Australian Government
Australian Centre for
International Agricultural Research

Extending low-chill fruits in northern Thailand: an ACIAR–World Vision collaborative project

ACIAR IMPACT ASSESSMENT SERIES 70

Research that works for developing countries and Australia

Extending low-chill fruits in northern Thailand: an ACIAR–World Vision collaborative project

David N. Harris
D.N. Harris & Associates

ACIAR
Research that works for developing countries and Australia
www.aciar.gov.au

2011

The Australian Centre for International Agricultural Research (ACIAR) was established in June 1982 by an Act of the Australian Parliament. ACIAR operates as part of Australia's international development cooperation program, with a mission to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia. It commissions collaborative research between Australian and developing-country researchers in areas where Australia has special research competence. It also administers Australia's contribution to the International Agricultural Research Centres.

Where trade names are used this constitutes neither endorsement of nor discrimination against any product by the Centre.

ACIAR IMPACT ASSESSMENT SERIES

ACIAR seeks to ensure that the outputs of the research it funds are adopted by farmers, policymakers, quarantine officers and other beneficiaries. In order to monitor the effects of its projects, ACIAR commissions independent assessments of selected projects. This series of publications reports the results of these independent studies. Numbers in this series are distributed internationally to selected individuals and scientific institutions, and are also available from ACIAR's website at <aciar.gov.au>.

Harris D.N. 2011. *Extending low-chill fruits in northern Thailand: an ACIAR–World Vision collaborative project*. ACIAR Impact Assessment Series Report No. 70. Australian Centre for International Agricultural Research: Canberra. 52 pp.

ISSN 1832-1879
ISBN 978 1 921738 53 1 (print)
ISBN 978 1 921738 54 8 (online)

Editing by Mary Webb, Canberra
Design by Clarus Design, Canberra
Printing by CanPrint Communications, Canberra

Cover: Mr Anusorn Somsiri, from the World Vision Foundation of Thailand, picks low-chill plums from a farm in the Pang Khon village area of Chiang Rai province. Photo © D.N. Harris.

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 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 WV's network of localised Area Development Programs (ADPs).

Six projects were jointly selected by ACIAR and WV for inclusion in the program. They included: 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.

An evaluation of the net benefits of the entire collaborative program would be a major undertaking and ACIAR decided this was not feasible. Instead, selected components of the program were chosen for an impact assessment. The first of these was a review of the Thai fish-farming project (ACIAR Impact Assessment Series Report No. 66). This report presents the findings of a second review, of the Thai low-chill fruits project.

The impact of the project was assessed on the basis of the economic returns that accrue to farmers adopting the extension advice. This report has found that poverty alleviation gains were limited. Production difficulties and marketing constraints have restricted the number of farmers that successfully adopted the extension advice. There were no significant social welfare benefits in the form of improved food security or raising the nutritional content of the family diet.

The project link to one of WV's ADPs was an effective way to reach the potential beneficiaries—poor farmers with few options for agricultural production on mountainous terrain. But the report notes some issues for consideration to improve the effectiveness and sustainability of outcomes from this type of project. There are several useful lessons for future planning and implementation of extension advice for high-value fruit products that are sensitive to growing conditions.

Nick Austin
Chief Executive Officer, ACIAR

Contents

Figure

Tables

Acknowledgments

The preparation of this impact assessment report was made possible by the assistance of several individuals. The assistance of Dr Debbie Templeton, Ms Chiraporn Sunpakit and Mr Niphon Yodsangkam from the Australian Centre for International Agricultural Research (ACIAR) was greatly appreciated.

In Thailand, a number of people contributed to the assessment. The Office of Agricultural Economics (OAE) in the Thai Ministry of Agriculture and Cooperatives (MOAC) was able to provide information on market returns for low-chill fruits in northern Thailand. The efforts of Mr Nattawund Yaowarittha to find the information was greatly appreciated, as pricing information on low-chill fruits is not readily available.

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 1). 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 the 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 trip and acted as an interpreter during site visits to meet with farmers and government officials. He supervised the survey activity and ensured 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 organisation efforts were greatly appreciated.

Executive summary

In 2001 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 research results from previous technical projects. The program had six projects in Thailand, Lao PDR and Vietnam. The objective of the projects was either poverty alleviation or food security.

There was a combination of participatory research and capacity building in each project. They were implemented by the in-country WV agencies as self-improvement activities in their Area Development Programs (ADPs). The ADPs are located in areas of poverty where the farmer members have limited land areas and low incomes.

WV focuses its development assistance on the poorest members of local communities. This meant the extension efforts of each project were targeted at a particular group of farmers in specified locations. The impact area and potential beneficiaries are limited by the membership of the ADPs chosen to participate in each project.

To evaluate the effectiveness of the program, selected projects were chosen for an impact assessment. The first of these was an assessment of a low-cost fish farming project in northern and central Thailand. This report presents an assessment of a second project, on low-chill fruit production in the highland areas of northern Thailand.

The Thai low-chill fruits project

Temperate-zone fruits can be grown in areas where temperatures fall below 7.2 °C for a specified period. Mountain areas in Chiang Mai have the required climatic conditions. Previous ACIAR projects had shown high-value low-chill fruits could be grown in the region as an alternative to local fruits such as Thai peaches.

The aim of the low-chill fruits project was to encourage farmers to establish an enterprise based on new cultivars. The objective was poverty alleviation. This would be achieved by promoting a shift from low-quality Thai peach production into higher returning fruits such as peaches, nectarines, plums and persimmons.

Implementation of the project was confined to a single ADP—the Huai Chomphu ADP in Chiang Rai province. There were two phases to the project. The first phase, from 2000–01 to 2003–04, focused on evaluating the suitability of different varieties of temperate-zone fruits and teaching farmers the required tree-management practices.

Three village areas were nominated to participate in the project. ADP staff collaborated with professional staff from the Chiang Mai Royal Agricultural Research Centre (RARC) to provide extension training. Demonstration plots and training centres were established. Several varieties of temperate-zone peaches, nectarines and plums were trialled.

Initially 174 farm households participated in the project. Seedlings and cuttings for grafting were distributed at the start of the project (i.e. late 2000–01). There was a selection of new varieties of peaches, plums, nectarines and persimmons.

The project had limited success in phase one. ADP staff did not have sufficient technical knowledge to advise the farmers. Monitoring on-farm adoption was difficult because the participants were widely dispersed. Many farmers failed to apply the required tree-care practices and had trouble establishing the new varieties. Some trees failed to produce any fruit because of poor site selections and others took several years to fruit.

These difficulties caused a loss of interest in the project. The project was extended to 2005–06 but was substantially modified and consolidated to a single village. Extension activities were redesigned to strengthen the technical advice from the RARC and promote the use of top-grafting techniques to accelerate the establishment of new varieties.

At the start of phase two, the scope of the project was reduced to 36 farms in Pang Khon village. Some were new participants and others were phase one participants. No further training or assistance was provided to phase one participants in other village areas. Many of the farmers in these villages ceased trying to grow the new low-chill varieties.

Consolidation of the project substantially reduced project participation. By the end of phase two, participation had declined to 22 farms. WVFT decided to focus on these farms because they were interested and had land more than 1,000 metres above sea level.

Benefits of the Thai low-chill fruits project

A survey of adopting farmers was used to estimate the project benefits. It showed the inventory of low-chill trees was small, with a preference for plums and persimmons. They were high-yielding fruit trees and easier to manage than peaches and nectarines.

Advice from the RARC was used to develop a likely time path of yield performance. It suggested maximum yield outcomes of 20 kg/tree for peaches, 35 kg/tree for plums and 75 kg/tree for persimmons. When compared with a 'no impact' base case situation, the farm-level impact generated an estimated project benefit of A$782,600.

Most of the benefits will come in future years—the trees had not reached peak yields in 2009–10 when the impact assessment was undertaken. Low-chill plums and persimmons account for most of the benefits. Very few low-chill peach and nectarine trees have been established and their yields are low.

Net benefits of the Thai low-chill fruits project

The present value of the project net benefits is estimated at just A$59,000. In part, this reflects the low number of adopters. The problems that arose in phase one caused many farmers to lose interest. Establishment failures and consolidation of the project to a single village (Pang Khon) in phase two reduced the effectiveness of the project.

Another factor contributing to the small net benefits was low fruit returns. Marketing impediments and the inability or unwillingness to apply the required tree-management practices affected the quality of the fruit. The survey results on average returns show the growers are producing low-grade fruit.

Project participants currently producing low-chill fruits have benefited from higher farm incomes. The poverty alleviation objective has been achieved for these farmers although the gains are much smaller than predicted. The project has not achieved the widespread improvement in farm incomes that was expected.

Attribution of the net benefits between ACIAR and WVFT is based on the respective shares of total project expenditure. It shows the return on investment for each agency would be A$41,000 for ACIAR and A$18,000 for WVFT.

The impact assessment is sensitive to future enterprise developments on yield growth. A sensitivity analysis of the estimated net benefits for a 'best case' and 'worst case' yield scenario was prepared. It shows the net benefits would vary between a gain of A$180,000 and a loss of A$72,000.

Some lessons from the impact assessment

Using WV's ADP network to deliver extension training is a good approach to enhancing adoption of technical research. It can be an effective way to achieve a poverty alleviation objective targeted at very poor people in rural communities. However, there are limits to the extent of the impact. In this case, the potential benefits were limited to a small number of growers in northern Thailand.

The pool of potential beneficiaries was reduced by implementation problems in the first phase of the project. Difficulties arose because of poor site selection, the premature distribution of new cultivars and the low skill base of participants—establishment problems that discouraged participation.

The problems suggest deficiencies in the design of the project. A failure to check that all the selected sites had the required microclimate suggests inadequate planning. More generally, the establishment difficulties suggest that there was insufficient training before the new cultivars were distributed and that participants did not receive enough monitoring advice during on-farm adoption of the extension advice.

Post-farm marketing problems reduced the impact of the project. Harvesting and handling are critical issues for producing high-quality fruits. The project focused on growing fruits and needed a training component on fruit marketing to enhance the income benefits of adopting the extension advice. Poor tree management practices by the adopting farmers contributed to limited income gains from the project. Irrigation during fruit development, pest protection and the timing of harvest are key factors in producing high-quality, high-value fruits.

1 Introduction

The impact of Australian Centre for International Agricultural Research (ACIAR) investments in applied scientific research projects in developing economies depends on the effectiveness of post-project extension efforts. Reliance on non-government organisations (NGOs) and government agencies for adoption of research results is often ineffective. For this reason, ACIAR emphasises the importance of extension in project design.

An alternative approach is for ACIAR to invest in participatory research and complementary extension activities that use the results of research and development (R&D) investments. To assess the value of this approach, ACIAR collaborated with World Vision (WV) Australia, investing in a program of extension-enhancing projects in selected developing countries.

WV is an NGO active in several countries where ACIAR has invested funds in technical research projects. It focuses on poverty alleviation, food security and social welfare improvements among the poorest members of rural communities. It is an organisation with close links to the farming communities in locations where it has staff engaged in its Area Development Programs (ADPs).

WV collaborates with government agencies to deliver health, education and other welfare programs to the poor living in its ADP areas. This includes self-help extension projects aimed at poverty alleviation. These projects often involve collaboration with government farm extension services and other public or private sector agencies.

ACIAR funded the WV extension projects through a program called 'Facilitating farmer uptake of ACIAR project results: World Vision collaborative program' (PLIA/2000/165). The program was nominated for an impact assessment, with selected projects reviewed to provide an indication of the benefits of this type of investment. There were six program components:

- component 1 in southern Thailand—agriculture reform preventing agri-chemical 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-eastern 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.

Each component involved participatory research and extension activities based on the results from related ACIAR project investments in keeping with the organisation's mandate. A 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.
- An extension project may not be implemented in all the areas where WV has an active ADP—participation decisions are optional and decentralised.

The number of potential direct beneficiaries for each component is restricted to a targeted group of poor farmers in particular communities and locations. Wealthy and low-income farmers do not participate in ADP projects. Adoption of the extension advice beyond the target group relies on other farmers observing and adopting the outcomes. If there is no follow-up extension work, the prospects for greater adoption over time are limited.

The collaborative program was administered through WV Australia but the individual extension projects were implemented by the in-country WV organisation. Each project was integrated into the work program of selected ADPs as a specific activity. The local WV organisation contributed funds to its projects and arranged for in-country project partners to provide technical advice as necessary.

The total program budget from ACIAR and WV was A$1.799 million over the 2000–01 to 2007–08 period. ACIAR's contribution of A$1.453 million accounted for about 80% of the budget. The program began in January 2001 and was initially designed for each component to run for 2–3 years with similar-size budgets. Extensions were granted in some cases and the completion dates varied accordingly.

The review of the ACIAR–WV collaborative program commenced with an impact assessment of component 3—Thai fish farming with low-cost feed. The assessment (ACIAR Impact Assessment Series Report No. 66) found significant poverty alleviation and food security benefits for the adopting farm households. In present value terms, the net benefits were estimated at A$6.9 million with a benefit:cost ratio of 5.1:1.

This report presents the findings of an impact assessment for component 2—low-chill fruits in northern Thailand. The project was developed and implemented by the World Vision Foundation of Thailand (WVFT). The review of the collaborative program will conclude with an impact assessment of component 5—improving rice crop yields in southern Lao PDR. The report on that assessment will be published during 2011.

2 The Thai low-chill fruits project

The low-chill fruits project was developed to extend the results of an ACIAR project on growing temperate-zone fruits in the high-elevation areas of northern Thailand. For several years ACIAR supported a collaborative research project with the Chiang Mai Royal Agricultural Research Centre (RARC), an agency of the Thai Department of Agriculture. The project identified cultivars of stone fruits that were suitable for the region, such as peaches, nectarines, plums and persimmons.

Temperate-zone fruits are grown in areas where the temperature falls below 7.2 °C for a specified period in the annual production cycle. Mountain areas in Chiang Mai province have the required climatic conditions, and the ACIAR project showed that high-value, temperate-zone low-chill fruits could be grown in the region. Many hill tribe farmers in Chiang Mai are growing the new varieties as an alternative to local fruits and other agricultural products.

- The Royal Project Foundation (RPF 2010) supported farm extension efforts to encourage the adoption of these new varieties as a substitute for illegally growing opium.
- The fruits are being marketed throughout the country as high-quality, high-value produce under the Foundation's brand name.

The objective of the ACIAR–WV collaborative project was to encourage poor farmers in the high elevation areas of Chiang Rai province to grow the same low-chill fruits. Climatic conditions are similar to those in Chiang Mai, and poverty alleviation was a focus of WVFT efforts in its regional ADP activities. The technology was transferable and the project was expected to generate substantial farm income benefits.

Low-chill fruit production in Thailand

There is a strong demand for deciduous fruits in Thailand and temperate-zone varieties of peaches and plums are popular with consumers. The highland area of northern Thailand is the only location with suitable growing conditions. Thai local varieties of peaches and plums have adapted to the conditions and have been grown in this area for some time.

The 'Thai peach' is a low-quality, small-size fruit that sells at a substantial discount compared to the larger, higher quality imported fruits. Thai peaches are picked early before the fruits ripen. Most are sold to processors to make a preserved product that is widely consumed. Some are sold as a fresh fruit and some are retained by the farmer for preserving.

The local plum is small in size but the quality is higher than that of peaches as the fruit is partially ripened before harvest. There is a longer picking season as the fruit is less susceptible to insect attack. Most of the annual harvest is sold as fresh fruit with about 20% of production sold to processors for juice and preserved products.

Other deciduous fruits grown in northern Thailand include persimmon, Japanese apricot, Marian plum and Asian pear. Formal orchards account for about half of the low-chill fruit cultivation in Thailand (Table 1). The remaining output comes from informal 'scattered' cultivation in conjunction with other crops.

There is some cultivation of imported cultivars of temperate-zone varieties of peaches, nectarines and plums, but their contribution to the deciduous fruit industry is difficult to judge. The industry is small and

Table 1. Cultivation of low-chill fruits in Thailand[a]

Fruit type	Number of farms[b]	Number of productive trees	Orchard cultivation	Informal cultivation
	no.	'000 trees	%	%
Peach	1,939	344.8	66.8	33.2
Japanese apricot	2,395	375.9	59.6	40.4
Plum	526	81.0	75.4	24.6
Marian plum	16,950	407.6	28.6	71.4
Total	21,810	1,209.3	52.3	47.7

Source: NSO (2010)

[a] Based on agricultural census results for 2003

[b] Farms with fruit-bearing trees

there are very few statistical data on production, yields and market prices for the different varieties of fruits.

The most recent information indicates that Thai peach production was around 3,255 tonnes in 2004 (Table 2). Some production growth has probably occurred since that time because of the farm extension and marketing activities of the RPF in Chiang Mai. However, a law that prevents the clearing of forest land for new orchards will have constrained the growth to some extent.

Most fruit trees are grown under rainfed conditions and the use of irrigation is limited. There is a 4–6 month dry period in northern Thailand and water for human consumption has highest priority. There have been some irrigation and water storage developments in the fruit-growing areas of Chiang Mai. In the Chiang Rai highlands, access to water supplies is severely limited by storage constraints.

A lack of water during fruit development affects tree yields and fruit quality. It is a factor in the small size of the fruits from the local variety of peach trees. Other factors affecting yield and fruit quality are temperatures in the fruit-setting phase, tree management (i.e. pruning), fertiliser use, tree diseases, fruit insects and the timing of harvest. Managing these issues has been a focus of the farm extension training in Chiang Mai.

Chemical spraying to control pests and diseases is discouraged by extension advisers as most production areas are located in water catchments. Spoilage from fruit-fly attack is a major issue. This is especially the case for peaches, which have a soft skin as the fruit ripens. Control measures commonly used to protect peaches from insect attacks are: individually bagging immature fruits on the tree before they begin to ripen; and hanging insecticide bottles on trees to attract and kill the insects.

There is no incentive for farmers to bag Thai peaches on the tree because market returns are low. This measure is used for only higher value fruit grown from imported cultivars. Thai peaches are generally picked before they ripen and are then preserved. This avoids the spoilage problem from fruit-fly attack. Local plums are less susceptible to insect attacks and are generally harvested as ripened fruits.

The orchard management issues highlight the practical difficulties of growing temperate-zone varieties in northern Thailand. They partially explain why the market prices for Thai peaches and plums are much lower than the prices paid for fruit from imported cultivars. When sold as fresh fruits, Thai consumers consider the quality (i.e. texture, flavour, juiciness etc.) of the local varieties to be inferior to the imported varieties.

Market price data for Thai peaches and plums could not be obtained for this assessment. Discussions during the in-country visits suggested farm prices were typically around 4–8 baht/kg for peaches and 5–9 baht/kg for plums. Farm returns for fruits from the temperate-zone cultivars were reportedly much higher. Wholesale price data for fruit sales by the RPF in Chiang Mai support this view (Table 3).

Table 2. Thai peach production in Thailand

Year	Area planted to Thai peach trees	Productive area of Thai peach trees		Thai peach production	Average yield[a]
	ha	ha	%	t	t/ha
2000	876	684	78.0	3,027	4.4
2001	763	634	83.2	2,392	3.8
2002	904	550	60.8	2,443	4.4
2003	944	710	75.2	3,444	4.9
2004	789	688	87.2	3,255	4.7

Source: NSO (2010)

[a] Based on productive area

For example, in 2009 the average price of top-quality Tropic Beauty peaches was around 150 baht/kg. The price of low-grade fruit was around 80 baht/kg. Prices for top-grade Ban Luang Daeng plums averaged around 75 baht/kg and low-grade processing fruit was around 18 baht/kg. Price differentials were similar for Gulf Ruby plums.

These wholesale prices are for fruits grown in the Chiang Mai highlands and sold under the RPF brand. They are not farm-level returns. However, even if allowance is made for a marketing margin, they provide an indication of the price premiums. This was the primary motivation for encouraging hill tribe farmers to grow imported cultivars of peaches, plums, nectarines and persimmons.

The premiums that are evident from these market prices are dependent on the farming and marketing practices required by the RPF. Orchard management practices are important for producing high-quality fruits. They need to be complemented by harvesting, handling and transport practices that ensure the fruit arrives at the wholesale market in good condition

- For the ACIAR–WV project in the Chiang Rai highlands to be successful, farmers would need to adopt the required orchard management practices and develop an appropriate supply-chain capability.

Extension activities in the low-chill fruits project

The objective of the ACIAR–WV collaborative project was to encourage farmers in the Huai Chomphu ADP to establish a fruit enterprise based on high-value temperate-zone cultivars. The ADP is operating in the Huai Chomphu subdistrict of the Mueang Chiang Rai district, Chiang Rai province.

The strategy was to improve farm returns through an enterprise that was suited to the mountainous terrain and climatic conditions. Most farmers were growing Thai peaches or plums as a sideline activity. Switching to high-valued imported cultivars and expanding the enterprise was expected to raise farm incomes.

- The project had a general theme of poverty alleviation and providing farmers an alternative to illegal opium crops.
- It differed from the ACIAR–WV collaborative project on Thai fish farming, which had a food security objective in conjunction with poverty alleviation.

There were two phases to the project. The first phase from 2000–01 to 2003–04 focused on evaluating which varieties of temperate-zone fruits were suitable and teaching farmers the required tree management practices. Three villages in the Huai Chomphu ADP were nominated to participate in the project.

Table 3. Wholesale prices of low-chill fruits in northern Thailand[a]

Fruit type and quality	2005	2006	2007	2008	2009	2010
	baht/kg	baht/kg	baht/kg	baht/kg	baht/kg	baht/kg
Tropic Beauty peach						
Top grade	140	140	140	130	150	150
Second grade	100	100	85	75	115	120
Low grade[b]	80	80	65	60	80	100
Other peach varieties[c]						
Top grade	120	80	200	120	130	130
Second grade	100	60	135	65	105	105
Low grade[b]	90	50	100	50	75	75
Gulf Ruby plum						
Top grade	80	80	75	65	65	65
Second grade	60	60	45	40	40	40
Low grade[d]	15	25	20	20	20	20
Ban Luang Daeng plum						
Top grade	80	80	75	75	75	65
Second grade	60	60	45	45	45	45
Low grade[d]	20	25	20	15	18	18
Other plum varieties[c]						
Top grade	80	80	80	80	80	70
Second grade	60	60	60	60	60	50
Low grade[d]	17	17	17	17	17	17
Fuyu persimmon						
Top grade	80	80	75	75	75	75
Second grade	60	60	45	45	45	45
Low grade[d]	20	25	20	15	18	18

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

[a] Average weekly prices for fruits marketed by the Royal Project Foundation—price quotes during the fruit-harvesting season from February to May

[b] Prices of third-grade fresh fruits

[c] Prices for new, unspecified varieties being evaluated by the Royal Project Foundation

[d] Prices of factory-grade fruit for processing

Selection of the villages was based on the elevation of the surrounding areas. Sites had to be 1,200 metres above sea level to meet the climatic conditions required for growing low-chill fruits. The trees require temperatures to fall below 7.2 °C for a period in their annual production cycle to ensure fruit setting is triggered.

- At least 100 hours of temperatures below 7.2 °C per year is needed for plums and up to 275 hours per year for peaches—elevations of at least 1,200 metres above sea level were expected to meet this requirement.

Initially, 200 farm households were targeted to participate in the project. There was no assessment of the microclimate of individual farms to determine if growing conditions were suitable. Farms with Thai peach rootstock were assumed to be in locations that would satisfy the minimum temperature threshold even though land elevation in the region was highly variable.

WVFT staff of the ADP collaborated with technical officers from the RARC. They supervised the participatory research and directed the extension activities. There was little involvement of the Australian scientists from the previous ACIAR research project at Chiang Mai.

Demonstration plots and training centres were established in two villages to support the training. Several varieties of temperate-zone peaches, nectarines and plums were trialled. Farmers selected to participate in the project received training on tree care practices and grafting. They were paid to help maintain the demonstration plots.

Seedlings and shoots for grafting were distributed free of charge to project participants at the start of the project (i.e. late 2000–01). A selection of new varieties of peaches, plums and nectarines was purchased from the RARC for distribution. New varieties of macadamias, apricots and persimmons were also distributed. Farmers were given enough cultivars to establish a small-scale orchard covering about 0.5 ha.

The seedlings and grafting shoots were grown at the Khun Wang Research Station in Chiang Mai province, which is one of the experimental research sites for the RARC. The research station is located 1,300–1,400 metres above sea level. It was established to evaluate and propagate new varieties of temperate-zone crops. RARC staff visited the project demonstration sites each month to provide technical advice.

In subsequent years, farmers were encouraged to graft cuttings of new varieties onto their existing rootstock as they were evaluated by the RARC. New cuttings were progressively distributed as they became available but there were difficulties in obtaining sufficient supplies from the research station in Chiang Mai.

Communication difficulties limited the effectiveness of the extension training in the early stages of the project. Monitoring on-farm adoption was restricted because the participants were widely dispersed and travel was difficult. Many farmers had problems establishing the new varieties because of a failure to apply the required tree care practices. The high loss rate required replacement cultivars to be distributed.

Study tours and extension activities relied on small groups receiving training and sharing their knowledge with other farmers. The drawbacks of the 'trickle-down' approach to capacity building may have contributed to the failure to apply the required orchard management practices. Most farmers did not give much attention to their Thai peach and plum trees. It is likely the same approach was applied to the newly established low-chill cultivars.

- The project was implemented at a time when ADP farmers were being encouraged to develop other crop enterprises to improve their cash flow.
- Farmers had also received ADP extension training on growing lychee, macadamia and coffee trees—they were suited to the climate and were low maintenance.
- Favourable returns for lychees and coffee may have been a factor in the casual approach to the application of extension advice on low-chill tree care.

In some cases, the new trees did not produce any fruit for several years. In other cases, the trees failed to produce any fruit when they reached fruit-bearing age. This was mostly due to poor site selection—the microclimate did not have the required low-chill climatic conditions. The existing location of Thai fruit trees did not guarantee success from the grafting of new low-chill varieties.

An issue that subsequently emerged was the reduced income in situations where farmers had replaced their local peach and plum trees with graftings of new varieties. Grafting failures, slow growth of seedlings and

grafted trees, low fruit yields and problems with pests and diseases limited the saleable output.

- Progress reports for the project noted a need for complementary farm enterprises to provide other income streams until the new trees reached maturity.

The first phase of the project had limited success. By the end of 2002–03, participation had declined to 174 farms in the three villages. Poor site selection and problems with establishing the new trees contributed to the loss of interest. It was also apparent the ADP staff did not have sufficient technical knowledge to adequately advise the farmers. This reduced the effectiveness of the extension training activities.

- The indications are that there was insufficient technical support and training for ADP staff and insufficient monitoring of on-farm application of the extension advice.
- Relying on groups of farmers to share their knowledge with others may not have been an effective approach because of cultural differences in the villages.

In phase one, the distribution of new varieties primarily focused on graftings of peaches—small numbers of plums, nectarines and persimmons were also distributed. Peaches were popular because farmers were familiar with growing Thai peaches. Very few peach trees had produced fruit by the end of phase one. Slow tree growth and the need to replace failed grafts delayed the transition to fruit-yielding orchards.

In September 2003, the project was reviewed as part of an assessment of the ACIAR–WV collaborative program. The review noted the problems with implementing the project and found it was unlikely to achieve its objective of improving farm incomes. Subsequently, the project was extended to a second phase but with substantial modifications.

- It was recommended the distribution of new varieties should end until assessments were made to establish which farms had the required microclimate, and extension activities were redesigned to strengthen the technical advice for farmers.

Phase two extended the project for a further 2 years to 2005–06. The project activities were consolidated to one village area (Pang Khon) with one demonstration site. Training activities were redesigned to incorporate a stronger technical input from the RARC. The project objective remained the same but the specific aims of phase two were to:

- focus extension advice on growing fruits that showed the most promise
- assess the suitability of the project participants to grow temperate-zone fruits, based on the local microclimate of their orchard area
- trial new tree management systems and develop nursery training programs
- conduct market research on the viability of low-chill fruit sales.

The scope of the project was substantially reduced. Extension training and distribution of new varieties were restricted to 36 farm households in the Pang Khon village area. Some were new project participants and others were phase one participants. The decline in Pang Khon participation reflected a loss of interest by some farmers and the exclusion of others because their farm microclimate was assessed to be unsuitable.

- No further training was provided for phase one participants in villages other than Pang Khon.

There was a stronger technical input from RARC staff during phase two and top-grafting techniques were promoted to accelerate the establishment of new varieties. Project funds were provided to RARC staff for monthly visits to Pang Khon. Monitoring of the on-farm application of tree management practices by RARC and ADP staff was more effective. Farmers were encouraged to use fertilisers, disease and pest controls and to water the trees during dry conditions.

By the end of phase two, project participation had declined to 22 farms. WVFT decided to focus on these farms because they were interested and had land at more than 1,000 metres above sea level. A core group of 10 farmers was selected for training at the RARC. They were expected to pass on their knowledge to other phase two participants. The success of coffee as a cash crop was another factor in the reduced interest in the project.

Phase two training and farmer preferences focused on plums—Ban Luang Daeng and Gulf Ruby were the favoured varieties. Some peach varieties had performed well at the demonstration site but were not successful on farm. Persimmons were successfully established on farm and contributed to an improvement in household incomes. There was very little interest in growing nectarines.

- By the end of phase two, most of the 22 farm households had decided to graft plum varieties onto the rootstocks of their nectarine and peach trees.

In phase two, the project was composed of two groups of farmers. One group comprised phase one participants that began growing new varieties in 2000–01. The other group was new participants that made their initial graftings onto rootstock of Thai peaches and plums in 2004–05. The timing of the first harvest varied between the two groups. In some cases, it was delayed by decisions to graft plums onto some low-chill trees.

- The first significant harvest for participants from phase one occurred in 2005–06 which represented a production lag of 5 years.
- The first significant fruit harvest for new phase two participants occurred in 2008–09 which represented a production lag of 4 years.

RARC scientists had found there was a production lag of 3–4 years before new trees produced their first fruit in the Chiang Mai highlands. The production lag was longer for project participants in Chiang Rai because of difficulties with implementation.

- Peach and nectarine yields typically peak after 5–6 years of production and then decline slowly after about 8–10 years of production.
- Plum and persimmon yields typically peak after about 8–10 years of production and then decline slowly after about 20 years of production.

At the end of phase two, WVFT developed a new project to meet a problem raised in the project review in September 2003. To provide another source of income, farmers were encouraged to grow short-term crops such as vegetables and flowers. This was a response to concerns about the income effects of production lags in fruit growing.

- The 'Income generating development project for the Huai Chomphu ADP' was a separate initiative by WVFT—there was no ACIAR funding for this project.

This new project provided training on how to establish another enterprise in mixed farming situations involving activities such as growing deciduous fruits, coffee, lychees and macadamias. The scope of the project was much wider than the second phase of the low-chill fruits project. It targeted five village areas, including Pang Khon.

Participation in this initiative was not limited to farmers growing low-chill fruits. It targeted villages that had not been involved in the low-chill fruits project. It also targeted farmers who had decided against growing low-chill fruits after an initial involvement in the project. Some of the 22 Pang Khon farmers who were still growing low-chill fruits at the end of phase two participated in the initiative.

While related to the poverty alleviation theme of the WV–ACIAR project on low-chill fruits, the outcomes of this initiative were excluded from the impact assessment. Some funds were used for extension activities on low-chill fruit growing but the amount was negligible. The initiative was almost entirely focused on other enterprise options that did not depend on the existence of a fruit-growing enterprise.

On balance, it is reasonable to exclude the A$43,000 invested in this initiative by WVFT from an impact assessment of the low-chill fruits project. It maintains consistency with the treatment of other ADP projects on mixed farming activities such as coffee, lychees and macadamias.

Project participants and area of impact

WVFT is an NGO that helps poor and underprivileged people through a system of ADPs operating in 50 provinces. The ADPs are established in districts with a high incidence of poverty. They are usually composed of several villages within a specified district and they have a lifespan that typically extends over more than 10 years.

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

One of the ADP assistance activities is to implement projects that create opportunities for self-improvement in the economic development of farm households. ADP members are ranked into four groups according to their financial situation. The poorest of the poor are the lowest ranked group. These people are often the focus of self-development projects such as establishing a low-chill fruit-growing enterprise.

WVFT records indicate there were 2,647 farm households in the eight village areas of the Huai Chomphu ADP (Table 4). Most of these farmers were members of the ADP. The potential for adoption of new cultivars of low-chill fruits was limited to locations where the farm land had the required elevation.

Three village areas were targeted for participation in the project—Pang Khon is located beside Pang Taki and they are classed as one village. From an original target of 200 farm households, 174 ADP members joined the project. There was little prospect for adoption to spread beyond these villages because of unsuitable growing conditions.

- The impact assessment has defined the project impact area as the ADP farming communities in the villages of Pang Khon, Huai Kaew and Huai Mae Liam.
- The maximum number of potential adopters was defined as the ADP membership in these villages with farm areas that had the required elevation.

First phase participants benefited from the extension activities and distribution of new low-chill cultivars. It was expected other farmers would observe their experiences and adopt the new varieties. In time, this could expand the impact of the project. However, the enterprise establishment problems during phase one and the reduced scope of the project in phase two greatly diminished the prospects for this to occur.

The impact assessment assumes no flow-on adoption beyond the direct participants. There were alternative ways for farmers to improve their farm income.

Table 4. Project participation in the Area Development Program (ADP) of Huai Chomphu[a]

Village	Total farm households	Participation in phase one[b]	Participation in phase two[c]	Current low-chill fruit growers
	no.	no.	no.	no.
Pang Khon[d]	357	83	36	22
Rom Yen	180	0	0	0
Pha Lang	295	0	0	0
Huai Kaew[e]	232	15	0	5
Huai Mae Liam[e]	610	76	0	23
Huai San Lee Saw	160	0	0	0
Mae Mon	393	0	0	0
Kok Noi	420	0	0	0
Total	**2,647**	**174**	**36**	**50**

Source: World Vision Foundation of Thailand (WVFT) (pers. comm.)

[a] Participation restricted to nominated farmers in selected villages—the Huai Chomphu ADP is located in Mueang Chiang Rai district, Chiang Rai province

[b] Phase one covered the 2000–01 to 2002–03 period

[c] Phase two covered the 2003–04 to 2005–06 period

[d] Includes Pang Taki village—estimate of current growers based on advice from ADP staff

[e] Estimate of current growers based on WVFT survey results—30% were growing low-chill fruits

Other ADP activities such as growing coffee, lychees, macadamias and vegetables did not have the difficulties that were evident with growing low-chill fruits. The assessment also assumes no flow-on adoption by non-ADP members.

- WVFT had no expectations of adoption beyond the ADP membership.
- If there have been flow-on adoption effects beyond the direct participants, the estimated net benefits of the project will be underestimated.

Most of the participants in the first phase of the project had previous experience in fruit growing. They had small numbers of fruit trees as a sideline enterprise to other farming activities. The trees were mostly Thai peaches generating a small amount of income.

Establishment difficulties encountered with the distribution of new cultivars caused some initial participants to end their involvement in the project. Consolidation of the project to one village in phase two caused a further decline in participation. Many of the farmers who left the project ceased trying to grow the new low-chill cultivars.

There were 36 farms participating when the second phase of the project began. By the end of the project, participation had declined to 22 farms. Some of these growers participated in the new WVFT extension project on growing vegetables and flowers. When this new project ended in September 2007, these 22 farmers were still growing low-chill fruits.

- In mid 2010, WVFT investigations confirmed the 22 Pang Khon farms were still growing the new varieties of low-chill fruits.

It was possible that some farmers in the other phase one villages were still growing the new cultivars. WVFT investigations confirmed this was the case. It was not possible to determine the precise number of beneficiaries in these other villages. A random sample of phase one participants in Huai Kaew and Huai Mae Liam indicated that about 30% of the farms were growing low-chill fruits in mid 2010.

- For the impact assessment, it was assumed that 30% of the phase one participants in other village areas were growing low-chill fruits—28 farms.
- The total number of project beneficiaries was therefore estimated to be 50 farms.

Project expenditure

The project was jointly funded by ACIAR and WVFT over a 6-year period to 2005–06 (Table 5). There was a small amount of additional funding by WVFT for a further 3 years. The total investment was A$266,000 with ACIAR contributing 69% of the total expenditure. WVFT managed the project budget which included distributions for the expenses of third parties.

- The WVFT project funding was calculated from a financial reconciliation of the annual expenditures by the Huai Chomphu ADP.

The cost of advisory contributions from project partners was covered by WVFT. This included time and travel expenses for the small number of site visits made by Australian collaborators in the ACIAR technical project. The contributions of professional staff from the RARC were also covered by the project budget.

Table 5. Source of project expenditure[a]

Year	ACIAR[b]	WVFT[c,d]	Total project funding	
	A$'000	A$'000	A$'000	A$'000[e]
2000–01	46.2	–	46.2	59.5
2001–02	48.7	9.5	58.1	72.8
2002–03	24.3	11.3	35.7	43.4
2003–04	35.6	10.8	46.3	55.0
2004–05	23.2	8.7	31.9	37.0
2005–06	5.6	12.7	18.3	20.5
2006–07	–	10.3	10.3	11.2
2007–08	–	10.2	10.2	10.7
2008–09	–	8.7	8.7	8.9
Total	183.5	82.1	265.6	319.1
Percentage	69%	31%	–	–

Sources: United States Federal Reserve (2010); WVFT (pers. comm.)

a Expenditure for year ended September

b Australian Centre for International Agricultural Research

c World Vision Foundation of Thailand

d Expenditure on the low-chill fruits project from WVFT funding for the Area Development Program (ADP) in Huai Chomphu

e Expressed in 2009–10 dollars

3 Net benefits of the Thai low-chill fruits project

To gain a first-hand perspective of the project impact, a short field trip was undertaken in mid 2010. This involved consultations with WVFT project staff, a selection of farmers in Pang Khon and RARC professional staff in Chiang Mai. It also included visits to some fruit-selling centres in Chiang Mai. A list of the people and agencies that participated in the consultations is provided in Appendix 1.

Farmers who successfully established the new low-chill cultivars and remained active fruit growers gained benefits in the form of higher farm incomes. This was the primary impact of the project—poverty alleviation. The project benefits can be assessed from the number of adopters and estimates of the change in net farm income from low-chill fruit sales.

Survey of project beneficiaries

The economic returns from low-chill fruit enterprises established by project participants were expected to vary. There were likely to be differences in the composition of fruit trees, numbers of trees, use of inputs and fruit yields. Fruit marketing and the prices received were another potential source of difference among the adopters.

There was insufficient and inconsistent information in the project documentation on many of these variables. Obtaining the relevant information from all project adopters was not feasible. The Huai Chomphu ADP is located in a highly mountainous region and travel is difficult, especially in the rainy season.

To obtain data to estimate the project benefits, a sample survey of adopting farmers was conducted. A questionnaire was developed to establish the dimensions of the low-chill fruit enterprise for each survey respondent. It provided a current perspective (i.e. 2008–09) on enterprise performance and returns.

Local WVFT staff in the Huai Chomphu ADP collected the survey information in July–August 2010. The sample was randomly selected by WVFT staff and was limited to 20 growers in the Pang Khon village area. Participation in the modified project implemented in phase two would be the best indicator of on-farm adoption benefits.

WVFT inquiries in mid 2010 had found there were 22 growers of low-chill fruits in Pang Khon. These farmers had participated in the second phase of the project. The survey sample of 20 farms was expected to provide a good indication of the project impacts.

Survey results for key adoption outcomes are summarised in Appendix 2 (Table A1). The survey identified two types of growers. Some joined the project at the start of phase one and established new low-chill cultivars in 2001–02. Another group had joined the project in phase two and established their new cultivars in 2004–05.

The survey results were used to calculate average per-farm outcomes for the two types of growers. This was necessary because production lags would mean the time path of annual adoption benefits would vary. Survey results confirmed the variability in fruit enterprise outcomes for the two groups of farmers. There was little difference in farm size.

- Growers who participated in phases one and two had farm sizes ranging from 0.8 hectares (ha) to 3.2 ha and an annual farm income ranging from A$2,800 to A$10,600.
- Growers who participated in only phase two had farm sizes ranging from 0.3 ha to 3.2 ha and an annual farm income ranging from A$1,600 to A$10,500.

There are several features of the survey results worth noting. From the perspective of technical characteristics, the results showed:

- all growers established their low-chill fruit enterprise by grafting new cultivars onto existing rootstock of Thai peach trees
- the production lag until the first harvest of saleable fruit was 4 years
- almost all farmers were growing low-chill plums and persimmons
- some growers had no low-chill peach trees—this was especially evident among the growers who participated in only phase two
- very few growers had nectarines—this is consistent with ACIAR progress reports which indicated most farmers grafted plum cultivars onto nectarine and peach rootstock during the second phase of the project
- the inventory of new low-chill trees was relatively small—per farm averages were 4 peach trees, 22 plum trees and 10 persimmon trees
- most farmers were still growing Thai peaches—an average of 9 trees/farm
- for growers involved in the first phase of the project, average yields for low-chill plums (21 kg/tree) and persimmons (28 kg/tree) were considerably higher than for low-chill peaches (5 kg/tree)
- all farmers had favourable yields from their Thai peach trees (26 kg/tree)
- no farmers were using chemical pesticides or irrigating their fruit trees—less than a third were applying chemical fertilisers.

From a financial perspective, the survey results confirmed there was some variability in the gross income generated by the fruit enterprise. The following were some key findings.

- Chemical fertiliser was a significant input cost on farms where it was used.
- Average returns for low-chill peaches (20 baht/kg) and plums (9 baht/kg) were similar across all farms—when assessed against local wholesale prices, they were indicative of returns for low-grade fruits.
- Low-chill peaches were worth five times more than Thai peaches (4 baht/kg).
- Persimmons were the largest contributor to enterprise income because of average returns of 15 baht/kg and high-yielding trees.
- Almost all growers sold their low-chill fruits to wholesalers and processors—sales to local villages were also an important marketing outlet.

The situation of phase one participants in villages other than Pang Khon is also of some interest. Some farmers may have been still growing new low-chill fruit varieties despite their exclusion from phase two. Others were either unsuccessful or had lost interest in the project and ceased growing low-chill fruits. Information on the reasons for non-adoption is a useful contribution to the impact assessment.

A separate questionnaire was developed and WVFT staff interviewed a random selection of 20 farmers in other villages. The questionnaire focused on project outcomes, with the aim of identifying project implementation problems. It also provided an indication of successful project adoption outside of Pang Khon.

Survey results for key adoption outcomes are summarised in Appendix 2 (Table A2). The responses are divided into two groups—farmers who failed to establish a low-chill enterprise and those who succeeded. Average per farm outcomes were calculated for each group.

Several features of the survey results for phase one training outcomes are worth noting. The following were among the key findings.

- All farmers are earning income from alternative farming activities such as coffee, lychees and macadamias—they have been profitable alternative or complementary activities to a low-chill fruit enterprise.
- The initial interest in low-chill fruits had favoured plums—on average, the enterprise establishment began with 3 peach and 10 plum trees per farm.
- Almost half the farmers did not succeed.
- Almost half of the successful farmers have ceased producing low-chill fruits.
- Most of the unsuccessful farmers did not receive training on fruit harvesting.
- There was very little training on fruit marketing and the financial management of a low-chill fruit enterprise.
- Most of the successful adopters who were still growing fruit did not use pesticides, apply chemical fertiliser, irrigate or apply the required pruning techniques.

Non-adoption was either voluntary or because enterprise establishment was unsuccessful. It is worth noting some of the reasons for non-adoption:

- Enterprise labour demands, difficulties in growing low-chill varieties and a lack of irrigation water were the primary reasons for voluntary non-adoption.
- Fruit marketing difficulties were an important factor in voluntary non-adoption.
- Low yields, low returns and problems with pests and diseases were not key issues in voluntary adoption.
- More than half of the voluntary non-adopters could earn more from other land-use activities (producing coffee etc.).
- Enterprise labour demands, lack of irrigation water, difficulties in fruit marketing and tree deaths or grafting failures were the main issues that discouraged the unsuccessful farmers from persisting with their attempts to establish a low-chill fruit enterprise.

Approach to estimating the project benefits

The economic effect of the project can be evaluated by estimating the average per-farm income from the low-chill fruit enterprises that were established. It can be compared with a 'no impact' base case situation to estimate the farm-level benefit. Assumptions on the number of adopters can then be used to assess the total impact of the project.

Project participants who currently have a low-chill fruit enterprise are the best indicator of adoption numbers. In 2009–10, there were an estimated 50 low chill-fruit growers across the ADP (see Table 4). These growers were assumed to be the project beneficiaries over the historical period (i.e. 2000–01 to 2009–10) and into the future.

When the project commenced, it was expected other farmers could establish a low-chill enterprise by learning from the experiences of participants. This did not occur and project participation declined over time. Enterprise establishment failures and favourable returns from competing enterprises caused a loss of interest in the project. For these reasons, it has been assumed there is no flow-on adoption effect on non-participants.

To allow for differences in enterprise composition and fruit yields, estimates of the farm income from fruit growing were prepared for three groups of farmers:

- Pang Khon growers who participated in phases one and two
- Pang Khon growers who only participated in phase two
- phase one participants in other villages who were still producing fruit in 2009–10.

Assumptions used for these estimates were based on the survey results. Supplementary information on the yield performance of low-chill fruit trees was obtained from the RARC. This was used to develop assumptions on annual changes in fruit production. Price data provided by the Thai Office of Agricultural Economics (OAE) were used to value the enterprise outputs.

In addition to the 50 long-term beneficiaries, there were some phase one participants who successfully established new cultivars but ceased production for

various reasons. These farmers would have produced some fruit for a short period. To account for this outcome, it was assumed that 25% of the initial 174 phase one participants produced fruit for 1 year.

- This assumption was based on the survey results for villages other than Pang Khon which indicated that 25% of the respondents successfully established the new varieties but ceased growing low-chill fruits (Table A2).

These 44 farms were assumed to achieve a 1-year project benefit in 2005–06 and this was included in the estimate of project benefits. Survey results indicated 2005–06 was the first year of saleable production for phase one participants. The output of these short-term beneficiaries was assumed to reflect the survey results for tree inventories and the fruit yields achieved by Pang Khon phase one participants in 2005–06.

Estimates of the farm-level impact

The Pang Khon farm-level impact assumed a low-chill enterprise composed of peaches, plums, persimmons and Thai peaches was established. New cultivars were distributed for peaches, plums, nectarines and persimmons. The survey results show nectarines have not been adopted. Most Pang Khon growers are still producing some Thai peaches.

Valuations of the enterprise outputs were based on indicative farm returns. Survey results for Pang Khon provided an average price for each variety in 2008–09. Historical indices derived from OAE market prices were used to develop a historical time path of price assumptions from the survey results. Future prices were assumed to remain unchanged from 2009–10 levels.

- These price assumptions were used to value farm outputs for the three groups of growers included in the assessment—they are documented in Appendix 3.

The price assumptions reflect low-grade fruit valuations. Survey results were consistent with the wholesale prices for low-grade fruits after adjusting for transaction costs (see Table 3). It is unlikely fruit quality will improve over the medium term and a conservative approach to output valuations seems appropriate.

- The survey results confirmed the impressions obtained during the field trip.
- Production deficiencies in pruning, fertiliser applications, pesticide protection and irrigation have affected the quality of the fruits as well as tree yields.
- The low standard of fruit handling and poor road access from the production areas is also a major impediment to quality improvements.

Enterprise outputs were estimated from an assumed inventory of fruit trees and average fruit yields. The Pang Khon survey results gave a snapshot of physical performance in 2008–09. Tree inventories were assumed to remain unchanged over the assessment period. The critical variable is the average yield per tree, which will vary over time.

Advice from the RARC provided a basis for developing a time path of yield assumptions for each type of fruit. Experiences in the Chiang Mai highlands suggest the following yield performances are typical:

- Low-chill peach yields peak at 20–30 kg/tree after 5–6 years of fruit harvesting and then begin to decline slowly after 8 years.
- Low-chill plum yields peak at 40–50 kg/tree after 8–10 years of fruit harvesting and then begin to decline slowly after 20 years.
- Persimmon yields peak at 80–120 kg/tree after 8–10 years of fruit harvesting and then begin to decline slowly after 20 years.
- The low-chill fruit trees typically begin producing fruits after 3–4 years.
- Initial yields from the first harvest are typically 5–7 kg/tree for peaches, 7–10 kg/tree for plums and 20–40 kg/tree for persimmons.

Yield performance in the Chiang Mai highlands reflects the close attention given to tree management practices. The trees are correctly pruned, irrigated and fertilised. They also get the required pesticide protection. Pang Khon survey results indicated this approach is not evident in the Huai Chomphu ADP and peak yields are likely to be lower. Therefore, the following assumptions were used in the assessment:

- peak yields of approximately 75% of the mid-point of the yield range in Chiang Mai—20 kg/tree for peaches, 35 kg/tree for plums and 75 kg/tree for persimmons
- attainment of peak yields after 6 years of harvest for peaches and 10 years of harvest for plums and persimmons
- yields remaining constant after the peak performance is reached.

Initial fruit yields achieved by the project participants were affected by the difficulties in establishing the new cultivars. They are likely to be lower than the initial yields achieved in Chiang Mai. Survey results for Pang Khon growers that participated in only phase two provided a reasonable indicator of the initial fruit yields:

- 2008–09 was the first year of harvest for new phase two participants—these yields were assumed to reflect the initial performance of phase one participants.
- Assumptions for initial fruit yields were 4 kg/tree for peaches, 7 kg/tree for plums and 24 kg/tree for persimmons.

Assumptions for initial yields, peak yields and the timing of peak performance were used to develop an annual time path of yields that incorporated the 2008–09 survey results. The yield changes were evenly distributed over the intervening years. Enterprise outcomes included a fixed yield for Thai peaches—it was assumed these trees had already reached their peak performance at the time the low-chill cultivars were established.

Fruit output for growers from villages other than Pang Khon were derived in a similar manner. A fixed inventory of low-chill peach and plum trees was developed from the average survey response of growers from other villages. The inventory of persimmon and Thai peach trees was aligned with the assumptions developed from the Pang Khon survey results for phase one participants. Yields for all four fruits were aligned with assumptions used for Pang Khon participants in phase one.

Details on the output assumptions and project impact for the three groups of growers are summarised in Appendix 4. The estimated impact includes an allowance for the cost of chemical fertiliser applications. Fertiliser prices were held constant over the evaluation period and fertiliser was applied to only low-chill peach and plum trees.

- For Pang Khon growers, the annual fertiliser application was based on the survey results—2.1 kg/tree for participants in phases one and two and 0.7 kg/tree for growers that only participated in phase two.
- For growers from other village areas, the application rate was aligned with Pang Khon survey results for participants in phase one.

A 'no impact' base case

Project benefits were estimated by comparing the estimated enterprise outcomes against a 'no impact' base case. In developing a base case, it was assumed adoption of the project training would not affect market prices. Total low-chill fruit production was too small to have any appreciable effect on market conditions in northern Thailand.

The issue of home consumption versus market sales of fruits was another consideration. Survey results confirmed most of the output was sold locally. The small amount retained for home use was extra food consumption. These fruits would not have been purchased if the project had not been implemented. If there is no substitution effect, the fruits consumed at home can be valued at the market price.

The base case for the three groups of growers was developed from the survey results. If the project had not been implemented, the farmers would have continued to produce Thai peaches. In this situation it is reasonable to assume the inventory of low-chill peach and plum trees used for the impact estimates would have been Thai peach trees.

- The Pang Khon survey results showed that all growers established their new cultivars by grafting onto the pre-existing rootstock of Thai peaches.

For each group of growers, the base case situation assumed the fruit-growing enterprise was composed of Thai peach trees calculated from the inventory assumptions used in the impact estimates. Yields were held constant at the rate used for the impact estimates.

The base case assumed there were no persimmon trees—this implicitly assumes the project participants established their persimmon trees as seedlings.

Details on the output assumptions and base case estimates for the three groups of growers are summarised in Appendix 4. It shows the average income for an enterprise growing Thai peaches. There were no adjustments for fertiliser costs as traditional management practices typically did not involve the use of chemical fertilisers.

Project benefits

The annual benefits of the project reached a steady state in 2017–18 at an annual gain of A$27,527 (Table 6). Benefits will continue to arise beyond this period. Therefore, an annuity for the benefits that accrue in perpetuity for the period of 2018–19 and beyond has been 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$782,600. In the period when the low-chill peaches and plums were being established there was a loss of income. This was due to the loss of Thai peach production as the rootstock was converted to the new cultivars of peaches and plums. Project benefits achieved in Pang Khon accounted for 43% of the total benefits.

Most of the benefits will be achieved in future years as fruit yields rise. Low-chill plums and persimmons account for most of the benefits. This reflects the small number of low-chill peach trees that was established and low fruit yields. Peak yields for persimmons are substantially higher than the expected peak yields from low-chill plums.

Net benefits of the project

The discounted net benefit of the project is derived by comparing project expenditure with the estimated benefits. The present value of the net benefits is A$59,300 (Table 7). This estimate is based on a discount rate of 5%.

The net benefits are small. In part, this reflects the problems that arose in the first phase of the project and which caused many farmers to lose interest. Establishment failures, enterprise exits and consolidation of the project to a single village in phase two contributed to its limited impact.

Another factor in the small size of the net benefits is the low fruit returns. Marketing impediments and the inability or unwillingness to apply the required tree management practices affected the quality of the fruit. A few core growers in Pang Khon are making an effort to produce higher quality fruit.

- The survey results showed a few cases where higher returns were achieved for plums but all respondents are receiving low returns for peaches.

Higher returns from supplying higher grade fruit to regional markets may be achievable in the future. However, this will require substantial, sustained changes in enterprise management practices and the development of a more sophisticated post-farm supply chain.

Project adopters have benefited from improved farm incomes. The poverty alleviation objective has been achieved for these farmers although the gains are smaller than anticipated, and not as widespread. When assessed against the size of the project investment, the regional benefits for the ADP are small.

- The project outcomes yield a benefit:cost ratio of 1.2:1.
- Results for alternative discount rates show the present value of the net benefits varies between a loss of A$150,000 for a 10% discount rate and a gain of A$2.2 million for a 1% discount rate.

Attribution of the estimated net benefits is divided between ACIAR and WVFT. Based on the respective shares of the project expenditure, this would attribute around 69% of the benefit to ACIAR. Therefore, the respective return on investment for each agency would be A$41,000 for ACIAR and A$18,000 for WVFT.

A progressive evaluation of the gains achieved to date may be of some interest. It shows the net benefits of the project to be a loss of A$275,000 for a 10-year evaluation period up to 2009–10 (Table 7). The overall evaluation result is sensitive to assumptions about future enterprise developments—yield growth and fruit output are the critical variables.

Table 6. Estimate of project benefits

	Pang Khon		Other participants in phase one[a]	Total benefits	
	Participants in phases one and two	Participants in phase two		Nominal	Real[b]
	A$	A$	A$	A$	A$
2000–01	–	–	–	–	–
2001–02	–2,855	–	–3,863	–6,717	–8,416
2002–03	–2,633	–	–3,562	–6,195	–7,529
2003–04	–2,293	–	–3,102	–5,395	–6,407
2004–05	–2,177	–1,103	–2,946	–6,226	–7,217
2005–06	6,230	–1,115	9,183	14,298	16,060
2006–07	2,454	–1,005	5,001	6,450	7,041
2007–08	1,937	–918	3,967	4,986	5,264
2008–09	2,909	269	5,952	9,131	9,350
2009–10	3,691	503	7,135	11,329	11,329
2010–11	4,906	999	9,226	15,132	15,132
2011–12	5,672	1,495	10,779	17,946	17,946
2012–13	6,439	1,991	12,331	20,760	20,760
2013–14	7,205	2,487	13,883	23,575	23,575
2014–15	7,971	2,896	15,435	26,302	26,302
2015–16	7,971	3,304	15,435	26,710	26,710
2016–17	7,971	3,713	15,435	27,119	27,119
2017–18	7,971	4,121	15,435	27,527	27,527
2018–19[c]	167,383	86,541	324,142	578,067	578,067
Total	230,751	104,178	449,868	784,797	782,612

[a] Benefits for farmers who did not participate in the project after phase one and are currently growing low-chill fruits

[b] Benefits expressed in 2009–10 dollars: see Appendix 3 for exchange rate and inflation assumptions; see Appendix 4 for a summary of project impact and base case estimates for the three groups of farmers

[c] Values for 2018–19 are the present value of an annuity for the benefits accrued in perpetuity after 2017–18

A sensitivity analysis of the estimated net benefits to assumptions for future fruit yields is worth examining. The 'best case' scenario is for maximum fruit yields to match those achieved in the Chiang Mai highlands. A 'worst case' scenario could be maximum yields of only half those achieved in Chiang Mai.

The sensitivity analysis shows the net benefits would be A$180,000 if yields were the same as those achieved in Chiang Mai (Table 8). But if maximum yields were half the Chiang Mai levels, the project would generate a loss of A$72,000. This analysis shows the extra benefits that could be achieved if farm management practices reached the standards applied in Chiang Mai.

Table 7. Net benefits of the Thai low-chill fruits project[a]

		PV of project costs	PV of project benefits	PV of project net benefits
Project evaluation, 5% discount rate[b]	A$'000	284.2	343.5	59.3
Benefit:cost ratio		–	–	1.2:1
Project evaluation, 10% discount rate[b]	A$'000	256.9	106.9	−150.0
Benefit:cost ratio		–	–	0.4:1
Project evaluation, 1% discount rate[b]	A$'000	311.4	2,502.4	2,191.1
Benefit:cost ratio		–	–	8.0:1
Progressive project evaluation[c]	A$'000	284.2	8.9	−275.4
Benefit:cost ratio		–	–	0.0:1

a Discounted present values (PVs) expressed in 2009–10 dollars

b Evaluation includes annual outcomes for the 2000–01 to 2017–18 period plus an annuity for the benefits arising in perpetuity after 2017–18

c Progressive evaluation for the period from 2000–01 to 2009–10 using a 5% discount rate

Table 8. Yield sensitivity of project net benefits[a]

		PV of project costs	PV of project benefits	PV of project net benefits
Project evaluation, 5% discount rate[b]	A$'000	284.2	343.5	59.3
Benefit:cost ratio		–	–	1.2:1
High yield sensitivity, 5% discount rate[c]	A$'000	284.2	463.9	179.7
Benefit:cost ratio		–	–	0.4:1
Low yield sensitivity, 5% discount rate[d]	A$'000	284.2	212.1	−72.1
Benefit:cost ratio		–	–	8.0:1

a Discounted present values (PVs) expressed in 2009–10 dollars

b Assumes maximum yields of 20 kg/tree for peaches, 35 kg/tree for plums and 75 kg/tree for persimmons

c Assumes maximum yields of 25 kg/tree for peaches, 45 kg/tree for plums and 100 kg/tree for persimmons

d Assumes maximum yields of 12.5 kg/tree for peaches, 22.5 kg/tree for plums and 50.0 kg/tree for persimmons

4 Concluding comments

The Huai Chomphu ADP has some of the poorest farmers in the village communities of the Chiang Rai highlands. In general, they have limited land areas and very low incomes. The terrain is highly mountainous and the options for farm enterprises are restricted by the climatic conditions.

Widespread poverty makes it difficult for village communities to achieve a financially sustainable way of life. It limits their opportunity to enjoy the benefits of economic development that are available to the wider population. In the past, this has encouraged some farmers to grow illegal opium crops.

Farmer members of the ADP that were involved in the project have limited land areas. Survey results showed the adopting farmers had an average land area of:

- 1.6 ha in the Pang Khon village area
- 1.4 ha in the other village areas.

Improved farm incomes require the available land area to be used for the most profitable activities. A low-chill fruit enterprise based on higher quality, temperate-zone cultivars is a viable option in selected areas. The aim of the project was to encourage this sort of farm development because of the potential to generate more income than an enterprise based on Thai peaches.

Impact on poverty

The average annual farm income of survey respondents in 2008–09 was:

- A$4,300 in the Pang Khon village area
- A$2,350 for successful project participants in the other village areas.

The project has had a small poverty alleviation benefit for the small number of farmers who have established and maintained a low-chill fruit enterprise. The potential income gains from growing low-chill fruits will vary according to the type of fruit trees and their yields. The survey results indicate the income generated by low-chill fruit sales in 2008–09 was limited:

- In Pang Khon, fruit sales were worth A$274, about 6% of farm income.
- In other village areas, fruit sales of A$110 were about 5% of farm income.

Most of the project adopters appear to treat their low-chill fruit enterprise as a secondary farming activity. Other farming activities such as growing coffee, lychees, vegetables and macadamias are more important sources of income.

Poverty alleviation benefits for adopting farmers will grow as the fruit yields increase. But the gains will still be relatively small in comparison to other enterprises. The small number of fruit trees and low farm returns will limit the size of the benefits. When the fruit yields reach their peak, indicative annual income from fruit sales will be:

- A$705 in Pang Khon, a 115% improvement on 2009–10 fruit income
- A$665 in other village areas, an 80% improvement on 2009–10 fruit income.

These predictions assume that fruit quality and average farm returns remain unchanged from the current situation and the entire harvest is sold.

The poverty alleviation benefits for the area of impact were limited by the small number of farmers who ultimately established a low-chill fruit enterprise with

new cultivars. Only 22 Pang Khon farmers were growers in 2008–09. In the other village areas, an estimated 28 farmers have continued to produce low-chill fruits.

Some lessons from the impact assessment

A schematic view of the pathway to the project benefits is presented in Figure 1. Capacity building of farmer skills in low-chill fruit growing has had economic and social impacts that were concentrated among a small group of ADP members. Enterprise sustainability and the motivation for self-improvement were risks that emerged during the project. They contributed to a loss of interest and reduced the effectiveness of the project.

It is worth making a few observations that may be relevant for future projects that involve extending the results of ACIAR technical research. The project was part of an ACIAR–WV collaborative program and was an experimental investment for ACIAR.

- The project was focused on extension training with participatory evaluation assessments to determine the suitability of alternative fruit varieties based on previous technical research funded by ACIAR.
- It was a collaboration with an NGO providing aid for poor people in rural areas.
- There was minimal involvement by the Australia project partners in the related technical research.
- It largely relied on the WVFT network of ADP staff to manage training activities that had an emphasis on self-determination by the potential beneficiaries.

Using the WV ADP network to deliver extension training on technical research results is a good approach to enhancing adoption. It is potentially a highly effective way to extend the information because of the established relationships between ADP members and WV staff. It can be an effective way to achieve poverty alleviation objectives for the very poor people in rural communities.

However, there are limits to the extent of the impact. In this case, potential benefits were confined to a small area in northern Thailand. This is not necessarily a limitation of the approach—it depends on the number of potential beneficiaries in the area of impact.

The target group of potential adopters is defined by WVFT operating plans and the size of their ADP memberships. It is also concentrated on the very poor farmers within the boundaries of the ADP. Therefore, the approach is suitable for projects with a poverty alleviation or food security objective.

In this case, the pool of potential beneficiaries was reduced by implementation problems in the first phase of the project. The difficulties arose because of poor site selection, the premature distribution of new cultivars and the low skill base of farmers. Participants were widely dispersed in a remote area and this affected monitoring of on-farm application. These issues caused establishment problems that discouraged participation.

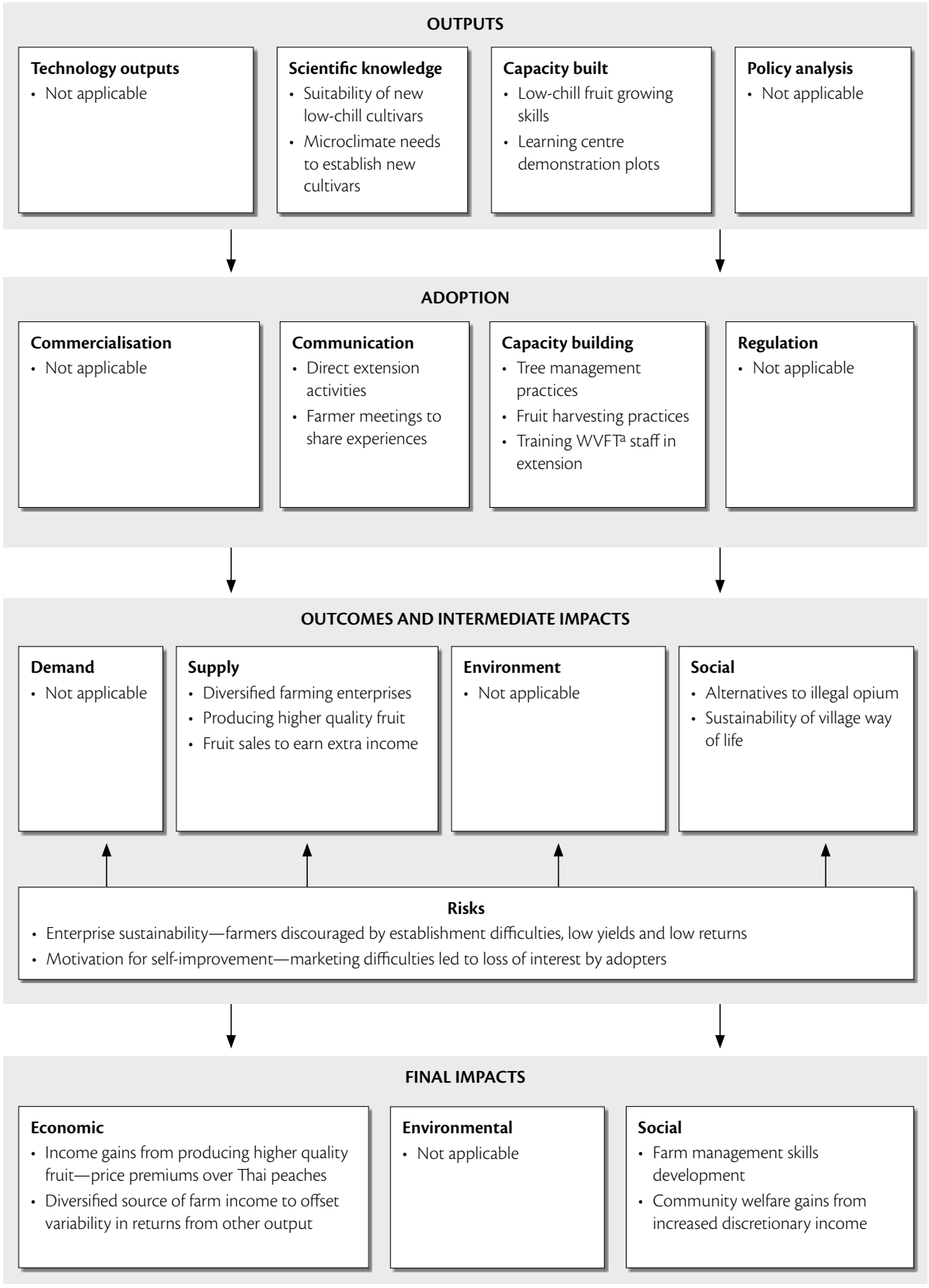
The problems suggest deficiencies in the project design. A failure to check that all the selected sites had the required microclimate suggests inadequate planning. It was also apparent the ADP staff did not have the technical knowledge to adequately advise the farmers. More generally, the establishment difficulties suggest there was:

- inadequate training before the new cultivars were distributed and a lack monitoring of on-farm application of the extension advice
- insufficient technical support and training for ADP staff.

Initially, the advisory resources allocated to training activities were inadequate. ADP staff needed some technical expertise to give advice on the difficulty of establishing fruit trees that are sensitive to their growing conditions. In general, the problems that arose illustrate the importance of project design and the allocation of resources to capacity building.

- The small number of adopting farmers in 2008–09 suggests some refinements to the approach used in the extension training may be necessary.

Adoption problems are not solely caused by the way a project is implemented. In this case, it appears many participants were unwilling to apply the required tree management practices. A lack of irrigation water is a structural constraint. Tree pruning, fertiliser use and pest protection are issues that reflect on the attitudes of participants.



[a] WVFT = World Vision Foundation of Thailand

Figure 1. Project pathway to benefits—Thai low-chill fruits

- Most farmers treated their low-chill fruit enterprise as a secondary farming activity—the participant selection process may need to be refined.
- A cultural change from the traditional approach to growing Thai peach trees was required—a stronger training emphasis on change may be appropriate.

Successful implementation of extension projects requires the participants to be interested and committed. In this case, the ADP members were simultaneously being encouraged to diversify into products such as coffee, lychees, macadamias and vegetables. Competition for the attention of participants may have contributed to the low rate of adoption.

- Higher returns for other products and the perceived difficulties in growing low-chill fruits probably caused many farmers to lose interest.
- An integrated perspective is necessary when more than one extension activity is being promoted.

The other issue that limited the impact of the project was post-farm fruit marketing. The quality of the fruit in terms of taste, texture, colour and juiciness determines the price that consumers are willing to pay. High-quality fruits earn a price premium but need first-rate orchard management practices and a supply chain that incorporates high standards in fruit handling.

Low-chill peaches have a relatively soft skin and are highly susceptible to pest attacks during the ripening stage. If chemical pest treatment is not used, the fruit have to be bagged or harvested early. The fruit are also susceptible to bruising and need careful handling. These issues are less of a problem for plums.

Fruit harvesting and handling are critical issues for presenting high-quality fruit to the market. There was insufficient training in fruit marketing during the project. The current growers will not achieve high-grade fruit returns unless more attention is given to post-farm marketing. Improved orchard management will also be necessary—irrigation during fruit development, pest protection and the timing of harvest are key issues.

- A supplementary project on low-chill fruit marketing could be considered as a way to realise the potentially higher returns.

The Huai Chomphu ADP is isolated and travel is difficult. The primary access roads are in poor condition. This creates difficulties for the transport and handling of fruit. Lack of access to markets and fruit wholesalers is an impediment to achieving the returns that have been gained by Chiang Mai growers through the Royal Project Foundation.

- Projects with poverty alleviation objectives that depend on supplying high-quality produce should include a formal training component on marketing issues.
- It is critical that potential participants are fully aware of the entire supply-chain requirements to achieve premium prices—these will add unavoidable costs to the production process.

An assessment of the marketing needs and impediments is essential when these sorts of projects are being designed. Specific training activities with collaborative partners from downstream supply-chain participants such as processors, wholesalers or retailers should be incorporated into the project. In addition, potential project participants should be advised of the risks and probability of success.

- Participation should not be based solely on the suitability of growing conditions.
- A capacity and willingness to change and to adapt to the post-farm marketing needs is just as important.

Appendix 1 Impact assessment consultations

The Thai low-chill fruits project involved participatory research and extension training based around demonstration plots at the Ban Pang Khon Organisation Development Centre. Farmers participating in the extension project were located in the World Vision Foundation of Thailand (WVFT) Huai Chomphu Area Development Program (ADP) in the Mueang Chiang Rai district of Chiang Rai province. Impact assessment consultations with project staff and farmers were undertaken during a visit to Thailand in May 2010.

The purpose of the consultations was to:

- gain a first-hand perspective of the project and farm-level adoption from WVFT project staff and the technical advisers at the Chiang Mai Royal Agricultural Research Centre
- visit the Ban Pang Khon Development Centre established for the project
- visit a selection of farming enterprises with low-chill fruit trees to gain a practical appreciation of how the extension training was applied
- discuss adoption experiences with farmers
- test a pilot survey questionnaire
- visit wholesale fruit markets and other fruit-selling centres
- 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 visit and provided translation services. The farms visited were located in the Pang Khon village area of Huai Chomphu subdistrict, where commitment to adopting the training advice was strongest.

The impact assessment consultations included a visit to Chiang Mai to meet with technical officers from the Chiang Mai Royal Agricultural Research Centre (RARC). The RARC was the project partner with WVFT. They also included visits to various selling centres for rural produce in Chiang Mai:

- a supermarket selling high-value, imported low-chill fruits
- a fresh food municipal market selling domestic varieties of low-chill fruits
- a cooperative retail outlet selling fresh and preserved domestic varieties of low-chill fruits
- a retail outlet for low-chill fruits sold under the Royal Project Foundation brand name—fruits sold under this brand provide a benchmark for the price premium that could be achieved by participants in the ACIAR–WVFT project.

Meetings were held with a number of farmers and project staff during the course of the impact assessment consultations. Key contributors were:

- Mr Anusorn Somsiri, WVFT Manager of Ministry Operation Division for Central Region and Operation Division Support Manager
- Mr Chartchai Maneekarn, WVFT Operation Manager for Northern Region
- Mr Pichit Sripinta, Technical Officer and Project Adviser, Chiang Mai RARC, Department of Agriculture, Chiang Mai

- Mr Lorma Baecheku, farmer member of the Ban Pang Khon Organisation Development Centre, Ban Pang Khon, Mueang Chiang Rai district, Chiang Rai province
- Mr Arwuy Hayeku, farmer member of the Ban Pang Khon Organisation Development Centre, Ban Pang Khon, Mueang Chiang Rai district, Chiang Rai province
- Mr Armey Saelu, farmer member of the Ban Pang Khon Organisation Development Centre, Ban Pang Khon, Mueang Chiang Rai district, Chiang Rai province
- Ms Jantra Katu, WVFT Coordinator of Huai Chomphu Area Development Program (ADP), Mueang Chiang Rai district, Chiang Rai province
- Mr Kanungdej Upanan, WVFT Project Officer for Huai Chomphu ADP and low-chill fruits project coordinator (2004–2008), Mueang Chiang Rai district, Chiang Rai province
- Mr Somyos Katchina, WVFT Project Officer for Huai Chomphu ADP and low-chill fruits project coordinator (2004–2008), Mueang Chiang Rai district, Chiang Rai province.

Appendix 2 Survey results

Table A1. Survey results for Pang Khon project participants[a]

Item		Units	Participated phase one and two	Participated phase two	Sample average
Sample size		no.	13	7	20[b]
Average farm size		ha	1.3	1.9	1.6
Annual income from fruit sales		A$/farm	235	295	274
Annual farm income		A$/farm	5,490	3,665	4,304
Growing coffee, macadamias, lychees		%	85	100	90
Year of establishing low-chill varieties			2001–02	2004–05	–
New varieties grafted to existing rootstock		%	100	100	100
Physical & financial features of fruit-growing enterprise					
Growing low-chill peaches today		%	86	46	60
Growing low-chill nectarines today		%	29	0	10
Growing low-chill plums today		%	100	100	100
Growing Thai peaches today		%	86	85	85
Growing persimmons today		%	100	92	95
Number of trees	– peach & nectarine	no.	5	4	4
	– plum	no.	9	29	22
	– Thai peach	no.	11	7	9
	– persimmon	no.	12	8	10
Annual production	– peach & nectarine	kg	24	15	18
	– plum	kg	193	212	205
	– Thai peach	kg	243	204	218
	– persimmon	kg	343	204	253
Annual fruit yields	– peach & nectarine	kg/tree	4.9	3.8	4.2
	– plum	kg/tree	20.8	7.2	9.2
	– Thai peach	kg/tree	22.7	27.9	25.6
	– persimmon	kg/tree	28.2	24.1	25.9

Table A1. (continued)

Item		Units	Participated phase one and two	Participated phase two	Sample average
Price received for sales	– peach	baht/kg	20	20	20
	– plum	baht/kg	8	10	9
	– Thai peach	baht/kg	4	4	4
	– persimmon	baht/kg	20	13	15
Current fruit enterprise management practices					
Applying chemical fertiliser		%	43	23	30
Chemical fertiliser application rate		kg/tree	2.1	0.7	1.2
Cost of chemical fertiliser		baht/kg	20	20	20
Applying chemical pesticides		%	0	0	0
Irrigating fruit trees		%	0	0	0
Fruit sales to local villages		%	71	46	55
Fruit sales to wholesalers, processors		%	86	92	90

Source: World Vision Foundation of Thailand survey

[a] Average per farm results for random sample in Pang Khon village

[b] This figure is for the total in the sample, not the average.

Table A2. Survey results for other project participants[a]

		Units	Successful participants	Failed participants	Sample average
Sample size		no.	11	9	20[b]
Average farm size		ha	1.6	1.1	1.4
Annual income from fruit sales		A$/farm	110	0	60
Annual farm income		A$/farm	2,352	2,611	2,469
Growing coffee, macadamia, lychee		%	100	100	100
Training outcomes from phase one					
Year of establishing new low-chill varieties			2001–02	2001–02	2001–02
Number of trees	– low-chill peach	no.	4	2	3
	– low-chill plum	no.	11	8	10
	– low-chill nectarine	no.	0	0	0
Received training on	– fruit tree management	%	91	89	90
	– fruit harvesting	%	91	22	60
	– fruit marketing	%	9	0	5
Received training on enterprise financial management		%	9	0	5

Table A2. (continued)

		Units	Successful participants	Failed participants	Sample average
Low-chill fruit trees produced fruit		%	100	0	55
Production lag before initial fruit harvest		years	4	–	–
Aware of 3–4 year production lag		%	55	44	50
Non-adoption of low-chill fruit production					
Ceased producing low-chill fruits		%	45	–	25
Non-adoption reasons[c]	– low yields	%	20	–	7
	– trees died or grafting failed	%	–	100	64
	– low fruit prices	%	20	–	7
	– pest or disease problems	%	20	–	7
	– lack of irrigation water	%	80	56	65
	– lack of time to manage trees	%	100	89	93
	– fruit marketing difficulties	%	40	56	50
	– earn more from other land use	%	60	33	43
	– difficult to grow fruit trees	%	80	44	57
Current fruit enterprise management practices					
Currently producing low-chill fruits		%	55	–	30
Applying chemical fertiliser[d]		%	9	–	9
Applying chemical pesticides[d]		%	9	–	9
Irrigating fruit trees[d]		%	9	–	9
Applying recommended pruning techniques[d]		%	18	–	18

Source: World Vision Foundation of Thailand survey

[a] Average per-farm results for random sample in other ADP villages. All survey respondents participated in phase one of the project but were excluded from phase two. Successful participants were able to establish fruit-bearing, low-chill fruit trees. Failed participants were unable to establish fruit-bearing trees. Successful participants included both farmers growing low-chill fruits in 2009–10 and those who successfully established fruit-bearing tress in the early stages of the project but have ceased production.

[b] This figure is for the total in the sample, not the average.

[c] Sample size of 14 farmers for average survey response—excludes current producers of low-chill fruits. Responses by failed participants are the reasons for their inability to successfully establish fruit-bearing trees. Some successful participants no longer grow low-chill fruits—responses reflect the reasons for ceasing production.

[d] Survey response rate for current producers of low-chill fruits

Appendix 3 Impact assessment assumptions

Table A3. Wholesale price indices to value project benefits[a]

	Peaches[b]		Plums[c]		Thai peaches[b]		Persimmon[d]	
		% change		% change		% change		% change
2004–05	1.00	–	1.11	–	1.00	–	1.11	–
2005–06	1.00	0.0	1.39	25.0	1.00	0.0	1.39	25.0
2006–07	0.81	–18.8	1.11	–20.0	0.81	–18.8	1.11	–20.0
2007–08	0.75	–7.7	0.83	–25.0	0.75	–7.7	0.83	–25.0
2008–09	1.00	33.3	1.00	20.0	1.00	33.3	1.00	20.0
2009–10	1.25	25.0	1.00	0.0	1.25	25.0	1.00	0.0

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

[a] Indices (2008–09 = 1.0) based on prices for low grade fruit (see Table 3)

[b] Based on average prices for Tropic Beauty peach

[c] Based on average prices for Ban Luang Daeng plum

[d] Based on average prices for Fuyu persimmon

Table A4. Farm-level fruit price assumptions[a]

	Peaches	Plums	Thai peaches	Persimmons
	baht/kg	baht/kg	baht/kg	baht/kg
2000–01	–	–	4.0	–
2001–02	–	–	4.0	–
2002–03	–	–	4.0	–
2003–04	–	–	4.0	–
2004–05	20.0	10.0	4.0	16.7
2005–06	20.0	12.5	4.0	20.8
2006–07	16.3	10.0	3.3	16.7
2007–08	15.0	7.5	3.0	12.5
2008–09	20.0	9.0	4.0	15.0
2009–10	25.0	9.0	5.0	15.0
2010–11[b]	25.0	9.0	5.0	15.0

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

[a] Based on wholesale price indices for low-grade fruit (see Table A3) and Pang Khon survey results for average prices received in 2008–09 (see Table A1)

[b] Values for 2010–11 are the assumptions used for all subsequent years.

Table A5. Exchange rate and inflation assumptions

	Australian consumer price index		Thai exchange rates	
	2009–10 = 100	% change	Baht per US$1	Baht per A$1
2000–01	77.6		43.30	23.23
2001–02	79.8	2.9	43.98	23.00
2002–03	82.3	3.1	42.66	24.94
2003–04	84.2	2.4	40.16	28.64
2004–05	86.3	2.4	40.06	30.16
2005–06	89.0	3.2	39.92	29.84
2006–07	91.6	2.9	35.14	27.58
2007–08	94.7	3.4	31.41	28.17
2008–09	97.7	3.1	34.67	25.82
2009–10	100.0	2.4	33.12	29.22

Sources: ABARE (2009); United States Federal Reserve (2009)

Appendix 4 Impact of the low-chill fruits project

Table A6. Project impact—Pang Khon participants in phases one and two[a]

	Average fruit yields				Gross value of harvest[b]	Income from fruit sales[c]	Impact of project[d]
	Low-chill peaches	Low-chill plums	Thai peaches	Persimmons			
	kg/tree	kg/tree	kg/tree	kg/tree	baht/farm	baht/farm	'000 baht
2000–01	–	–	–	–	–	–	–
2001–02	–	–	23.0	–	1,012	424	15
2002–03	–	–	23.0	–	1,012	424	15
2003–04	–	–	23.0	–	1,012	424	15
2004–05	–	–	23.0	–	1,012	424	15
2005–06	4.0	7.0	23.0	24.0	8,200	7,612	266
2006–07	4.3	11.7	23.0	25.3	7,291	6,703	94
2007–08	4.7	16.3	23.0	26.7	6,212	5,624	79
2008–09	5.0	21.0	23.0	28.0	8,253	7,665	107
2009–10	12.5	23.3	23.0	35.8	11,168	10,580	148
2010–11	20.0	25.7	23.0	43.7	13,704	13,116	184
2011–12	20.0	28.0	23.0	51.5	15,303	14,715	206
2012–13	20.0	30.3	23.0	59.3	16,902	16,314	228
2013–14	20.0	32.7	23.0	67.2	18,501	17,913	251
2014–15	20.0	35.0	23.0	75.0	20,100	19,512	273
2015–16[e]	20.0	35.0	23.0	75.0	20,100	19,512	273

[a] Based on survey results for current Pang Khon growers who participated in phases one and two (see Table A1)

[b] Average per-farm output derived from yield assumptions and tree inventories assumed to remain unchanged for the assessment period—5 low-chill peach trees, 9 low-chill plum trees, 11 Thai peach trees and 12 persimmon trees. Thai peach trees produced fruit during the establishment period for low-chill peach, plum and persimmon trees. It was assumed that all low-chill peach and plum trees were established by grafting onto existing Thai peach rootstock. Annual output valued at average farm-level prices (see Table A4).

[c] Adjusted for production costs of fertiliser applications of 2.1 kg/tree for low-chill peach and plum trees. Fertiliser application rate assumed to remain unchanged over the assessment period. Fertiliser price assumed to remain unchanged at 20 baht/kg (Table A1).

[d] Based on net income from fruit sales and the number of Pang Khon growers who participated in phases one and two. It was assumed that 14 (65%) of the 22 Pang Khon growers met this criterion (see Table A1). Grower numbers include an extra 21 voluntary non-adopters who ceased production in 2005–06.

[e] Values for 2015–16 are the assumptions and outcomes for all subsequent years in the impact assessment.

Table A7. Project impact—Pang Khon participants in phase two[a]

	Average fruit yields				Gross value of harvest[b]	Income from fruit sales[c]	Impact of project[d]
	Low-chill peaches	Low-chill plums	Thai peaches	Persimmons			
	kg/tree	kg/tree	kg/tree	kg/tree	baht/farm	baht/farm	'000 baht
2000–01	–	–	–	–	–	–	–
2001–02	–	–	–	–	–	–	–
2002–03	–	–	–	–	–	–	–
2003–04	–	–	–	–	–	–	–
2004–05	–	–	28.0	–	784	322	3
2005–06	–	–	28.0	–	784	322	3
2006–07	–	–	28.0	–	637	175	1
2007–08	–	–	28.0	–	588	126	1
2008–09	4.0	7.0	28.0	24.0	5,811	5,349	43
2009–10	7.2	10.1	28.0	29.7	7,899	7,437	59
2010–11	10.4	13.2	28.0	35.3	9,711	9,249	74
2011–12	13.6	16.3	28.0	41.0	11,523	11,061	88
2012–13	16.8	19.4	28.0	46.7	13,335	12,873	103
2013–14	20.0	22.6	28.0	52.3	15,147	14,685	117
2014–15	20.0	25.7	28.0	58.0	16,639	16,177	129
2015–16	20.0	28.8	28.0	63.7	18,131	17,669	141
2016–17	20.0	31.9	28.0	69.3	19,623	19,161	153
2017–18	20.0	35.0	28.0	75.0	21,115	20,653	165
2018–19[e]	20.0	35.0	28.0	75.0	21,115	20,653	165

[a] Based on survey results for current Pang Khon growers who participated in only phase two (see Table A1)

[b] Average per-farm output derived from yield assumptions and tree inventories assumed to remain unchanged for the assessment period—4 low-chill peach trees, 29 low-chill plum trees, 7 Thai peach trees and 8 persimmon trees. Thai peach trees produced fruit during the establishment period of low-chill peach, plum and persimmon treas. It was assumed that all low-chill peach and plum trees were established by grafting onto existing Thai peach rootstock. These trees were established in 2004–05—it was assumed that all trees produced Thai peaches in the preceding period. Annual output valued at average farm-level prices (see Table A4).

[c] Adjusted for production costs of fertiliser applications of 0.7 kg/tree for low-chill peach and plum trees. Fertiliser application rate assumed to remain unchanged over the assessment period. Fertiliser price assumed to remain unchanged at 20 baht/kg (Table A1).

[d] Based on net income from fruit sales and the number of Pang Khon growers who participated in phase two. It was assumed that 8 (35%) of the 22 Pang Khon growers met this criterion (see Table A1).

[e] Values for 2018–19 are the assumptions and outcomes for all subsequent years in the impact assessment.

Table A8. Project impact—other participants in phase one[a]

	Average fruit yields				Gross value of harvest[b]	Income from fruit sales[c]	Impact of project[d]
	Low-chill peaches	Low-chill plums	Thai peaches	Persimmons			
	kg/tree	kg/tree	kg/tree	kg/tree	baht/farm	baht/farm	'000 baht
2000–01	–	–	–	–	–	–	–
2001–02	–	–	23.0	–	1,012	466	24
2002–03	–	–	23.0	–	1,012	466	24
2003–04	–	–	23.0	–	1,012	466	24
2004–05	–	–	23.0	–	1,012	466	24
2005–06	4.0	7.0	23.0	24.0	8,127	7,581	387
2006–07	4.3	11.7	23.0	25.3	7,267	6,721	188
2007–08	4.7	16.3	23.0	26.7	6,194	5,648	158
2008–09	5.0	21.0	23.0	28.0	8,242	7,696	215
2009–10	12.5	23.3	23.0	35.8	10,753	10,207	286
2010–11	20.0	25.7	23.0	43.7	12,935	12,389	347
2011–12	20.0	28.0	23.0	51.5	14,555	14,009	392
2012–13	20.0	30.3	23.0	59.3	16,175	15,629	438
2013–14	20.0	32.7	23.0	67.2	17,795	17,249	483
2014–15	20.0	35.0	23.0	75.0	19,415	18,869	528
2015–16[e]	20.0	35.0	23.0	75.0	19,415	18,869	528

[a] Based on survey results for other current growers who participated in phase one (see Tables A1 and A2)

[b] Average per-farm output derived from yield assumptions and tree inventories assumed to remain unchanged for the assessment period—3 low-chill peach trees, 10 low-chill plum trees, 11 Thai peach trees and 12 persimmon trees. Thai peach trees produced fruit during the establishment period for low-chill peach, plum and persimmon trees. It was assumed that all low-chill peach and plum trees were established by grafting onto existing Thai peach rootstock. Annual output valued at average farm-level prices (see Table A4).

[c] Adjusted for production costs of fertiliser applications of 2.1 kg/tree for low-chill peach and plum trees. Fertiliser application rate assumed to remain unchanged over the assessment period. Fertiliser price assumed to remain unchanged at 20 baht/kg (Table A1).

[d] Based on net income from fruit sales and the number of other current growers who participated in phase one. It was assumed that 28 (30%) of the 91 growers met this criterion (see Table A2). Grower numbers include an extra 23 voluntary non-adopters who ceased production in 2005–06.

[e] Values for 2015–16 are the assumptions and outcomes for all subsequent years in the impact assessment.

Table A9. Project base case—Pang Khon participants in phases one and two[a]

	Average yield of Thai peaches	Gross value of harvest[b]	Income from fruit sales[c]	Base case for project[d]
	kg/tree	baht/farm	baht/farm	'000 baht
2000–01	–	–	–	–
2001–02	23	2,300	2,300	81
2002–03	23	2,300	2,300	81
2003–04	23	2,300	2,300	81
2004–05	23	2,300	2,300	81
2005–06	23	2,300	2,300	81
2006–07	23	1,869	1,869	26
2007–08	23	1,725	1,725	24
2008–09	23	2,300	2,300	32
2009–10	23	2,875	2,875	40
2010–11	23	2,875	2,875	40
2011–12	23	2,875	2,875	40
2012–13	23	2,875	2,875	40
2013–14	23	2,875	2,875	40
2014–15	23	2,875	2,875	40
2015–16[e]	23	2,875	2,875	40

[a] Based on survey results for current Pang Khon growers who participated in phases one and two (see Table A1)

[b] Average per-farm output derived from yield assumptions and tree inventories assumed to remain unchanged for the assessment period—25 Thai peach trees. It was assumed that all low-chill peach and plum trees were established by grafting onto existing Thai peach rootstock. Therefore, the 14 low-chill peach and plum trees would have produced Thai peaches in the base case situation. Annual output valued at average farm-level prices (see Table A4).

[c] No adjustment for production costs—it was assumed no fertiliser was applied to Thai peach trees

[d] Based on net income from fruit sales and the number of Pang Khon growers who participated in phases ones and two—it was assumed that 14 (65%) of the 22 Pang Khon growers met this criterion (see Table A1)

[e] Values for 2015–16 are the assumptions and outcomes for all subsequent years in the impact assessment.

Table A10. Project base case—Pang Khon participants in phase two[a]

	Average yield of Thai peaches	Gross value of harvest[b]	Income from fruit sales[c]	Base case for project[d]
	kg/tree	baht/farm	baht/farm	'000 baht
2000–01	–	–	–	–
2001–02	–	–	–	–
2002–03	–	–	–	–
2003–04	–	–	–	–
2004–05	28	4,480	4,480	36
2005–06	28	4,480	4,480	36
2006–07	28	3,640	3,640	29
2007–08	28	3,360	3,360	27
2008–09	28	4,480	4,480	36
2009–10	28	5,600	5,600	45
2010–11	28	5,600	5,600	45
2011–12	28	5,600	5,600	45
2012–13	28	5,600	5,600	45
2013–14	28	5,600	5,600	45
2014–15	28	5,600	5,600	45
2015–16	28	5,600	5,600	45
2016–17	28	5,600	5,600	45
2017–18	28	5,600	5,600	45
2018–19[e]	28	5,600	5,600	45

[a] Based on survey results for current Pang Khon growers who participated in only phase two (see Table A1)

[b] Average per-farm output derived from yield assumptions and tree inventories assumed to remain unchanged for the assessment period—40 Thai peach trees. It was assumed that all low-chill peach and plum trees were established by grafting onto existing Thai peach rootstock. Therefore, the 33 low-chill peach and plum trees would have produced Thai peaches in the base case situation. Annual output valued at average farm-level prices (see Table A4).

[c] No adjustment for production costs—it was assumed no fertiliser was applied to Thai peach trees

[d] Based on net income from fruit sales and the number of current Pang Khon growers who participated in phase two—it was assumed that 8 (35%) of the 22 Pang Khon growers met this criterion (see Table A1)

[e] Values for 2018–19 are the assumptions and outcomes for all subsequent years in the impact assessment.

Table A11. Project base case—other participants in phase one[a]

	Average yield of Thai peaches	Gross value of harvest[b]	Income from fruit sales[c]	Base case for project[d]
	kg/tree	baht/farm	baht/farm	'000 baht
2000–01	–	–	–	–
2001–02	23	2,208	2,208	113
2002–03	23	2,208	2,208	113
2003–04	23	2,208	2,208	113
2004–05	23	2,208	2,208	113
2005–06	23	2,208	2,208	113
2006–07	23	1,794	1,794	50
2007–08	23	1,656	1,656	46
2008–09	23	2,208	2,208	62
2009–10	23	2,760	2,760	77
2010–11	23	2,760	2,760	77
2011–12	23	2,760	2,760	77
2012–13	23	2,760	2,760	77
2013–14	23	2,760	2,760	77
2014–15	23	2,760	2,760	77
2015–16[e]	23	2,760	2,760	77

[a] Based on survey results for other current growers who participated in phase one (see Tables A1 and A2)

[b] Average per-farm output derived from yield assumptions and tree inventories assumed to remain unchanged for the assessment period—24 Thai peach trees. It was assumed that all low-chill peach and plum trees were established by grafting onto existing Thai peach rootstock. Therefore, the 13 low-chill peach and plum trees would have produced Thai peaches in the base case situation. Annual output valued at average farm-level prices (see Table A4).

[c] No adjustment for production costs—it was assumed no fertiliser was applied to Thai peach trees

[d] Based on net income from fruit sales and the number of other current growers who participated in phase one—it was assumed that 28 (30%) of the 91 other growers met this criterion (see Table A2)

[e] Values for 2015–16 are the assumptions and outcomes for all subsequent years in the impact assessment.

References

ABARE (Australian Bureau of Agricultural and Resource Economics) 2009. Australian Commodity Statistics 2009. ABARE: Canberra.

ACIAR (Australian Centre for International Agricultural Research) 2008. Guidelines for assessing the impacts of ACIAR's research activities. ACIAR Impact Assessment Series No. 58. ACIAR: Canberra.

NSO (National Statistical Office) 2010. Statistical information database: statistical tables searched by keyword. Thai Ministry of Information and Communication Technology: Bangkok. At <http://web.nso.go.th/eng/en/stat/stat0.htm>, accessed 20 May 2010.

RPF (Royal Project Foundation) 2010. Royal Project Foundation: agricultural extension. At <http://www.royalprojectthailand.com/general/english/agr.html>, accessed 22 May 2010.

United States Federal Reserve 2010. Federal Reserve economic database—exchange rates. Federal Reserve Bank of St Louis: St Louis, MO. At <www.research.stlouisfed.org/fred2/categories/15/downloaddata>, accessed 15 July 2010.

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 Wattanutchariya 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 *Phalaris minor* 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.	*Mama Lus Frut* 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

IMPACT ASSESSMENT SERIES <CONTINUED>

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 and 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

IMPACT ASSESSMENT SERIES <CONTINUED>

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 and 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

IMPACT ASSESSMENT SERIES <CONTINUED>

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 and SMAR/2006/096
66	Harris D.N. 2010.	Extending low-cost fish farming in Thailand: an ACIAR–World Vision collaborative program	PLIA/2000/165
67	Fisher H. 2010.	The biology, socioeconomics and management of the barramundi fishery in Papua New Guinea's Western Province	FIS/1998/024
68	McClintock A. and Griffith G. 2010.	Benefit–cost meta-analysis of investment in the International Agricultural Research Centres	
69	Pearce D. 2010.	Lessons learned from past ACIAR impact assessments, adoption studies and experience	
70	Harris D.N. 2011.	Extending low-chill fruit in northern Thailand: an ACIAR–World Vision collaborative project	PLIA/2000/165

ACIAR

Research that works for developing countries and Australia

www.aciar.gov.au