. The aim was to apply the lessons learned in phase one to accelerate the adoption of best-practice fish raising in other areas of rural poverty.

In phase two of the project ACIAR funding in Udon and Surin continued until June 2006. Extension activities in another 14 ADP areas used WVFT funds. This funding continued until the end of 2008–09.

- *The times at which the project was implemented in the additional 14 ADP areas varied.*
- *In most cases the first output from farmer application of WVFT training in these areas occurred in 2005–06.*

Project participants and area of impact

WVFT is an NGO that helps poor and underprivileged people. Assistance activities are directed through a system of ADPs that are established in areas where there is a high incidence of poverty. Each ADP is composed of a number of villages within a specified district of the province.

People living in villages within the boundaries of an ADP are assessed for membership of the ADP. Low-income farmers with little accumulated wealth can join and participate in the program. High-income, wealthy farmers are excluded.

ADP members are ranked into three groups according to their financial situation. The poorest of the poor is the lowest ranked group. These people are often the primary focus of development projects such as establishing a fish-farming capability.

WVFT operates ADPs in 50 provinces. Sixteen of them were selected to participate in the second phase of the project. This was based on the level of interest expressed by ADP community leaders and the views of WVFT management. The location of the 16 ADPs that participated in the project defines the area of potential impact.

There were 638 villages with about 100,000 farmers in the areas covered by the 16 ADPs (Table 5). This is not the number of potential adopters as it includes both wealthy and poor farmers. The maximum number of potential adopters is the ADP membership, which is approximately 31,400 farmers—just over 30% of the total farming population.

Direct participation in the fish-farming project was not extended to all ADP members. It was targeted at the lowest ranked group—ADP farmers living in extreme poverty. WVFT confirmed the targeting objectives, which restricted the potential number of project beneficiaries.

A selected number of these farmers were invited to participate. It was expected that other ADP members living in extreme poverty would learn from their experiences. In time, other less needy ADP members could also establish a fish-raising enterprise and the project impact could expand.

The impact assessment has assumed there was no adoption effect on non-ADP members. WVFT had no expectations of a project impact on non-ADP farmers. High- and middle-income farmers do not face the same food security concerns and some already operated a fish-raising enterprise. To the extent that there is a flow-on adoption effect outside the ADP membership, the net benefits of the project would be higher.

Project expenditure

Initially the project was jointly funded by ACIAR and WV over the 2000–01 to 2005–06 period. The combined investment over that period was A\$388,000, with ACIAR contributing around 70% (Table 6). WVFT managed the project budget including distributions to third parties.

Since then WVFT has invested a further A\$1.7 million over a 3-year period to continue supporting the implementation of the project in an additional 14 ADPs. The allocation of this expenditure between different ADPs is summarised in Appendix 1. Total project expenditure was close to A\$2.1 million.

- *The large supplementary expenditure by WVFT means that the ACIAR share of the total project cost was just 13%.*

The cost of advisory contributions from project partners was covered by WVFT. This includes time and travel expenses for the small number of site visits made by Australian collaborators in the ACIAR technical project. The contributions of local officials from the Thai Department of Fisheries were limited and the cost was considered part of their routine extension work.

Table 5. Impact area for the Thai fish-farming project^a

Province	District	Size of ADP		Project target areas		
		Villages	Farms ^b	Villages	Farms ^c	
		no.	no.	no.	no.	%
Upper North-East region						
Udon Thani	Muang Udon ^d	3	810	3	810	100.0
	Kudjab	41	4,507	35	3,995	88.6
	Srang Khom	53	7,213	27	5,243	72.7
Lower North-East region						
Surin	Prasart ^d	32	3,276	32	3,276	100.0
Si Sa Ket	Praiburng	51	6,536	5	559	8.6
Khon Kaen	Wang Yai	4	450	1	66	14.7
	Ubonrat	28	2,579	28	2,579	100.0
	Muang Phon	31	3,688	15	1,545	41.9
Buri Ram	Bankroud	54	2,709	16	1,808	66.7
Northern region						
Chiang Rai	Chiang Khong	15	2,552	3	277	10.9
	Khun Tan	126	21,267	5	865	4.1
Lampang	Jae Hom	64	13,407	35	7,753	57.8
Phare	Denchai	52	9,898	6	853	8.6
Central Plain region						
Chon Buri	Panatnikhom	20	2,540	4	454	17.9
Kanchanaburi	Sangklaburi	14	7,994	4	1,172	14.7
Chanthaburi	Kaeng Hang Maew	50	10,249	1	130	1.3
Total		638	99,675	220	31,385	31.5

Source: WVFT

^a Impact area confined to selected villages in ADP districts^b Total farm households in the districts serviced by the ADPs—includes wealthy and poor farmers^c Total farm households in the villages targeted for project training—includes wealthy and poor farmers^d Primary impact areas in phase one of the project

Table 6. Expenditure on the Thai fish-farming project^a

	ACIAR	World Vision		Total costs	
	Contribution	Initial contribution	Supplementary expenditure	Nominal values	Real values
	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000
2000–01	39.2	27.6	–	66.8	86.7
2001–02	78.7	59.8	–	138.5	169.6
2002–03	39.5	32.3	–	71.7	85.2
2003–04	22.2	–	–	22.2	25.7
2004–05	52.1	–	–	52.1	59.0
2005–06	36.6	–	–	36.6	40.2
2006–07	–	–	593.2	593.2	632.7
2007–08	–	–	663.1	663.1	684.1
2008–09	–	–	446.0	446.0	446.0
Total	268.3	119.7	1,702.3	2,090.3	–

Sources: WVFT and ACIAR

^a Expressed in current (2008–09) dollars

4 Impact of the Thai fish-farming project

To assess the impact of the project, two in-country visits were made to gain a first-hand perspective of the project impact and farm-level adoption. Consultations with project staff and farmers were undertaken in a selection of districts. The consultations included visits to the primary project areas in Udon Thani province (Muang Udon district community group) and Surin province (Prasart district ADP). A list of the people who participated in the impact assessment consultations is provided in Appendix 2.

Survey of project beneficiaries

The impact of the Thai fish-farming project is the economic returns that accrue to farmers who adopt the extension advice. They can be estimated by the net returns from establishing a fish-raising enterprise and the number of adopters in the project impact areas. Regional differences in the impact were expected as the ADPs that participated in the project were widely dispersed across northern and central Thailand.

Farmers adopting the extension advice did not establish a fish-farming enterprise with uniform characteristics. There were differences in the production technology (e.g. cages, ponds, cement pipes), scale, fish breeds, fish survival rates, use of feed rations, fish-feeding rates and average catch weight. As a result, there was likely to be some variation in the output levels achieved by individual farmers.

Regional differences in the price of fingerlings, the price of feed rations and local market prices of fish were also

expected. This would mean that estimates of the net returns would vary across the project impact areas. A further issue in estimating the project impact was the use of low-cost fish feed. It was apparent from the in-country visits that some farmers were partial users while others were using only commercial fish feeds.

There was insufficient and inconsistent information in the project documentation on many of these factors. Obtaining the relevant information from all project adopters was not feasible. WVFT records indicated that 2,821 project participants had established a fish-farming enterprise.

- *Some 1,151 farmers commenced fish raising in the primary project impact areas of Muang Udon and the Prasart district ADP from 2002–03.*
- *A further 1,670 farmers established an enterprise in the 14 ADPs that participated in the second phase of the project from 2005–06.*

To obtain estimates of the project impact, a sample survey of adopting farmers in selected ADP districts was conducted. A questionnaire was developed to establish the dimensions and outcomes of their fish-farming enterprises. It provided a current (i.e. 2008–09) perspective on enterprise net returns.

A pilot questionnaire was tested during the project consultation visits. Local WVFT staff in the ADPs collected the survey information during September–October 2009. The sample of farm households was randomly selected by WVFT staff and was drawn from selected villages in the ADP areas. The sample covered a selection of ADP districts to provide a regional spread of the variability in project impacts.

To minimise the risk of bias in the survey results, WVFT staff were required to divide the sample among a spread of farmers of different abilities. The survey was limited to selected ADP areas to limit the cost of the exercise. Based on WVFT records of initial adopters, the selected sample was:

- 20 farmers in each of the upper North-East ADP districts of Muang Udon, Kudjab and Srang Khom
- 20 farmers in each of the lower North-East ADP districts of Prasart, Ubonrat and Praiburng
- 20 farmers in each of the northern ADP districts of Khun Tan and Jae Hom.

Adopting farmers who participated in the survey were those who had been involved at the start of the project and who continued to operate a fish-raising enterprise in 2009. These farmers are referred to as ‘adopters.’ It was evident from the in-country visits that some project participants had decided not to establish an enterprise or had ceased production.

There was some value in understanding why potential adopters were not operating an enterprise. A separate questionnaire was developed and the survey included the following sample of ‘non-adopters’ in the same locations:

- 10 farmers in each of the upper North-East ADP districts of Muang Udon, Kudjab and Srang Khom
- 10 farmers in each of the lower North-East ADP districts of Prasart and Ubonrat and 7 farmers in Praiburng
- 10 farmers in each of the northern ADP districts of Khun Tan and Jae Hom.

According to WVFT records there were 2,821 adopting farmers in the 16 ADP areas at the start of the project. The total sample size of 237 was about 8% of the initial direct beneficiaries of the project. This was sufficient to obtain a representative indication of the project impacts.

Survey results for key variables are summarised in Appendix 3. They show the average outcomes for the sample in each of the surveyed districts. The district results were used to calculate an average regional response. The results confirmed that enterprise outcomes varied among the project adopters.

- Average farm size across the districts ranged from less than 1 ha to 3.5 ha.
- Average annual farm income ranged from less than A\$1,000 to A\$3,390.

There are several noteworthy features of the survey results for project adopters. From the perspective of technical characteristics the results showed that:

- most farmers established a pond-based production system—some respondents were operating more than one type of production system
- some farmers operated a seasonal production system while others introduced more fingerlings during the year as mature fish were harvested
- in some districts catfish was the dominant species and in others both tilapia and catfish were being raised
- almost all farmers were using commercial fish feed and there was a degree of uncertainty about the protein level of the feed
- in most districts there were few farmers using low-cost fish feed purchased from one of the learning centres—Prasart district was an exception
- most farmers used other materials to supplement the use of feed rations
- in several districts many farmers obtained advice on fish farming from sources other than the project training.

From a financial perspective the results confirmed significant regional differences for input costs and prices. They also showed the variability in the physical aspects of the fish-farming enterprises that were established. The following were some of the key findings:

- There was considerable variation in the average number of fingerlings released and some variability in the cost of fingerlings.
- Fingerling survival rates were above 80% in most cases.
- The annual amount of fish feed used and average fish-feeding rates were highly variable, the latter ranging from less than 0.07 kg/fish in Prasart and Srang Khom districts to more than 0.2 kg/fish in Khun Tan district.

- The cost of fish feed varied from 19 baht/kg to almost 24 baht/kg.
- There was a large variation in annual production per farm, which ranged from 423 kg/farm in Muang Udon district to 77 kg/farm in Jae Hom district.
- Most farm households retained a large amount of fish for home use.
- Local market prices for catfish and tilapia varied between regions, ranging from 67 baht/kg for tilapia in Muang Udon district to 40 baht/kg in Srang Khom district.
- There were some differences in enterprise establishment costs between districts.

Survey results for the non-adopters revealed a variety of reasons why project participants had established an enterprise but then ceased production. Key findings included that:

- around two-thirds of the survey respondents cited a lack of money to purchase fingerlings and fish feed as the reason for non-adoption
- more than half cited a lack of time to manage the enterprise even although fish farming is not a labour-intensive enterprise
- lack of interest in project training was not a significant factor in non-adoption.

Project adoption

WVFT maintains an office in each ADP and local staff have a good knowledge of the farming activities of the members. Before the survey work commenced, ADP staff in each district compiled a list of members who participated in the project and were still actively involved in fish farming (Table 7).

- *In 2008–09 there were 977 active project adopters, which is substantially fewer than the 2,281 farms that initially applied the training.*

Project participants currently operating a fish-farming enterprise are a measure of the current level of adoption. The change since the initial application of the training

reflects the change in adoption levels. It was expected that more ADP farmers would establish an enterprise based on the experiences of others. This has not occurred.

The rate of adoption by potential beneficiaries is a key variable in estimating the impact of a project. Impact assessments often assume a rise in adoption rates over time as people observe the outcomes of early adopters and learn from their experiences. In this case there are data on the initial adoption level and the adoption level in 2008–09. These data were used to develop annual adoption levels for the intervening period.

The approach used to assess the project impact is to estimate the average net returns of the fish-farming enterprises in the ADP districts that participated. Annual changes in the number of adopters determine the aggregate effect each year for the 30-year impact assessment period. Estimates were prepared for five areas of impact:

- the Muang Udon district
- other ADP districts in the upper North-East region
- the Prasart ADP district
- other ADP districts in the lower North-East region
- all ADP districts in the northern and central regions.

This approach was taken to allow for regional differences in the characteristics of the fish-farming enterprises and because it yields more information than an aggregated result for Thailand. It also allowed for differences in input and output prices and adoption levels.

The decline in adoption is evident in all but one of the ADP districts. The difference between initial adopters and the current number of farmers was used for assumptions on annual adoption levels before 2008–09. The net loss was evenly distributed over a 3-year period following the initial adoption year, and then remained static until 2008–09.

For the period after 2008–09 it was assumed that there would be a small rise in the number of adopters over a 5-year period from 2010–11. This was based on discussions during the in-country consultations and views expressed by village leaders during site visits. WVFT has been aware of the decline in fish farming and is looking at ways for local ADP staff to encourage more interest and adoption among the members.

Table 7. Application of Thai fish-farming training

Province	Districts	Farms in target area ^a	Initial adoption of project training ^b		Current adoption of project training ^c	
		no.	no.	%	no.	%
Upper North-East region						
Udon Thani	Muang Udon	810	415	51.2	85	10.5
	Kudjab	3,995	380	9.5	76	1.9
	Srang Khom	5,243	216	4.1	43	0.8
Lower North-East region						
Surin	Prasart	3,276	736	22.5	210	6.4
Si Sa Ket	Praiburg	559	181	32.4	146	26.1
Khon Kaen	Wang Yai	66	42	63.6	25	37.9
	Ubonrat	2,579	433	16.8	200	7.8
	Muang Phon	1,545	121	7.8	7	0.5
Buri Ram	Bankroud	1,808	30	1.7	53	2.9
Northern region						
Chiang Rai	Chiang Khong	277	10	3.6	1	0.4
	Khun Tan	865	40	4.6	21	2.4
Lampang	Jae Hom	7,753	125	1.6	94	1.2
Phare	Denchai	853	25	2.9	1	0.1
Central Plain region						
Chon Buri	Panatnikhom	454	7	1.5	1	0.2
Kanchanaburi	Sangklaburi	1,172	40	3.4	3	0.3
Chanthaburi	Kaeng Hang Maew	130	20	15.4	11	8.5
Total		31,385	2,821	9.0	977	3.1

Source: WVFT

^a Total farm households—includes wealthy and poor farmers

^b Farms participating in the initial training and applying it to a fish-feeding enterprise. Numbers reflect initial adoption rate by households defined as 'poor' in project target areas—wealthy farmers were excluded from the WV project.

^c Households continuing to operate a fish-feeding enterprise in September 2009 as a result of WV training

The current adopting farmers have had several years' experience. They have developed a track record of success in raising fish for home consumption and local sales. It seems likely this will generate some renewed interest among other ADP members.

Taking a conservative approach, it was assumed that the total increase in adoption would be equivalent to a quarter of the number of farms that ceased fish raising before 2008–09. The increase was evenly distributed over the period to 2014–15. Assumptions for each of the five areas of impact are summarised in Appendix 4.

Estimates of project impact

To estimate the project impact, average net returns for fish-farming enterprises for the five areas of impact were calculated from the survey results. An average of survey responses for the key variables provided an indicative perspective of current (2008–09) enterprise performance. It was assumed that this reflected typical outcomes for adopting farmers in the areas of impact.

- *Enterprise performance for Muang Udon and Prasart districts was calculated individually—more time had passed since initial application of the training.*
- *Calculations for other upper North-East districts were based on the average for the three survey areas—Muang Udon, Kudjab and Srang Khom.*
- *Calculations for other lower North-East districts were based on the average for the three survey areas—Prasart, Ubonrat and Praiburng.*
- *Calculations for other upper northern and central districts were based on the average for the two survey areas—Khun Tan and Jae Hom.*

Key variables for calculating annual enterprise financial performance included:

- the quantity of fish harvested
- the amount of commercial feed used
- the number of fingerlings released and their survival rate
- enterprise establishment costs
- the local market prices for catfish and tilapia
- the per-unit costs of fish feed and fingerlings.

Estimates of these variables were used to calculate the gross value of the fish catch and production costs. The average net return is a measure of the current gain from having established an enterprise based on the project training. The number of adopters was used to calculate an aggregate 2008–09 effect for the five areas of impact.

Some additional assumptions were required to estimate the project impact. For the years before 2008–09 the physical performance was assumed to be unchanged.

No other information was available and it was not feasible for the survey to collect historical data from the respondents.

Discussions with farmers suggested that most had an enterprise of a similar size to that in their initial production year. Adopters from phase two of the project have not been operating for long and current outcomes probably reflect historical outcomes. In Prasart and Muang Udon some farmers may have increased their output while others may have reduced their production.

- *Estimates of the project impact in these two districts may be marginally under- (over-) estimated if there has been a trend of increased (reduced) production over the historical period.*

Price and cost outcomes during the historical period would have varied over time and between regions. Official price data show significant regional differences in the prices of the two fish species predominantly used by project adopters (Table 8). The survey results provided snapshot indicators of 2008–09 local market prices. These prices were indexed to time-series data for representative indicator prices over the historical period.

Representative prices for catfish and tilapia in the North-East and northern regions were provided by the Office of Agricultural Economics of the Ministry of Agriculture and Cooperatives. The data were obtained during the IA consultation visits. Details of the price indexes are provided in Appendix 4.

A representative price series for feed rations was not available for indexing the survey results on feed costs. It was assumed that the average feed ration prices recorded for each of the impact areas applied in the historical period. Similarly, the cost of fingerlings reported in the survey was assumed to apply in the historical period.

All output prices and input costs were assumed to remain unchanged in future years. Almost all physical performance enterprise variables were also assumed to remain unchanged. The one exception was the inclusion of a modest growth factor for the fish harvest.

Some growth in the average enterprise output can be expected over time as farmers gain more confidence in fish farming. But the capacity to expand will vary, especially among very poor farmers. During the in-country visits it was apparent that some farmers

Table 8. Freshwater fish prices in selected Thai provinces^a

	Walking catfish	Striped catfish	Nile tilapia
	baht/kg	baht/kg	baht/kg
North-East region			
Udon Thani	42.2	29.6	38.9
Surin	36.5	32.9	32.8
Si Sa Ket	34.8	28.8	41.1
Khon Kaen	38.0	–	36.2
Buri Ram	40.9	41.0	41.1
Northern region			
Chiang Rai	34.7	30.2	31.0
Lampang	38.7	34.8	40.9
Phare	36.5	30.0	38.7
Central Plain region			
Chon Buri	30.0	25.5	26.0
Kanchanaburi	31.4	25.0	37.7
Chanthaburi	38.3	30.0	34.6
Thailand	32.2	22.0	31.7

Source: DOF (2008a)

^a Average prices for 2006—data unavailable for subsequent years

face land constraints that prevent them establishing more ponds. It was also evident that some farmers were focused on food security and satisfied with what they had achieved. However, some indicated that they were planning or intending to expand their enterprise.

For some farmers expansion would involve increasing the number of fingerlings released; for others it would mean activating spare infrastructure (i.e. ponds, cages, concrete pipes) or expanding capacity. To account for some growth the average fish harvest was assumed to rise by 5% per year over a 5-year period from 2010–11.

Costs were adjusted to reflect the output expansion. The fingerling release numbers and feed use were increased. The increase in costs was calibrated to reflect the feeding rate and fingerling survival rate in the 2008–09 survey results. An adjustment for enterprise establishment costs was included, based on the cost per unit of output in the survey results.

Details of the estimates of the project impact for the five impact areas are provided in Appendix 5. Summary results for the aggregate impact are provided in Table 9.

The estimates show a positive net return in all five impact areas. In nominal terms the annual impact of the project reached a steady state of A\$714,000 in 2015–16. The impact was strongest in the lower North-East region, with an impact of more than A\$438,000—about 61% of the total effect.

The impacts in districts that were the focus of phase one of the project were significant despite a sizeable fall in adoption levels since 2002–03. The combined steady-state impact for the Muang Udon and Prasart districts was around A\$301,000. In 2008–09 these two districts had 295 active producers, accounting for about 30% of the total project adoption level (see Table 7).

The steady-state project impact in the northern and central districts is relatively small (A\$32,000). Initial adoption levels were relatively low in this region and

Table 9. Impact of the Thai fish-farming project^a

	Upper North-East		Lower North-East		Northern and central districts	Total impact
	Muang Udon district	Other districts	Prasart district	Other districts		
	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000
2002–03	87	–	74	–	–	161
2003–04	68	–	98	–	–	166
2004–05	59	–	83	–	–	142
2005–06	33	126	56	129	13	356
2006–07	37	116	62	199	22	436
2007–08	36	71	60	157	15	339
2008–09	52	44	83	172	20	372
2009–10	52	44	83	172	20	372
2010–11	65	55	94	184	21	419
2011–12	79	67	109	201	24	480
2012–13	94	81	126	220	26	547
2013–14	110	96	145	240	28	619
2014–15	128	112	164	260	31	696
2015–16	130	114	171	267	32	714
2017–2030	130	114	171	267	32	714

^a Expressed in nominal terms—see Appendixes 4 and 5 for exchange rate and project impact assumptions

there has been a substantial fall in adoption since 2005–06. According to WVFT records there were just 132 adopters in this region by 2008–09.

These results provide an estimate of the project impact. Implicitly they assume that the survey results of enterprise performance are indicative of all the adopters in each of the impact areas. In general there is a reasonable level of consistency among the survey results for the key variables that determine the value of the impact (see Appendix 3). Therefore, the relative size of the regional effects seem plausible.

The only substantial difference is the small size of the average fish harvest in Jae Hom district. Average farm output in this district was 77 kg/year compared with 268 kg/year in the other districts. This survey outcome reduces the size of the impact in the northern and central districts.

The result may simply reflect a smaller scale enterprise in the district, but it should be noted that only two districts were surveyed to establish the enterprise performance for this region. An additional survey district may have raised the fish-harvest assumption although this is unlikely to materially change the aggregate project impact.

- *Current adoption levels in the northern and central districts account for just 14% of the total number of project adopters.*

5 Net benefits of the Thai fish-farming project

The impact of the project based on the net returns of establishing a fish-farming enterprise is one element of calculating the project benefits. The estimated impact needs to be compared against a ‘no impact’ base case to estimate the project benefits.

Some project participants had previous experience with fish raising. This was confirmed by the survey results. In most cases this involved a less-formal approach with limited use of feed rations for small numbers of fish in rice paddies. A base case for each of the five project areas was developed from the survey results.

A ‘no impact’ base case

In estimating the project benefits there are two considerations worth noting. The first is that the impact of the project is unlikely to have any influence on market outcomes. The total output effect of the project is small and aquaculture is a large industry (Table 10).

In 2006 Thailand’s aquaculture output was 527 kt. The additional output generated by project adoption was approximately 0.5 kt in 2005–06. This estimate is based on the average per-farm fish harvest for each of the impact areas and the adoption level at that time. Even at a regional level there is unlikely to be a significant impact on local market prices for fish.

- *District-level impacts of the increased output are very small because of the small number of adopters and the small scale of the fish enterprises.*

A second consideration is the consumption impact. The survey results confirmed that much of the output of the fish-farming enterprises is retained for home use. Only small quantities are sold locally. This further diminishes the likelihood of any market impact.

Enterprise outputs have substantial food security and nutritional benefits for adopting households. Output retained for home use is largely additional consumption. Adopting households are able to consume more fish that would not have been purchased if the project had not been implemented. As the target population was very poor farmers, the amount of fish purchased in the absence of the project would have been minimal.

- *In estimating the project impacts, all output was valued at the local market price.*
- *Fish consumed at home would have a value equivalent to the market price.*

The ‘no impact’ base case involved valuations of the net returns from a less-formal approach to fish farming before the project training was implemented. It was assumed that this approach would have continued in the absence of the project.

The sample survey included questions to gain an indication of the fish output, fingerling release and feed use in the year before the formal fish-farming enterprise was established. It provided an indication of the average net returns that was then used to calculate a measure of the base case for the five areas of impact.

Details of the estimates of the project base case for the five impact areas are provided in Appendix 5. Summary results for the aggregate base case are provided in

Table 10. Provincial freshwater aquaculture in Thailand^a

	Farm households		Aquaculture production ^b	Average farm output
	with aquaculture	no aquaculture		
	'000 farms	'000 farms	'000 t	kg/farm
North-East region				
Udon Thani	14.0	154.2	8.4	597.9
Surin	17.5	170.4	2.9	165.4
Si Sa Ket	9.2	191.6	2.4	257.1
Khon Kaen	40.1	165.0	11.8	293.1
Buri Ram	12.6	159.6	1.8	140.1
Northern region				
Chiang Rai	19.7	129.0	24.2	1,228.5
Lampang	11.9	84.6	3.6	300.8
Phare	5.0	67.5	0.8	160.3
Central Plain region				
Chon Buri	1.4	34.1	5.0	3,471.0
Kanchanaburi	5.6	56.9	6.8	1,217.5
Chanthaburi	0.6	57.0	0.3	541.2
Thailand	488.2	5 307.4	527.4	1,080.4

Source: DOF (2008b)

^a Based on survey data for 2006—data unavailable for subsequent years^b Excludes other wild catch—production from fish farms only**Table 11.** The estimates used the same fish price and feed cost assumptions for measuring the project impacts.

Average survey results were used for key variables on the physical characteristics of the informal fish-raising activities. In some cases the adopting farmers had no previous experience with fish farming. The averaging effect implicitly accounts for the fact that some adopters gained the full benefit of the impact while others benefited from an improvement in their fish-raising outcomes. These survey variables included:

- the quantity of fish harvested
- the amount of commercial feed used
- the number of fingerlings released.

Project benefits

The project benefits are calculated by comparing the estimated impacts to the base case valuations. The annual benefits reached a steady state in 2015–16 with an annual gain of A\$591,000 (Table 12). Benefits will continue to arise beyond this period. Therefore an annuity for the benefits that accrue in perpetuity after 2016–17 needs to be incorporated in the estimate. This is a requirement of the impact assessment guidelines (ACIAR 2008).

The results show an aggregate non-discounted benefit of around A\$17.1 million. Benefits were highest in the lower North-East region, with a gain of A\$10.6 million—almost two-thirds of the total benefit.

Table 11. Base case for the Thai fish-farming project impact assessment^a

	Upper North-East		Lower North-East		Northern and central districts	Total base case
	Muang Udon district	Other districts	Prasart district	Other districts		
	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000
2002–03	35	–	41	–	–	76
2003–04	21	–	25	–	–	47
2004–05	17	–	21	–	–	38
2005–06	9	34	14	38	4	99
2006–07	10	27	16	36	4	93
2007–08	9	17	16	28	3	73
2008–09	13	10	22	32	3	80
2009–10	13	10	22	32	3	80
2010–11	15	12	24	34	3	89
2011–12	18	14	27	35	3	97
2012–13	20	16	30	37	4	106
2013–14	22	18	32	38	4	115
2014–15	25	20	35	39	4	123
2015–16	25	20	35	39	4	123
2017–2030	25	20	35	39	4	123

^a Base case expressed in nominal terms—see Appendix 4 for exchange rate assumptions. Values reflect a ‘no impact’ base case using assumptions based on WVFT survey results. Survey respondents provided fish-farming outcomes for the year before the initial application of WVFT training.

Benefits in the districts that were the focus of phase one of the project were significant despite the fall in adoption levels. The combined impact for the Muang Udon and Prasart districts was almost A\$7.0 million—about 41% of the total benefits. Benefits are small in the northern and central regions (A\$0.8 million) because of low adoption levels.

Net benefits of the project

The net benefits of the project are calculated by comparing project expenditure with the estimated benefits. The present value of the net benefits is A\$6.9 million (Table 13). This estimate assumes a discount rate of 5%.

- This yields a benefit:cost ratio of 5.1:1.
- The results for alternative discount rates show the present value of the net benefits varying between A\$2.0 million and A\$53.0 million.

Attribution of the estimated net benefits should be divided between ACIAR and WVFT. Based on the respective shares of the total project expenditure, this would attribute around 12.8% of the benefit to ACIAR. Therefore, the respective return on investment for each organisation would be:

- a net benefit of A\$0.9 million to ACIAR
- a net benefit of A\$6.0 million to WVFT.

Table 12. Benefits of the Thai fish-farming project^a

	Upper North-East		Lower North-East		Northern and central districts	Total benefits
	Muang Udon district	Other districts	Prasart district	Other districts		
	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000	A\$'000
2002–03	61	–	40	–	–	101
2003–04	54	–	85	–	–	139
2004–05	49	–	70	–	–	118
2005–06	27	101	45	99	10	282
2006–07	29	94	49	174	19	366
2007–08	28	56	46	133	13	275
2008–09	40	34	61	140	17	292
2009–10	40	34	61	140	17	292
2010–11	49	43	70	150	18	330
2011–12	61	53	82	166	20	383
2012–13	74	65	97	183	22	441
2013–14	88	78	112	201	25	504
2014–15	103	92	129	221	27	573
2015–16 ^b	105	94	136	228	28	591
Total	3,017	2,716	3,938	6,619	807	17,097

^a Non-discounted benefits expressed in 2008–09 dollars—see Appendix 4 for exchange rate and price deflator assumptions

^b Values are a 2016–17 present value of an annuity for the benefits accrued in perpetuity after 2015–16.

The results of the evaluation are sensitive to assumptions on future adoption levels and growth in average farm output. A progressive evaluation for the gains achieved to date is of interest for this reason. It shows the net value of the project to be a loss of A\$0.5 million. This reflects 9 years of the evaluation period up to 2008–09.

The sensitivity of the estimated net benefits to assumptions for future adoption levels is worth examining. A ‘worst case’ scenario is that adoption rates do not change from current levels. Project benefits and the base case were re-estimated under this assumption.

The results of the sensitivity analysis show the present value of the net benefits to be A\$4.6 million. This reflects a fall in the project benefits to A\$6.3 million. Therefore, even if there is no further adoption of the project training, the project will still yield a positive net benefit.

Table 13. Net benefits of the Thai fish-farming project^a

		PV of project costs	PV of project benefits	PV of project net benefits
Project evaluation—5% discount rate ^b	A\$m	1.7	8.6	6.9
Benefit:cost ratio		–	–	5.1
Project evaluation—10% discount rate ^b	A\$m	1.3	3.3	2.0
Benefit:cost ratio		–	–	2.5
Project evaluation—1% discount rate ^b	A\$m	2.1	55.1	53.0
Benefit:cost ratio		–	–	26.2
Progressive project evaluation ^c	A\$m	1.7	1.2	–0.5
Benefit:cost ratio		–	–	0.7

^a Discounted present value (PV) of project costs, benefits and net benefits expressed in 2008–09 dollars

^b The evaluation includes annual outcomes for the 2000–01 to 2015–16 period plus an annuity for the benefits arising in perpetuity after 2015–16.

^c Progressive evaluation for the period from 2000–01 to 2008–09 using a 5% discount rate

6 Concluding comments

The farmer members of the WVFT ADPs are some of the poorest members of village communities. They can join the ADPs if they meet certain assessment criteria. ADP members are not allowed to participate in other NGO aid programs. In general they have limited land areas, very low incomes and food security is a significant issue for them.

The survey results showed that the adopting farmers had an average land area of:

- 2.1 ha in the upper North-East districts
- 2.7 ha in the lower North-East districts
- 0.9 ha in the northern and central districts.

The average annual net household income of survey respondents was:

- A\$2,563 in the upper North-East districts
- A\$2,212 in the lower North-East districts
- A\$1,259 in the northern and central districts.

Impact on poverty and food security

The project has had significant poverty alleviation and food security benefits for the adopting farm households. Income gains vary according to the amount of fish retained for home use. The following survey results provide an indication of the income gains in 2008–09.

- *In Muang Udon about 5% of enterprise output was sold for a gain of A\$31.*
- *In other upper North-East districts about 40% of enterprise output was sold for a gain of A\$149.*

- *In Prasart about 40% of enterprise output was sold for a gain of A\$158.*
- *In other lower North-East districts about 30% of enterprise output was sold for a gain of A\$120.*
- *In the northern and central districts about 50% of enterprise output was sold for a gain of A\$76.*

These gains are significant in the context of household income levels. Larger benefits were obtained in reducing food security deficiencies. Survey results confirmed that most farm households grow rice, which is the dominant part of their daily diet. Adopting farms are producing more food and have improved the nutritional content of the family diet.

- *In some cases pond-water replacement has been used to grow more vegetables.*

The income and food consumption gains have improved the quality of life for adopting farmers. This has important social benefits for the village communities by improving the sustainability of their way of life. Project beneficiaries have gained health benefits from increasing the protein content of their diet and, in some cases, increasing the amount of food consumed.

The beneficiaries have also gained more discretionary income. The local sale of fish is one source of extra income and this could increase if the adopting farmers choose to expand their fish enterprise. Another source is from the replacement of market purchases of fish that may have occurred in the absence of the project.

Measuring the human health benefit of improving the nutritional content of the family diet through higher fish consumption was beyond the scope of the study. There was also no allowance for the benefits of higher vegetable production on the edges of ponds, which occurred in some cases. The net benefits of

the project will be underestimated to some extent, but these omissions are unlikely to materially change the assessment.

Some lessons from the impact assessment

A schematic summary of the pathway to the project benefits is presented in Figure 1. It is worth noting some observations from the IA that may be relevant for future extension projects. This was an experimental project for ACIAR for several reasons:

- It was primarily focused on extension training, with some participatory research that made use of technical research funded by ACIAR.
- It was a collaboration with an NGO involved in providing aid for poor people in rural communities.
- The project was undertaken with minimal involvement of the Australian project partners in the related technical research.
- It used the established networks of WVFT ADP staff to deliver training with an emphasis on self-determination by the potential beneficiaries.

Using the established ADP network as an extension mechanism to encourage adoption of low-cost fish-farming practices was a worthwhile exercise. It was an effective way to reach a target group of potential beneficiaries as defined by WVFT operating plans—very poor farmers with little land. The area of potential impact was substantial once the project was extended to a second phase that included another 14 ADPs.

However, the collaboration meant that the project was targeted at a particular group of very low income farmers in northern Thailand. It limited the scale of the potential impact as non-ADP members could benefit only by observing the experiences of adopting farmers. Given the relatively small number of adopters in many of the participating ADPs in 2008–09, the potential for this to occur seems limited.

The restricted scope of potential direct beneficiaries—ADP members—is not necessarily a limitation on the project effectiveness and return on investment. There was a sizeable number of potential beneficiaries

in the participating ADPs, but a small number of adopting farmers by 2008–09 would suggest that some refinements to the approach used in the extension training may be necessary:

- *The large decline in adoption levels evident by 2008–09 would support this.*

The fall in adoption levels is contrary to the outcome that is often expected in assessing project benefits. It highlights the importance of taking care in making IA assumptions on adoption rates for farmers with low incomes and limited financial resources. Investigating the reasons why initial adopters ceased fish farming would be a worthwhile exercise.

- *Knowing why initial adopters ceased fish farming would provide valuable information for WVFT and ACIAR that could be used to enhance the effectiveness of future extension-focused projects.*

The survey work undertaken for the project included a set of questions for non-adopters. Several reasons were cited for non-adoption by the respondents. While some indicated that the time involved in running the enterprise was an issue, it was clear from discussions with adopting farmers that the time involved in feeding fish is minimal. The only significant time-related issues would seem to be in:

- preparing and making the low-cost fish feed
- collecting or purchasing feed from the local market or the learning centre where the low-cost feed is made
- harvesting and transporting fish for commercial sale.

These activities are not especially time-consuming but they may have been a factor in non-adoption in some cases. WVFT could invest some time in advising farmers how to reduce the time involved in these enterprise activities. Harvesting and selling fish by inviting buyers to catch their requirements is one possible solution. Establishing a feed distribution system for farm deliveries is another.

Other factors raised by non-adopters were technical issues such as low fingerling survival rates and low fish growth rates. The significance of these issues should be investigated by ADP staff. It may reflect a need for post-adoption advisory work. Collaboration with

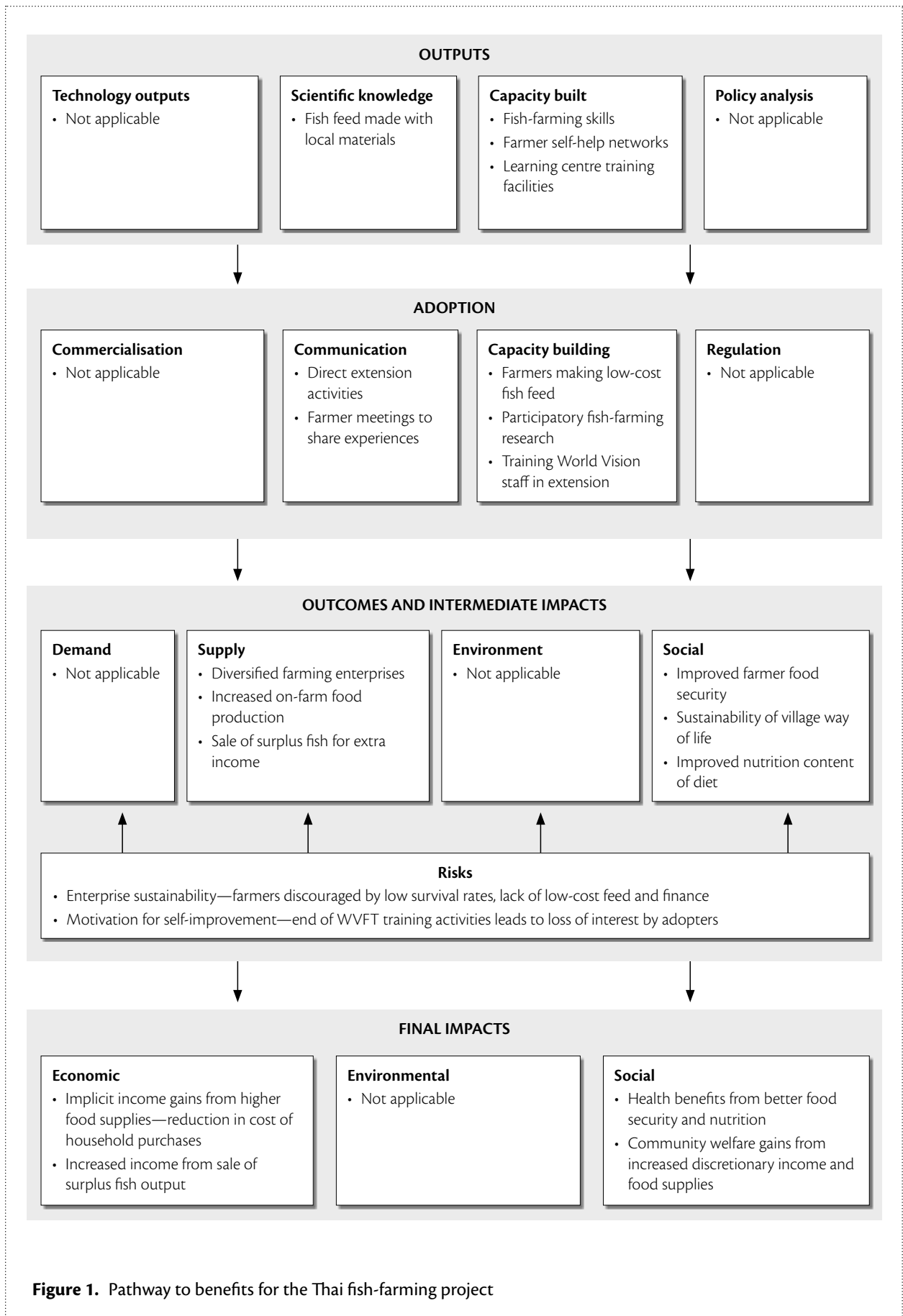


Figure 1. Pathway to benefits for the Thai fish-farming project

government extension services may be an effective way to overcome these problems.

- *As adopters gain experience in overcoming the technical problems that can arise in fish farming, the sustainability of the project benefits will increase.*

Some non-adopters also raised the issue of a lack of financial resources to buy fingerlings and feed. It was apparent from the IA consultation visits that some initial adopters did not continue fish farming for this reason. In some cases adopting farmers retained the entire fish harvest for home consumption—there were no commercial sales.

This would suggest that some initial adopters were unaware of the need to finance future output by selling a portion of their fish harvest. Financial sustainability of the enterprise requires this—WVFT provided the initial fingerlings and feed for free in some cases. This issue should be investigated. Extension projects such as this should include basic financial advice on enterprise performance in addition to technical training.

- *Provision of financial as well as technical advice would increase the effectiveness of WVFT and ACIAR extension projects.*

The IA also highlighted a number of issues related to the use of low-cost feed. The project was successful in developing a lower cost alternative but it seems the uptake has been limited. It was evident from discussions with farmers that most of them used commercial feeds. Visits to the learning centres suggested that production of low-cost feed was limited and the processing capacity was under-utilised. Survey results showed that:

- in the upper North-East districts 20% of farmers purchased low-cost feed from the learning centre and 92% were using some commercial feed
- in the lower North-East districts 33% of farmers purchased low-cost feed from the learning centre and they all used some commercial feed
- in the northern and central districts no farmers were using low-cost feed—they all used commercial feed rations as WVFT did not promote the use of the feed in these areas.

Use of a low-cost feed was a key focus of the project. Over time it was expected there would be widespread use of the alternative feed, but this has not occurred.

Feed-making equipment at the learning centres appears to be used on an ad-hoc basis when orders are received. Recipe and feed preparation knowledge does not seem to have been effectively dispersed beyond the areas immediately around the learning centres.

It would be worthwhile for WVFT to establish the use of low-cost fish feed among the adopting farmers. This could be a factor in the decline in adoption levels. If farmers have to use commercial feed it removes one of the primary financial benefits for adopting the project advice. Efforts to reinvigorate the use of the low-cost feed could increase the net benefits of the project.

- *A follow-up extension activity to more effectively disperse the knowledge on making fish-feed beyond the learning centres should be considered.*
- *Such an activity may lead to higher adoption levels in the future.*

A related issue is the capacity of the learning centres' facilities to service the fish-feed requirements of farmers in local and surrounding districts. A lack of saleable stock and a regular delivery service have been constraints on use of the feed. Production is based on orders and is partially dependent on cooperative labour inputs. It may be worthwhile for WVFT to investigate the feasibility of establishing a more regular production system with an associated distribution system based around the learning centres.

- *A stockpile of low-cost fish feed would provide year-round availability and increase the uptake of this aspect of the project.*
- *A feed delivery service to specified collection points would reduce the time and cost of feed pick-up as well as increasing the sales area.*

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Appendix 1 Additional funding for the Thai fish-farming project

Joint ACIAR–WV funding of the Thai fish-farming project ended in 2005–06 with total expenditure of A\$388,000. WVFT invested further funds in the project over a 3-year period. The funds were used to support implementation of the project in 14 additional ADPs when the project was extended. WVFT provided details of the supplementary expenditure in each of the ADP project impact areas. They are summarised in Table A1.

Table A1. WVFT supplementary expenditure on the fish-farming project^a

Province	Districts	2006–07	2007–08	2008–09	Total
		A\$'000	A\$'000	A\$'000	A\$'000
Upper North-East region					
Udon Thani	Muang Udon ^b	–	–	–	–
	Kudjab	22.4	19.6	16.1	58.2
	Srang Khom	72.4	54.8	47.7	174.9
Lower North-East region					
Surin	Prasart ^b	11.5	84.4	13.3	109.2
Si Sa Ket	Praiburng	20.8	23.7	30.8	75.3
Khon Kaen	Wang Yai	28.5	24.7	19.1	72.3
	Ubonrat	40.7	25.3	22.1	88.0
	Muang Phon	14.3	80.1	7.7	102.1
Buri Ram	Bankroud	86.6	75.9	13.4	175.9
Northern region					
Chiang Rai	Chiang Khong	23.5	21.0	20.5	64.9
	Khun Tan	82.5	72.0	67.5	222.0
Lampang	Jae Hom	68.0	64.0	68.2	200.2
Phare	Denchai	50.6	45.3	38.2	134.0
Central Plain region					
Chon Buri	Panatnikhom	26.1	24.3	23.9	74.2
Kanchanaburi	Sangklaburi	13.9	15.2	26.9	56.1
Chanthaburi	Kaeng Hang Maew	31.5	32.8	30.7	94.9
Total		593.2	663.1	446.0	1,702.3

Source: WVFT

^a Expenditure for the year ended 30 September^b Primary impact areas in phase one of the project

Appendix 2 Impact assessment consultations

The Thai fish-farming project involved research and extension activities in several ADPs. Farmers targeted for inclusion in the extension program were located in 16 districts in the northern, North-East and Central Plain regions. IA consultations with project staff and farmers were undertaken in several districts during two visits to Thailand in August and November of 2009.

The aims of the consultations were to:

- gain a first-hand perspective of the project impact and farm-level adoption
- discuss adoption experiences with farmers
- test a pilot survey questionnaire
- visit the learning centres established during phase one of the project
- examine a selection of fish-farming enterprises to gain a practical appreciation of how the extension training was applied
- assess the application of ACIAR technical research on low-cost fish feed
- collect data and anecdotal evidence to verify the survey results.

The project coordinator for WVFT, Mr Anusorn Somsiri, participated in all meetings during the in-country visits and provided translation services. Selection of the site visits was based on the level of farmer adoption of the training advice and a need to account for regional differences in project outcomes. The IA consultations covered the following project impact areas:

- Muang Udon district in Udon Thani province—the focus of phase one of the project
- Kudjab district in Udon Thani province
- Srang Khom district in Udon Thani province
- Ubonrat district in Khon Kaen province
- Praiburng district in Si Sa Ket province
- Prasart district in Surin province—the focus of phase one of the project
- Khun Tan district in Chiang Rai province.

Many farmers were interviewed during the course of the consultations. In addition, the following people participated in the IA consultations:

- Ms Chitra Thumborisuth, Executive Director, World Vision Foundation of Thailand (WVFT)
- Mr Anusorn Somsiri, WVFT Manager of Ministry Operation Division for Central Region and Operation Division Support Manager
- Mr Ruengrit Danprasit, WVFT Regional Manager for North-East ADPs
- Mr Sarawut Ratchasrimuang, WVFT Operation Manager for North-East ADPs
- Mr Somsak Phupharos, WVFT Project Officer for Muang Udon ADP, Udon Thani province
- Mr Lien-Thong Supabpong, Village Headman and Chairperson of the Advisory Committee for the WVFT Ban Hnongwah Vocational Training Centre, Muang Udon ADP, Udon Thani province

- Ms Thewee Chaivises, WVFT Coordinator of Sriboonrueng ADP, Nong Bualumpoo province
- Mr Kamol Katekaen, Chief of Kudjab district Agriculture Office, Ministry of Agriculture and Cooperatives
- Mr Serm Saengwarn, Agriculture Extension and Technical Support Officer, Kudjab district Agriculture Office, Ministry of Agriculture and Cooperatives
- Mr Suwit Pengsawad, WVFT Coordinator of Kudjab ADP, Udon Thani province
- Ms Jaruwan Bootwang, WVFT Economic Development Officer for Kudjab ADP, Udon Thani province
- Mr Surasak Pantasri, WVFT Coordinator of Ubonrat ADP, Khon Kaen province
- Ms Petchchan Danprasit, WVFT Project Officer for Ubonrat ADP, Khon Kaen province
- Mr Adisorn Pha-Kod, Chief of Ubonrat district Agriculture Office, Ministry of Agriculture and Cooperatives
- Mr Vichien Wannasit, Agriculture Extension Officer, Ubonrat district Agriculture Office, Ministry of Agriculture and Cooperatives
- Mr Somjit Khamsri, Agriculture Extension Officer, Ubonrat district Agriculture Office, Ministry of Agriculture and Cooperatives
- Mr Kiattisak Prawai, WVFT Coordinator of Praiburng ADP, Si Sa Ket province
- Mr Gorragoth Pongpetch, Pa Ang Village Headman, Praiburng ADP, Si Sa Ket province
- Mr Loy Wongsu, Hnong Samram Village Headman, Praiburng ADP, Si Sa Ket province
- Ms Suwaree Boon-Art, WVFT Project Officer for Surin ADP, Surin province
- Mr Chop Sakanin, Chairperson of the Advisory Committee for the WVFT Koksa-ard subdistrict Centre for Promotion of Sustainable Economy, Surin ADP, Surin province
- Ms Khamporn Prasarnsook, Administrator for WVFT Koksa-ard subdistrict Centre for Promotion of Sustainable Economy, Surin ADP, Surin province
- Mr Watcharaphon Samrandet, Village Headman and Chairperson of the Advisory Committee for the WVFT Hnongna Krong Occupation Development Project Training Centre, Surin ADP, Surin province
- Ms Ra-Rai Samrandet, Member of the Advisory Committee for the WVFT Hnongna Krong Occupation Development Project Training Centre, Surin ADP, Surin province
- Mr Chamlong Kammoon, WVFT Regional Manager for northern ADPs
- Mr Supot Srisuwan, WVFT Coordinator of Khun Tan ADP, Chiang Rai province
- Mr Weeramak Somsak, WVFT Project Officer for Khun Tan ADP, Chiang Rai province
- Ms Panida Karanet, Chairperson of the Fish Raising Group at the WVFT Community Learning Centre, Khun Tan ADP, Chiang Rai province.

Appendix 3 Survey results for the Thai fish-farming project

Table A2. Survey results for project adopters—upper North-East districts^a

			Muang Udon district	Kudjab district	Srang Khom district	Upper North-East
Sample size	no.		20	20	20	60
Average farm size	ha		2.1	0.9	3.2	2.1
Annual net household income	A\$/farm		3,200	1,098	3,390	2,563
Fish-farming experience before WVFT training	%		75	35	35	48
Fish-farming experience after WVFT training						
Production system	– dirt or plastic pond	%	100	100	90	97
	– floating basket	%	0	0	5	2
	– other methods	%	0	0	20	7
Production pattern	– seasonal	%	70	0	55	42
	– non-seasonal	%	30	100	45	58
Type of fish	– tilapia	%	85	15	5	35
	– catfish	%	90	100	95	95
Using commercial feed rations	%		94	100	100	98
Feed protein level	– 30% or higher	%	88	60	95	81
	– less than 30%	%	6	0	5	4
	– unknown	%	6	40	0	15
Purchase feed from WVFT training centre	%		19	35	5	20
Purchase feed from local market	%		100	80	95	92
Feeding other materials to fish	%		100	90	70	87
Technical advice from other sources ^b	%		80	25	5	37

Table A2. (continued)

			Muang Udon district	Kudjab district	Srang Khom district	Upper North-East
Annual physical and financial features of current enterprise						
Fingerlings released per farm		no.	2,559	1,923	885	1,789
Cost of fingerlings		baht/fish	1.0	1.2	1.0	1.1
Fingerling survival rate		%	79	87	93	86
Commercial feed use	– total	kg/farm	264	191	57	171
	– feeding rate	kg/fish	0.131	0.114	0.069	0.105
Commercial feed cost		baht/kg	23.7	19.0	21.8	21.5
Annual production	– total	kg/farm	423	293	159	292
	– home use	%	96	31	60	62
	– commercial sales	%	4	69	40	38
Local market price	– tilapia	baht/kg	67.1	50.0	40.0	52.4
	– catfish	baht/kg	50.0	53.3	54.7	52.7
Enterprise capital cost	– total ^c	baht/farm	4,400	3,305	1,670	3,125
	– share paid by WVFT	%	60	77	95	77

Source: WVFT survey

- ^a Random sample of villages in three districts of Udon Thai province. Survey results reflect the average responses for the sample after adjusting for non-responses. Results for the upper North-East region are an average of the district results.
- ^b Obtained advice on fish farming beyond WVFT training (e.g. government extension officers)
- ^c Cost of establishing fish-farming facilities after WVFT training

Table A3. Survey results for project adopters—lower North-East districts^a

			Prasart district	Ubonrat district	Praiburng district	Lower North-East
Sample size		no.	20	20	20	60
Average farm size		ha	3.5	1.1	3.5	2.7
Annual net household income		A\$/farm	2,031	1,756	2,848	2,212
Fish-farming experience before WVFT training		%	45	95	0	47
Fish-farming experience after WVFT training						
Production system	– dirt or plastic pond	%	95	65	80	80
	– floating basket	%	5	0	10	5
	– other methods	%	55	45	85	62
Production pattern	– seasonal	%	60	10	5	25
	– non-seasonal	%	40	90	95	75

Table A3. (continued)

			Prasart district	Ubonrat district	Praiburng district	Lower North-East
Type of fish	– tilapia	%	85	20	45	50
	– catfish	%	55	95	95	82
Using commercial feed rations		%	65	100	100	88
Feed protein level	– 30% or higher	%	0	25	5	10
	– less than 30%	%	31	5	40	25
	– unknown	%	69	70	55	65
Purchase feed from WVFT training centre		%	85	5	10	33
Purchase feed from local market		%	100	100	100	100
Feeding other materials to fish		%	85	65	85	78
Technical advice from other sources ^b		%	100	50	100	83
Annual physical and financial features of current enterprise						
Fingerlings released per farm		no.	1,767	939	1,700	1,469
Cost of fingerlings		baht/fish	0.8	1.0	1.0	1.0
Fingerling survival rate		%	75	87	90	84
Commercial feed use	– total	kg	95	83	247	142
	– feeding rate	kg/fish	0.072	0.101	0.160	0.111
Commercial feed cost		baht/kg	19.9	21.2	22.5	21.2
Annual production	– total	kg	234	149	372	252
	– home use	%	60	78	67	68
Local market price	– tilapia	baht/kg	62.5	65.7	60.0	62.7
	– catfish	baht/kg	52.3	58.0	54.5	54.9
Enterprise capital cost	– total ^c	baht/farm	8,318	4,255	4,211	5,594
	– share paid by WVFT	%	64	55	23	47

Source: WVFT survey

^a Random sample of villages in districts of Surin, Khon Kaen and Si Sa Ket provinces. Survey results reflect the average responses for the sample after adjusting for non-responses. Results for the lower North-East region are an average of the district results.

^b Obtained advice on fish farming beyond WVFT training (e.g. government extension officers)

^c Cost of establishing or redeveloping fish-farming facilities after WVFT training

Table A4. Survey results for project adopters—northern and central districts^a

		Khun Tan district	Jae Hom district	Northern and central	
Sample size	no.	20	20	40	
Average farm size	ha	1.1	0.7	0.9	
Annual net household income	A\$/farm	1,699	819	1,259	
Fish-farming experience before training	%	100	25	63	
Fish-farming experience after WVFT training					
Production system	– dirt or plastic pond	%	85	45	65
	– floating basket	%	0	0	0
	– other methods	%	30	55	43
Production pattern	– seasonal	%	0	50	25
	– non-seasonal	%	100	50	75
Type of fish	– tilapia	%	85	35	60
	– catfish	%	95	75	85
Using commercial feed rations	%	100	100	100	
Feed protein level	– 30% or higher	%	80	60	70
	– less than 30%	%	10	0	5
	– unknown	%	10	40	25
Purchase feed from WVFT training centre	%	0	0	0	
Purchase feed from local market	%	100	100	100	
Feeding other materials to fish	%	90	70	80	
Technical advice from other sources ^b	%	0	5	3	
Annual physical and financial features of current enterprise					
Fingerlings released per farm	no.	1,365	670	1,018	
Cost of fingerlings	baht/fish	1.0	1.1	1.0	
Fingerling survival rate	%	87	88	88	
Commercial feed use	– total	kg/farm	248	69	158
	– feeding rate	kg/fish	0.209	0.117	0.163
Commercial feed cost	baht/kg	23.8	21.6	22.7	
Annual production	– total	kg/farm	247	77	162
	– home use	%	25	71	48
Local market price	– tilapia	baht/kg	49.5	57.5	53.5
	– catfish	baht/kg	59.5	47.1	53.3
Enterprise capital cost	– total ^c	baht/farm	2,470	2,999	2,735
	– share paid by WVFT	%	50	69	60

Source: WVFT survey

^a Random sample of villages in districts of Chiang Rai and Lampang provinces. Survey results reflect the average responses for the sample after adjusting for non-responses. Results for the northern and central regions are an average of the district results.

^b Obtained advice on fish farming beyond WVFT training (e.g. government extension officers)

^c Cost of establishing or redeveloping fish-farming facilities after WVFT training

Table A5. Survey results for non-adopters—all districts^a

			Muang Udon district	Kudjab district	Srang Khom district
Sample size	no.		10	10	10
Average farm size	ha		0.9	1.9	2.2
Farming fish in paddy fields	%		10	10	0
Commenced fish farming but ceased ^b	%		90	100	100
Non-adoption reasons	– water or land deficiencies	%	70	60	50
	– insufficient time to run enterprise	%	90	50	50
	– high development costs	%	50	30	60
	– lack of money for feed, fingerlings	%	40	30	60
	– low fingerling survival rate	%	30	60	0
	– no interest in technical training	%	10	0	0
			Prasart district	Ubonrat district	Praibung district
Sample size	no.		10	10	7
Average farm size	ha		1.9	1.3	1.8
Farming fish in paddy fields	%		10	10	0
Commenced fish farming but ceased ^b	%		100	100	100
Non-adoption reasons	– water or land deficiencies	%	10	70	29
	– insufficient time to run enterprise	%	70	40	57
	– high development costs	%	40	30	100
	– lack of money for feed, fingerlings	%	100	40	100
	– low fingerling survival rate	%	10	20	43
	– no interest in technical training	%	0	20	14
			Khun Tan district	Jae Hom district	All districts^c
Sample size	no.		10	10	77
Average farm size	ha		4.4	0.2	1.8
Farming fish in paddy fields	%		0	0	5
Commenced fish farming but ceased ^b	%		100	100	99
Non-adoption reasons	– water or land deficiencies	%	100	0	49
	– insufficient time to run enterprise	%	90	20	58
	– high development costs	%	100	0	49
	– lack of money for feed, fingerlings	%	90	80	66
	– low fingerling survival rate	%	100	30	36
	– no interest in technical training	%	20	0	8

Source: WVFT survey

^a Survey conducted in the same districts as used for survey of project adopters. All respondents participated in WVFT training. The results reflect sample average after adjusting for non-responses.

^b Fish-farming enterprise established after attending WVFT training but farmer had ceased fish feeding

^c Aggregated results for entire sample

Appendix 4 Impact assessment assumptions

Table A6. Farm adoption assumptions^a

	Upper North-East region		Lower North-East region		Northern and Central Plain districts ^d
	Muang district Udon Thani	Other districts ^b	Prasart district Surin	Other districts ^c	
	no.	no.	no.	no.	
2000–01	0	0	0	0	0
2001–02	0	0	0	0	0
2002–03	415	0	736	0	0
2003–04	305	0	560	0	0
2004–05	195	0	385	0	0
2005–06	85	596	210	807	267
2006–07	85	437	210	681	218
2007–08	85	278	210	556	170
2008–09 ^e	85	119	210	431	132
2009–10	85	119	210	431	132
2010–11	101	143	236	450	139
2011–12	117	167	262	469	146
2012–13	133	191	288	488	153
2013–14	149	215	314	507	159
2014–15	165	240	340	525	165
2015–16	165	240	340	525	165
2017–2030	165	240	340	525	165

^a Adoption time path based on initial farmer participation and those still fish farming

^b Includes Kudjab and Srang Khom districts in Udon Thani

^c Includes Wang Yai, Ubonrat and Muang Phon districts in Khon Kaen, Praibung district in Si Sa Ket and Bankroud district in Buri Ram

^d Includes districts of Chiang Khong and Khun Tan in Chiang Rai, Jae Hom in Lampang, Denchai in Phare, Panatnikhom in Chon Buri, Sangklaburi in Kanchanaburi and Kaeng Hang Maew in Chanthaburi

^e Households still operating a fish-feeding enterprise in September 2009 after WVFT training. Adoption is assumed to increase for a 5-year period from 2010–11. The total increase is equivalent to one-quarter of the number of farms that ceased operating in the period before 2008–09. The increase was evenly distributed over the period to 2014–15. Adoption numbers remain unchanged for the remainder of the assessment period.

Table A7. Farm prices for selected freshwater fish in Thailand

	Thailand		North-East region		Northern region	
	baht/kg	% change	baht/kg	% change	baht/kg	% change
Tilapia						
2000	16.8	–	22.2	–	16.1	–
2001	23.7	40.9	34.3	54.5	19.7	22.2
2002	24.2	2.3	27.5	–19.8	18.2	–7.4
2003	24.6	1.6	32.0	16.4	20.5	12.5
2004	24.0	–2.6	40.0	25.0	21.5	4.9
2005	30.6	27.6	42.7	6.7	20.7	–4.0
2006	33.0	8.1	43.3	1.5	21.5	3.9
2007	36.8	11.3	43.9	1.3	20.7	–3.7
2008	27.6	–25.1	53.3	21.5	27.4	32.5
Catfish						
2000	30.4	–	33.0	–	29.2	–
2001	30.0	–1.6	34.1	3.1	25.0	–14.3
2002	26.0	–13.2	32.8	–3.6	23.8	–4.9
2003	25.3	–2.7	26.0	–20.7	24.9	4.5
2004	28.7	13.2	28.5	9.5	28.6	14.9
2005	29.2	2.0	35.3	24.0	29.1	1.6
2006	29.9	2.2	36.1	2.2	29.9	2.8
2007	29.0	–3.0	35.0	–3.0	29.0	–3.0
2008	33.6	16.1	40.7	16.1	31.6	9.1

Source: Office of Agricultural Economics (pers. comm.)

Table A8. Fish price indexes for valuing project impacts^a

	North-East region tilapia		North-East region catfish		Northern region tilapia		Northern region catfish	
	2008 = 1.0	% change	2008 = 1.0	% change	2008 = 1.0	% change	2008 = 1.0	% change
2000	0.42	–	0.81	–	0.59	–	0.92	–
2001	0.64	54.5	0.84	3.1	0.72	22.2	0.79	–14.3
2002	0.52	–19.8	0.81	–3.6	0.67	–7.4	0.75	–4.9
2003	0.60	16.4	0.64	–20.7	0.75	12.5	0.79	4.5
2004	0.75	25.0	0.70	9.5	0.79	4.9	0.90	14.9
2005	0.80	6.6	0.87	24.0	0.75	–4.0	0.92	1.6
2006	0.81	1.5	0.89	2.2	0.78	3.9	0.94	2.8
2007	0.82	1.3	0.86	–3.0	0.75	–3.7	0.92	–3.0
2008	1.00	21.5	1.00	16.1	1.00	32.5	1.00	9.1

Source: Office of Agricultural Economics (pers. comm.)

^a Indexes based on price data in Table A7. North–East region prices were used to index 2008–09 survey results for local prices in Muang Udon, Prasart, and other upper and lower North-East districts. Northern region prices were used to index 2008–09 survey results for local prices in the northern and central districts.

Table A9. Exchange rate and deflator assumptions

	Australian price deflator ^a		Thai exchange rate
	2008–09 = 100	% change	Baht per A\$1
2000–01	77.0	–	23.23
2001–02	81.7	6.0	23.00
2002–03	84.2	3.1	24.94
2003–04	86.2	2.4	28.64
2004–05	88.3	2.4	30.16
2005–06	91.1	3.2	29.84
2006–07	93.8	2.9	27.58
2007–08	96.9	3.4	28.17
2008–09	100.0	3.2	25.82

Source: US Federal Reserve (2009) and ABARE (2009)

^a Price deflator series is the Australian consumer price index

Appendix 5 Impact of the Thai fish-farming project

Table A10. Project impact—Muang Udon district, upper North-East region^a

	Average fish harvest ^b	Market price of fish ^c	Average value of catch	Average production costs ^d	Average farm outcome	Adopting farms	Project impact
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2002–03	425	37.5	15.9	10.7	5.2	415	2.2
2003–04	425	36.1	15.4	9.0	6.4	305	2.0
2004–05	425	42.7	18.1	9.0	9.2	195	1.8
2005–06	425	48.6	20.6	9.0	11.7	85	1.0
2006–07	425	49.5	21.0	9.0	12.1	85	1.0
2007–08	425	49.2	20.9	9.0	11.9	85	1.0
2008–09	425	58.6	24.9	9.0	15.9	85	1.4
2009–10	425	58.6	24.9	9.0	15.9	85	1.4
2010–11	446	58.6	26.1	9.6	16.5	101	1.7
2011–12	469	58.6	27.4	10.1	17.3	117	2.0
2012–13	492	58.6	28.8	10.6	18.2	133	2.4
2013–14	517	58.6	30.3	11.1	19.1	149	2.8
2014–15	542	58.6	31.8	11.7	20.1	165	3.3
2015–16	570	58.6	33.4	12.3	21.1	165	3.5
2017–2030	570	58.6	33.4	12.0	21.4	165	49.3

^a Net value of impacts using assumptions based on WVFT survey results for 2008–09. Survey outcomes were assumed to apply in the period before 2008–09. Farmer application of WVFT training commenced in 2002–03.

^b Annual harvest of 425 kg based on 2,600 fingerlings, 80% survival rate and per-fish weight of 204 g. It is assumed that harvest rises by 5% per year over the 2010–11 to 2014–15 period to reflect expansion intentions by selected farm households operating a fish-feeding enterprise in September 2009.

^c Average local market prices for tilapia and catfish. Prices for 2008–09 were survey results. For the 2002–03 to 2007–08 period, indexes of price changes for the North-East region (see Appendix 4) were applied to 2008–09 survey prices (e.g. the 2007–08 price reflects the 2007 index value).

^d Costs include fingerlings (1.0 baht/fish), feed (annual feed-use of 265 kg and feed price of 24.0 baht/kg) and subsidised enterprise-establishment costs in 2002–03 (40% farmer share of total cost of 4,400 baht). For the 2010–11 to 2014–15 period, production costs are adjusted to reflect assumed enterprise output growth. Fingerling release and feed use are derived from the 2008–09 average feeding rate of 127 g/fish and total fish harvest. Capital cost is based on cost per kg of output in 2002–03 (10.4 baht/kg) excluding WVFT subsidy.

Table A11. Project impact—other upper North-East districts^a

	Average fish harvest ^b	Market price offish ^c	Average value of catch	Average production costs ^d	Average farm outcome	Adopting farms	Project impact
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2005–06	290	43.8	12.7	6.4	6.3	596	3.8
2006–07	290	44.7	13.0	5.6	7.3	437	3.2
2007–08	290	44.2	12.8	5.6	7.2	278	2.0
2008–09	290	52.5	15.2	5.6	9.6	119	1.1
2009–10	290	52.5	15.2	5.6	9.6	119	1.1
2010–11	305	52.5	16.0	6.1	9.9	143	1.4
2011–12	320	52.5	16.8	6.4	10.4	167	1.7
2012–13	336	52.5	17.6	6.7	10.9	191	2.1
2013–14	352	52.5	18.5	7.0	11.5	215	2.5
2014–15	370	52.5	19.4	7.4	12.1	240	2.9
2015–16	389	52.5	20.4	7.8	12.7	240	3.0
2017–2030	389	52.5	20.4	7.6	12.9	240	43.2

- ^a Net value of impacts using assumptions based on WVFT survey results for 2008–09. Survey outcomes were assumed to apply in the period before 2008–09. Farmer application of WVFT training commenced in 2005–06. Impact is based on survey results for the upper North-East districts (see Appendix 3).
- ^b Annual harvest of 290 kg is based on 1,800 fingerlings, 85% survival rate and per-fish weight of 190 g. It is assumed that harvest rises by 5% per year over the 2010–11 to 2014–15 period to reflect expansion intentions by selected farm households operating a fish-feeding enterprise in September 2009.
- ^c Average local market prices for tilapia and catfish. Prices for 2008–09 were survey results. For the 2005–06 to 2007–08 period, indexes of price changes for the North-East region (see Appendix 4) were applied to 2008–09 survey prices (e.g. the 2007–08 price reflects the 2007 index value).
- ^d Costs include fingerlings (1.1 baht/fish), feed (annual feed use of 170 kg and feed price of 21.5 kg/baht) and subsidised enterprise-establishment costs in 2005–06 (25% farmer share of total cost of 3,125 baht). For the 2010–11 to 2014–15 period, production costs are adjusted to reflect assumed enterprise output growth. Fingerling release and feed use are derived from the 2008–09 average feeding rate of 111 g/fish and total fish harvest. Capital cost is based on cost per kg of output in 2005–06 (10.8 baht/kg) excluding WVFT subsidy.

Table A12. Project impact—Prasart district, lower North-East region^a

	Average fish harvest ^b	Market price of fish ^c	Average value of catch	Average production costs ^d	Average farm outcome	Adopting farms	Project impact
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2002–03	235	37.2	8.8	6.2	2.5	736	1.9
2003–04	235	35.5	8.3	3.3	5.0	560	2.8
2004–05	235	41.8	9.8	3.3	6.5	385	2.5
2005–06	235	47.7	11.2	3.3	7.9	210	1.7
2006–07	235	48.6	11.4	3.3	8.1	210	1.7
2007–08	235	48.3	11.3	3.3	8.0	210	1.7
2008–09	235	57.4	13.5	3.3	10.2	210	2.1
2009–10	235	57.4	13.5	3.3	10.2	210	2.1
2010–11	247	57.4	14.2	3.9	10.3	236	2.4
2011–12	259	57.4	14.9	4.1	10.8	262	2.8
2012–13	272	57.4	15.6	4.3	11.3	288	3.3
2013–14	286	57.4	16.4	4.5	11.9	314	3.7
2014–15	300	57.4	17.2	4.7	12.5	340	4.2
2015–16	315	57.4	18.1	5.0	13.1	340	4.5
2017–2030	315	57.4	18.1	4.4	13.6	340	64.9

^a Net value of impacts using assumptions based on WVFT survey results for 2008–09. Survey outcomes were assumed to apply in the period before 2008–09. Farmer application of WVFT training commenced in 2002–03.

^b Annual harvest of 235 kg is based on 1,770 fingerlings, 75% survival rate and per-fish weight of 177 g. It is assumed that the harvest rises by 5% per year over the 2010–11 to 2014–15 period to reflect expansion intentions by selected farm households operating a fish-feeding enterprise in September 2009.

^c Average local market prices for tilapia and catfish. Prices for 2008–09 were survey results. For the 2002–03 to 2007–08 period, indexes of price changes for the North-East region (see Appendix 4) were applied to 2008–09 survey prices (e.g. the 2007–08 price reflects the 2007 index value).

^d Costs include fingerlings (0.8 baht/fish), feed (annual feed use of 95 kg and feed price of 20.0 baht/kg) and subsidised enterprise-establishment costs in 2002–03 (35% farmer share of total cost of 8,320 baht). For the 2010–11 to 2014–15 period, production costs are adjusted to reflect assumed enterprise output growth. Fingerling release and feed use were derived from the 2008–09 average feeding rate of 72 g/fish and total fish harvest. Capital cost is based on cost per kg of output in 2002–03 (35.4 baht/kg) excluding WVFT subsidy.

Table A13. Project impact—other lower North-East districts^a

	Average fish harvest^b	Market price of fish^c	Average value of catch	Average production costs^d	Average farm outcome	Adopting farms	Project impact
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2005–06	250	49.0	12.2	7.5	4.8	807	3.8
2006–07	250	49.9	12.5	4.4	8.1	681	5.5
2007–08	250	49.5	12.4	4.4	8.0	556	4.4
2008–09	250	58.8	14.7	4.4	10.3	431	4.4
2009–10	250	58.8	14.7	4.4	10.3	431	4.4
2010–11	263	58.8	15.4	4.9	10.5	450	4.7
2011–12	276	58.8	16.2	5.2	11.1	469	5.2
2012–13	289	58.8	17.0	5.4	11.6	488	5.7
2013–14	304	58.8	17.9	5.7	12.2	507	6.2
2014–15	319	58.8	18.8	6.0	12.8	525	6.7
2015–16	335	58.8	19.7	6.3	13.4	525	7.1
2017–2030	335	58.8	19.7	5.9	13.8	525	101.5

- ^a Net value of impacts using assumptions based on WVFT survey results for 2008–09. Survey outcomes were assumed to apply in the period before 2008–09. Farmer application of WVFT training commenced in 2005–06. Impact is based on survey results for the lower North-East districts (see Appendix 3).
- ^b Annual harvest of 250 kg is based on 1,470 fingerlings, 85% survival rate and per-fish weight of 200 g. It is assumed that the harvest rises by 5% per year over the 2010–11 to 2014–15 period to reflect expansion intentions by selected farm households operating a fish-feeding enterprise in September 2009.
- ^c Average local market prices for tilapia and catfish. Prices for 2008–09 were survey results. For the 2005–06 to 2007–08 period, indexes of price changes for the North-East region (see Appendix 4) were applied to 2008–09 survey prices (e.g. the 2007–08 price reflects the 2007 index value).
- ^d Costs include fingerlings (1.0 baht/fish), feed (annual feed use of 140 kg and feed price of 21.0 baht/kg) and subsidised enterprise-establishment costs in 2005–06 (55% farmer share of total cost of 5,595 baht). For the 2010–11 to 2014–15 period, production costs are adjusted to reflect assumed enterprise output growth. Fingerling release and feed use were derived from the 2008–09 average feeding rate of 112 g/fish and total fish harvest. Capital cost is based on cost per kg of output in 2005–06 (22.4 baht/kg) excluding WVFT subsidy.

Table A14. Project impact—northern and central districts^a

	Average fish harvest^b	Market price of fish^c	Average value of catch	Average production costs^d	Average farm outcome	Adopting farms	Project impact
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2005–06	160	44.7	7.1	5.7	1.4	267	0.4
2006–07	160	46.1	7.4	4.6	2.8	218	0.6
2007–08	160	44.6	7.1	4.6	2.5	170	0.4
2008–09	160	53.4	8.5	4.6	3.9	132	0.5
2009–10	160	53.4	8.5	4.6	3.9	132	0.5
2010–11	168	53.4	9.0	5.0	4.0	139	0.6
2011–12	176	53.4	9.4	5.2	4.2	146	0.6
2012–13	185	53.4	9.9	5.5	4.4	153	0.7
2013–14	194	53.4	10.4	5.8	4.6	159	0.7
2014–15	204	53.4	10.9	6.1	4.8	165	0.8
2015–16	214	53.4	11.5	6.4	5.1	165	0.8
2017–2030	214	53.4	11.5	6.2	5.3	165	12.2

^a Net value of impacts using assumptions based on WVFT survey results for 2008–09. Survey outcomes were assumed to apply in the period before 2008–09. Farmer application of WVFT training commenced in 2005–06. Impact is based on survey results for northern and central districts (see Appendix 3).

^b Annual harvest of 160 kg is based on 1,020 fingerlings, 90% survival rate and per-fish weight of 174 g. It is assumed that the harvest rises by 5% per year over the 2010–11 to 2014–15 period to reflect expansion intentions by selected farm households operating a fish-feeding enterprise in September 2009.

^c Average local market prices for tilapia and catfish. Prices for 2008–09 were survey results. For the 2005–06 to 2007–08 period, indexes of price changes for the northern region (see Appendix 4) were applied to 2008–09 survey prices (e.g. the 2007–08 price reflects the 2007 index value).

^d Costs include fingerlings (1.0 baht/fish), feed (annual feed use of 160 kg and feed price of 22.5 baht/kg) and subsidised enterprise-establishment costs in 2005–06 (40% farmer share of total cost of 2,735 baht). For the 2010–11 to 2014–15 period, production costs are adjusted to reflect assumed enterprise output growth. Fingerling release and feed use were derived from the 2008–09 average feeding rate of 174 g/fish and total fish harvest. Capital cost is based on cost per kg of output in 2005–06 (17.1 baht/kg) excluding WVFT subsidy.

Table A15. Project base case—Muang Udon district, upper North–East region^a

	Average fish harvest ^b	Market price of fish ^c	Average value of catch	Average production costs ^d	Average farm outcome	Adopting farms	Base case
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2001–02	83	42.5	3.5	1.0	2.5	–	–
2002–03	83	37.5	3.1	1.0	2.1	415	0.9
2003–04	83	36.1	3.0	1.0	2.0	305	0.6
2004–05	83	42.7	3.5	1.0	2.6	195	0.5
2005–06	83	48.6	4.0	1.0	3.0	85	0.3
2006–07	83	49.5	4.1	1.0	3.1	85	0.3
2007–08	83	49.2	4.1	1.0	3.1	85	0.3
2008–09	83	58.6	4.9	1.0	3.9	85	0.3
2009–10	83	58.6	4.9	1.0	3.9	85	0.3
2010–11	83	58.6	4.9	1.0	3.9	101	0.4
2011–12	83	58.6	4.9	1.0	3.9	117	0.5
2012–13	83	58.6	4.9	1.0	3.9	133	0.5
2013–14	83	58.6	4.9	1.0	3.9	149	0.6
2014–15	83	58.6	4.9	1.0	3.9	165	0.6
2015–16	83	58.6	4.9	1.0	3.9	165	0.6
2017–2030	83	58.6	4.9	1.0	3.9	165	8.9

^a Net value of 'no impact' base case using assumptions based on WVFT survey results for fish-farming outcomes for the year before initial application of WVFT training (i.e. 2001–02).

^b Annual harvest of 83 kg is based on 435 fingerlings, 80% survival rate and per-fish weight of 239 g.

^c Average local market prices for tilapia and catfish—same price series used to value project impacts.

^d Costs include fingerlings (1.0 baht/fish) and feed (annual feed use of 23 kg and feed price of 24.0 baht/kg).

Table A16. Project base case—other upper North-East districts^a

	Average fish harvest^b	Market price of fish^c	Average value of catch	Average production costs^d	Average farm outcome	Adopting farms	Base case
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2004–05	54	38.1	2.1	0.7	1.4	–	–
2005–06	54	43.8	2.4	0.7	1.7	596	1.0
2006–07	54	44.7	2.4	0.7	1.7	437	0.8
2007–08	54	44.2	2.4	0.7	1.7	278	0.5
2008–09	54	52.5	2.8	0.7	2.2	119	0.3
2009–10	54	52.5	2.8	0.7	2.2	119	0.3
2010–11	54	52.5	2.8	0.7	2.2	143	0.3
2011–12	54	52.5	2.8	0.7	2.2	167	0.4
2012–13	54	52.5	2.8	0.7	2.2	191	0.4
2013–14	54	52.5	2.8	0.7	2.2	215	0.5
2014–15	54	52.5	2.8	0.7	2.2	240	0.5
2015–16	54	52.5	2.8	0.7	2.2	240	0.5
2017–2030	54	52.5	2.8	0.7	2.2	240	7.3

^a Net value of 'no impact' base case using assumptions based on WVFT survey results for fish-farming outcomes for the year before initial application of WVFT training (i.e. 2004–05). The base case is based on survey results for the upper North-East districts.

^b Annual harvest of 54 kg is based on 311 fingerlings, 85% survival rate and per-fish weight of 204 g.

^c Average local market prices for tilapia and catfish—same price series used to value project impacts.

^d Costs include fingerlings (1.1 baht/fish) and feed (annual feed use of 16 kg and feed price of 21.5 baht/kg).

Table A17. Project base case—Prasart district, lower North-East region^a

	Average fish harvest ^b	Market price of fish ^c	Average value of catch	Average production costs ^d	Average farm outcome	Adopting farms	Base case
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2001–02	63	42.0	2.6	1.0	1.7	–	–
2002–03	63	37.2	2.3	1.0	1.4	736	1.0
2003–04	63	35.5	2.2	1.0	1.3	560	0.7
2004–05	63	41.8	2.6	1.0	1.7	385	0.6
2005–06	63	47.7	3.0	1.0	2.1	210	0.4
2006–07	63	48.6	3.1	1.0	2.1	210	0.4
2007–08	63	48.3	3.0	1.0	2.1	210	0.4
2008–09	63	57.4	3.6	1.0	2.7	210	0.6
2009–10	63	57.4	3.6	1.0	2.7	210	0.6
2010–11	63	57.4	3.6	1.0	2.7	236	0.6
2011–12	63	57.4	3.6	1.0	2.7	262	0.7
2012–13	63	57.4	3.6	1.0	2.7	288	0.8
2013–14	63	57.4	3.6	1.0	2.7	314	0.8
2014–15	63	57.4	3.6	1.0	2.7	340	0.9
2015–16	63	57.4	3.6	1.0	2.7	340	0.9
2017–2030	63	57.4	3.6	1.0	2.7	340	12.7

^a Net value of 'no impact' base case using assumptions based on WVFT survey results for fish-farming outcomes for the year before initial application of WVFT training (i.e. 2001–02).

^b Annual harvest of 63 kg is based on 343 fingerlings, 75% survival rate and per-fish weight of 282 g.

^c Average local market prices for tilapia and catfish—same price series used to value project impacts.

^d Costs include fingerlings (0.8 baht/fish) and feed (annual feed use of 34 kg and feed price of 20.0 baht/kg).

Table A18. Project base case—other lower North-East districts^a

	Average fish harvest^b	Market price of fish^c	Average value of catch	Average production costs^d	Average farm outcome	Adopting farms	Base case
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2004–05	53	42.8	2.3	1.2	1.1	–	–
2005–06	53	49.0	2.6	1.2	1.4	807	1.1
2006–07	53	49.9	2.6	1.2	1.5	681	1.0
2007–08	53	49.5	2.6	1.2	1.4	556	0.8
2008–09	53	58.8	3.1	1.2	1.9	431	0.8
2009–10	53	58.8	3.1	1.2	1.9	431	0.8
2010–11	53	58.8	3.1	1.2	1.9	450	0.9
2011–12	53	58.8	3.1	1.2	1.9	469	0.9
2012–13	53	58.8	3.1	1.2	1.9	488	0.9
2013–14	53	58.8	3.1	1.2	1.9	507	1.0
2014–15	53	58.8	3.1	1.2	1.9	525	1.0
2015–16	53	58.8	3.1	1.2	1.9	525	1.0
2017–2030	53	58.8	3.1	1.2	1.9	525	14.3

^a Net value of 'no impact' base case using assumptions based on WVFT survey results for fish-farming outcomes for the year before initial application of WVFT training (i.e. 2004–05). The base case is based on survey results for the lower North-East districts.

^b The annual harvest of 53 kg is based on 381 fingerlings, 85% survival rate and per-fish weight of 164 g.

^c Average local market prices for tilapia and catfish—same price series used to value project impacts.

^d Costs include fingerlings (1.0 baht/fish) and feed (annual feed use of 38 kg and feed price of 21.0 baht/kg).

Table A19. Project base case—northern and central districts^a

	Average fish harvest ^b	Market price of fish ^c	Average value of catch	Average production costs ^d	Average farm outcome	Adopting farms	Base case
	kg/farm	baht/kg	'000 baht/farm	'000 baht/farm	'000 baht/farm	no.	million baht
2004–05	22	45.1	1.0	0.6	0.4	–	–
2005–06	22	44.7	1.0	0.6	0.4	267	0.1
2006–07	22	46.1	1.0	0.6	0.5	218	0.1
2007–08	22	44.6	1.0	0.6	0.4	170	0.1
2008–09	22	53.4	1.2	0.6	0.6	132	0.1
2009–10	22	53.4	1.2	0.6	0.6	132	0.1
2010–11	22	53.4	1.2	0.6	0.6	139	0.1
2011–12	22	53.4	1.2	0.6	0.6	146	0.1
2012–13	22	53.4	1.2	0.6	0.6	153	0.1
2013–14	22	53.4	1.2	0.6	0.6	159	0.1
2014–15	22	53.4	1.2	0.6	0.6	165	0.1
2015–16	22	53.4	1.2	0.6	0.6	165	0.1
2017–2030	22	53.4	1.2	0.6	0.6	165	1.4

^a Net value of 'no impact' base case using assumptions based on WVFT survey results for fish-farming outcomes for the year before initial application of WVFT training (i.e. 2004–05)

^b The annual harvest of 22 kg is based on 122 fingerlings, 90% survival rate and per-fish weight of 201 g.

^c Average local market prices for tilapia and catfish—same price series used to value project impacts.

^d Costs include fingerlings (1.0 baht/fish) and feed (annual feed use of 20 kg and feed price of 22.5 baht/kg).

IMPACT ASSESSMENT SERIES

No.	Author(s) and year of publication	Title	ACIAR project numbers
1	Centre for International Economics 1998.	Control of Newcastle disease in village chickens	AS1/1983/034, AS1/1987/017 and AS1/1993/222
2	George P.S. 1998.	Increased efficiency of straw utilisation by cattle and buffalo	AS1/1982/003, AS2/1986/001 and AS2/1988/017
3	Centre for International Economics 1998.	Establishment of a protected area in Vanuatu	ANRE/1990/020
4	Watson A.S. 1998.	Raw wool production and marketing in China	ADP/1988/011
5	Collins D.J. and Collins B.A. 1998.	Fruit fly in Malaysia and Thailand 1985–1993	CS2/1983/043 and CS2/1989/019
6	Ryan J.G. 1998.	Pigeonpea improvement	CS1/1982/001 and CS1/1985/067
7	Centre for International Economics 1998.	Reducing fish losses due to epizootic ulcerative syndrome—an ex ante evaluation	FIS/1991/030
8	McKenney D.W. 1998.	Australian tree species selection in China	FST/1984/057 and FST/1988/048
9	ACIL Consulting 1998.	Sulfur test KCL–40 and growth of the Australian canola industry	PN/1983/028 and PN/1988/004
10	AACM International 1998.	Conservation tillage and controlled traffic	LWR2/1992/009
11	Chudleigh P. 1998.	Postharvest R&D concerning tropical fruits	PHT/1983/056 and PHT/1988/044
12	Waterhouse D., Dillon B. and Vincent D. 1999.	Biological control of the banana skipper in Papua New Guinea	CS2/1988/002-C
13	Chudleigh P. 1999.	Breeding and quality analysis of rapeseed	CS1/1984/069 and CS1/1988/039
14	McLeod R., Isvilanonda S. and Wattanuchariya S. 1999.	Improved drying of high moisture grains	PHT/1983/008, PHT/1986/008 and PHT/1990/008
15	Chudleigh P. 1999.	Use and management of grain protectants in China and Australia	PHT/1990/035
16	McLeod R. 2001.	Control of footrot in small ruminants of Nepal	AS2/1991/017 and AS2/1996/021
17	Tisdell C. and Wilson C. 2001.	Breeding and feeding pigs in Australia and Vietnam	AS2/1994/023
18	Vincent D. and Quirke D. 2002.	Controlling <i>Phalaris minor</i> in the Indian rice–wheat belt	CS1/1996/013
19	Pearce D. 2002.	Measuring the poverty impact of ACIAR projects—a broad framework	
20	Warner R. and Bauer M. 2002.	<i>Mama Lus Frut</i> scheme: an assessment of poverty reduction	ASEM/1999/084
21	McLeod R. 2003.	Improved methods in diagnosis, epidemiology, and information management of foot-and-mouth disease in Southeast Asia	AS1/1983/067, AS1/1988/035, AS1/1992/004 and AS1/1994/038
22	Bauer M., Pearce D. and Vincent D. 2003.	Saving a staple crop: impact of biological control of the banana skipper on poverty reduction in Papua New Guinea	CS2/1988/002-C
23	McLeod R. 2003.	Improved methods for the diagnosis and control of bluetongue in small ruminants in Asia and the epidemiology and control of bovine ephemeral fever in China	AS1/1984/055, AS2/1990/011 and AS2/1993/001
24	Palis F.G., Sumalde Z.M. and Hossain M. 2004.	Assessment of the rodent control projects in Vietnam funded by ACIAR and AUSAID: adoption and impact	AS1/1998/036

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No.	Author(s) and year of publication	Title	ACIAR project numbers
25	Brennan J.P. and Quade K.J. 2004.	Genetics of and breeding for rust resistance in wheat in India and Pakistan	CS1/1983/037 and CS1/1988/014
26	Mullen J.D. 2004.	Impact assessment of ACIAR-funded projects on grain-market reform in China	ANRE1/1992/028 and ADP/1997/021
27	van Bueren M. 2004.	Acacia hybrids in Vietnam	FST/1986/030
28	Harris D. 2004.	Water and nitrogen management in wheat–maize production on the North China Plain	LWR1/1996/164
29	Lindner R. 2004.	Impact assessment of research on the biology and management of coconut crabs on Vanuatu	FIS/1983/081
30	van Bueren M. 2004.	Eucalypt tree improvement in China	FST/1990/044, FST/1994/025, FST/1984/057, FST/1988/048, FST/1987/036, FST/1996/125 and FST/1997/077
31	Pearce D. 2005.	Review of ACIAR's research on agricultural policy	
32	Tingsong Jiang and Pearce D. 2005.	Shelf-life extension of leafy vegetables—evaluating the impacts	PHT/1994/016
33	Vere D. 2005.	Research into conservation tillage for dryland cropping in Australia and China	LWR2/1992/009, LWR2/1996/143
34	Pearce D. 2005.	Identifying the sex pheromone of the sugarcane borer moth	CS2/1991/680
35	Raitzer D.A. and Lindner R. 2005.	Review of the returns to ACIAR's bilateral R&D investments	
36	Lindner R. 2005.	Impacts of mud crab hatchery technology in Vietnam	FIS/1992/017 and FIS/1999/076
37	McLeod R. 2005.	Management of fruit flies in the Pacific	CS2/1989/020, CS2/1994/003, CS2/1994/115 and CS2/1996/225
38	ACIAR 2006.	Future directions for ACIAR's animal health research	
39	Pearce D., Monck M., Chadwick K. and Corbishley J. 2006.	Benefits to Australia from ACIAR-funded research	FST/1993/016, PHT/1990/051, CS1/1990/012, CS1/1994/968, AS2/1990/028, AS2/1994/017, AS2/1994/018 and AS2/1999/060
40	Corbishley J. and Pearce D. 2006.	Zero tillage for weed control in India: the contribution to poverty alleviation	CS1/1996/013
41	ACIAR 2006.	ACIAR and public funding of R&D. Submission to Productivity Commission study on public support for science and innovation	
42	Pearce D. and Monck M. 2006.	Benefits to Australia of selected CABI products	
43	Harris D.N. 2006.	Water management in public irrigation schemes in Vietnam	LWR2/1994/004 and LWR1/1998/034
44	Gordon J. and Chadwick K. 2007.	Impact assessment of capacity building and training: assessment framework and two case studies	CS1/1982/001, CS1/1985/067, LWR2/1994/004 and LWR2/1998/034
45	Turnbull J.W. 2007.	Development of sustainable forestry plantations in China: a review	
46	Monck M. and Pearce D. 2007.	Mite pests of honey bees in the Asia–Pacific region	AS2/1990/028, AS2/1994/017, AS2/1994/018 and AS2/1999/060

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No.	Author(s) and year of publication	Title	ACIAR project numbers
47	Fisher H. and Gordon J. 2007.	Improved Australian tree species for Vietnam	FST/1993/118 and FST/1998/096
48	Longmore C., Gordon J., and Bantilan M.C. 2007.	Assessment of capacity building: overcoming production constraints to sorghum in rainfed environments in India and Australia	CS1/1994/968
49	Fisher H. and Gordon J. 2007.	Minimising impacts of fungal disease of eucalypts in South-East Asia	FST/1994/041
50	Monck M. and Pearce D. 2007.	Improved trade in mangoes from the Philippines, Thailand and Australia	PHT/1990/051 and CS1/1990/012
51	Corbishley J. and Pearce D. 2007.	Growing trees on salt-affected land	FST/1993/016
52	Fisher H. and Gordon J. 2008.	Breeding and feeding pigs in Vietnam: assessment of capacity building and an update on impacts	AS2/1994/023
53	Monck M. and Pearce D. 2008.	The impact of increasing efficiency and productivity of ruminants in India by the use of protected-nutrient technology	AH/1997/115
54	Monck M. and Pearce D. 2008.	Impact of improved management of white grubs in peanut-cropping systems	CS2/1994/050
55	Martin G. 2008.	ACIAR fisheries projects in Indonesia: review and impact assessment	FIS/1997/022, FIS/1997/125, FIS/2000/061, FIS/2001/079, FIS/2002/074, FIS/2002/076, FIS/2005/169 and FIS/2006/144
56	Lindner B. and McLeod P. 2008.	A review and impact assessment of ACIAR's fruit-fly research partnerships – 1984 to 2007	CS2/1983/043, CS2/1989/019, CS2/1989/020, CS2/1994/003, CS2/1994/115, CS2/1996/225, CS2/1997/101, CS2/1998/005, CS2/2003/036, CP/2007/002, CP/2007/187, PHT/1990/051, PHT/1994/133, PHT/1993/87, CP/1997/079, CP/2001/027 and CP/2002/086
57	Montes N.D., Zapata Jr N.R., Alo A.M.P. and Mullen J.D. 2008.	Management of internal parasites in goats in the Philippines	AS1/1997/133
58	Davis J., Gordon J., Pearce D. and Templeton D. 2008.	Guidelines for assessing the impacts of ACIAR's research activities	
59	Chupungco A., Dumayas E. and Mullen J. 2008.	Two-stage grain drying in the Philippines	PHT/1983/008, PHT/1986/008, PHT/1990/008
60	Centre for International Economics 2009.	ACIAR Database for Impact Assessments (ADIA): an outline of the database structure and a guide to its operation	
61	Fisher H. and Pearce D. 2009.	Salinity reduction in tannery effluents in India and Australia	AS1/2001/005
62	Francisco S.R., Mangabat M.C., Mataia A.B., Acda M.A., Kagaoan C.V., Laguna J.P., Ramos M., Garabiag K.A., Paguia F.L. and Mullen J.D. 2009.	Integrated management of insect pests of stored grain in the Philippines	PHT/1983/009, PHT/1983/011, PHT/1986/009 and PHT/1990/009
63	Harding M., Tingsong Jiang and Pearce D. 2009.	Analysis of ACIAR's returns on investment: appropriateness, efficiency and effectiveness	
64	Mullen J.D. 2010.	Reform of domestic grain markets in China: a reassessment of the contribution of ACIAR-funded economic policy research	ANRE1/1992/028 and ADP/1997/021

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No.	Author(s) and year of publication	Title	ACIAR project numbers
65	Martin G. 2010.	ACIAR investment in research on forages in Indonesia	AS2/2000/124, AS2/2001/125, AS2/2000/103, LPS/2004/005, SMAR/2006/061, SMAR/2006/096
66	Harris D.N. 2010.	Extending low-cost fish farming in Thailand: an ACIAR–World Vision collaborative program	PLIA/2000/165



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