ACACIA HYBRIDS IN VIETNAM

ACIAR Project FST/1986/030

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August 2004

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Impact Assessment Series Report No. 27

ISBN 1 83620 477 6 (print)
1 86320 478 4 (online)

Editing and typesetting: Clarus Design, Canberra

Foreword

ACIAR's impact assessment reports provide project impact information that helps to guide future research activities. While the main focus of these commissioned reports is on measuring the dollar returns to agricultural research, emphasis is also given to analysing the impacts of projects on poverty reduction.

This report focuses on the net economic, environmental and social value of spill-over benefits to Vietnam of a project which originated in Malaysia. The project developed methods for breeding acacia hybrids with higher productivity than species traditionally grown in the tropics. The main contribution of the project was to fast-track an acacia hybrid breeding program in Vietnam which has resulted in hybrid clones being available for commercial release up to four years ahead of what would have been possible otherwise. The returns are high because acacia hybrids have been rapidly adopted on a commercial scale in Vietnam.

This report is number 27 in ACIAR's Impact Assessment Series and is also available for free download at <www.aciar.gov.au>.

Peter Core
Director
Australian Centre for International Agricultural Research

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Glossary

ACIAR	Australian Centre for International Agricultural Research
AIDAB	Australian International Development Assistance Bureau (now AusAID)
ASEAN	Association of South-East Asian Nations
ATSC	Australian Tree Seed Centre
AusAID	Australian Agency for International Development
BCR	benefit–cost ratio
CDM	Clean Development Mechanism
FAO	Food and Agriculture Organization of the United Nations
5MHRP	Five Million Hectare Reforestation Program
FORTIP	FAO Regional Tree Improvement Project
FRIM	Forest Research Institute of Malaysia
FSIV	Forest Science Institute of Vietnam
IRR	internal rate of return
MARD	Ministry for Agriculture and Rural Development (Vietnam)
MDF	medium density fibreboard
RCFTI	Research Centre for Forest Tree Improvement
SAREC	SIDA's Department for Research Cooperation
SFE	State Forestry Enterprise
SIDA	Swedish International Development Cooperation Agency
Vinafor	Vietnam Forestry Corporation
Vinapex	Vietnam Paper Corporation
VND	Vietnamese monetary unit, the dong

Details of project evaluated

ACIAR project ID	FST/1986/030 – Hybridisation and vegetative propagation of Australian tropical acacias
Collaborating organisations	CSIRO Forestry and Forest Products, Canberra and Hobart, Australia (CSIRO-FFP); Forest Research Institute of Malaysia, Kuala Lumpur, Malaysia (FRIM); Sabah Forestry Development Authority, Sabah, Malaysia (SFDA)
Project leaders	Professor Rod Griffen (July 1988–January 1991), Dr Kron Arken (January 1991–December 1992) (CSIRO-FFP); Dr Wan Razali Wan Mohammad (FRIM); Mr Cyril Pinso (SFDA)
Duration of project	1 July 1988–1 December 1992 (extended 1 December 1991–1 December 1992)
Project objectives	• To develop reliable methodology for manipulated hybridisation of tropical acacias • To evaluate potential for open-pollinated hybridisation in seed orchards • To develop methods for mass vegetative propagation of tropical *Acacia* species and their hybrids

Summary

In 1988, ACIAR approved funding for a four-year project titled 'Hybridisation and vegetative propagation of Australian tropical acacias' (FST/1986/030). *Acacia* is a genus of trees and shrubs represented by a large number of species in Australia. The project was undertaken by scientists from CSIRO Forestry and Forest Products (CSIRO-FFP) in collaboration with the Forest Research Institute of Malaysia (FRIM). The objective of the research was to improve the commercial potential of Malaysia's plantation forest industry by developing methods for breeding acacia hybrids with higher productivity than traditional species of acacias grown in the tropics. Another aim of the project was to establish low-cost methods for mass vegetative propagation of hybrid clones. In total, A$502,727 was invested in the project (about A$1.0 million in today's dollars).

While the intended recipient of this research was Malaysia, Vietnam took a keen interest in the research results throughout the course of the project. Since completion of the research, Vietnam has made extensive use of the research findings in its own hybrid acacia breeding program, with funding assistance from SIDA, CSIRO and ACIAR, as well as the Government of Vietnam itself. It now has a burgeoning plantation industry based on hybrid acacias. This is a clear case of spill-over benefits, whereby research originally intended for one country (Malaysia) has benefited another (Vietnam).

This impact assessment focuses on the net economic, environmental and social value of the spill-over benefits accruing to Vietnam. No attempt is made to include the possible benefits of the research beyond this country. Benefits are assessed over a period of 30 years, from 1988 to 2018. The main contribution of the ACIAR-funded project has been to fast-track Vietnam's hybrid breeding program, which has resulted in hybrid clones being available for commercial release up to four years ahead of what would otherwise have been the case.

The net benefit of bringing forward the commercial release of acacia hybrids in Vietnam is estimated to be A$152 million in present value terms, calculated over the whole 30-year period. This is a significant return on the A$1.04 million invested in the project, and results in a benefit–cost ratio (BCR) of 145 to one. The returns are high because acacia hybrids have been rapidly adopted on a commercial scale in

Vietnam owing to the sizeable yield advantage — almost double — offered by hybrids over their parent species.

Acacia hybrid forestry has the potential to reduce poverty in those provinces where plantations are commercially viable. A preliminary analysis of poverty data shows that acacias have been established in both poor and relatively wealthy provinces.

The extent to which acacia forestry will help overcome poverty depends on the ownership structure of the plantations, the system of land allocation and the capacity of poor households to access capital, wood-product markets and technology. Wealthier households are likely to benefit the most from plantation development. The poorest of the poor, even if they have access to land, generally cannot afford to invest in an activity that does not yield a return for 3 to 5 years. However, poorer households may benefit from the new job opportunities generated by plantations, including tree growing, harvesting, transport and processing activities.

1. Introduction

In 1988, ACIAR began funding a four-year project which aimed to use genetic improvement to increase the yield and economic returns of tropical acacias. This project was undertaken by CSIRO-FFP in collaboration with Malaysia. Specifically, project FST/1986/030 sought to devise methods for breeding hybrids from the parent species *Acacia mangium* and *Acacia auriculiformis*. Hybrids are the offspring of genetically different parents and often have higher productivity and better resistance to adverse conditions than do the parents. Hybridisation can be induced artificially through controlled pollination, or hybrids can occur naturally in the field. The superior genetic qualities expressed in hybrids are generally unstable; that is, the hybrid vigour is not necessarily transferred to the next generation via seed. There are ways of developing stable hybrid lines that will produce quality seed but this is a slow and expensive process. Therefore, another aim of the ACIAR-funded project was to develop low-cost methods for mass, vegetative propagation of hybrid clones.

While the project fulfilled its scientific aims and established the basic technologies for implementing a program of breeding, propagating and testing hybrids (see project review by Nikles (1991)), there has been only limited uptake of the technology in Malaysia. However, during and upon completion of the project, Vietnam took a keen interest in the research results and has made extensive use of the techniques in its own hybrid acacia breeding program. Vietnam is now growing commercial plantations of hybrid acacias. This is a clear case of spill-over benefits, whereby the ACIAR-funded research, originally intended for Malaysia, has benefited another country.

This impact assessment focuses on the net economic, environmental and social value of the spill-over benefits accruing to Vietnam. No attempt is made to include the possible benefits of the research beyond this country. A comprehensive benefit–cost analysis is undertaken to examine the scale of net benefits over a 30-year time horizon, from 1988 to 2018. As it has been 15 years since the ACIAR-funded project commenced, observations of the actual adoption of acacia hybrids in Vietnam are used to assess project impact to date. For the next 15 years, the analysis uses ‘best-bet’ estimates of future adoption rates.

The social benefits of acacia hybrids are examined in terms of the degree to which the hybrid plantations are helping to reduce poverty. This

involves an assessment of the distribution of benefits between different socioeconomic strata in Vietnam, and whether the profits from commercial wood production and increased supply of fuelwood are improving the incomes and welfare of poor people in rural areas.

1.2 Acacia hybrid research and development in Vietnam

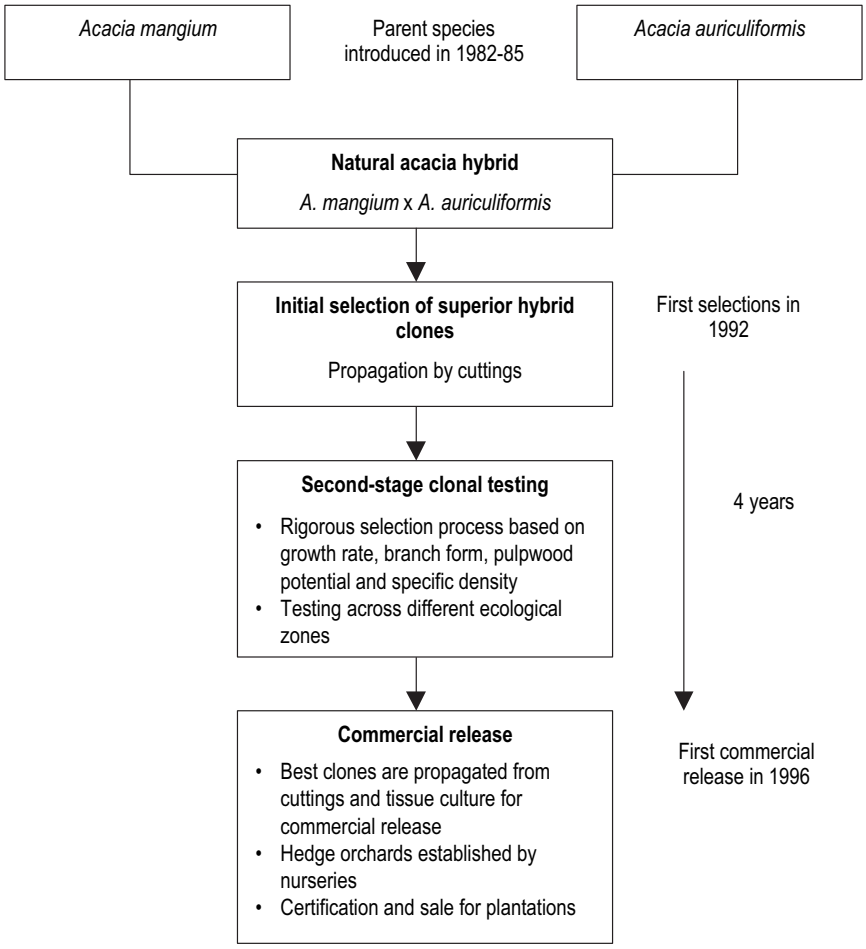
Australian acacia species were first introduced into Vietnam for testing in the early 1960s but from these early introductions — 16 species in total — only *Acacia auriculiformis* was widely adopted for planting, mostly in southern provinces (Turnbull et al. 1998). During the early 1980s, the Research Centre for Forest Tree Improvement (RCFTI) — a division of the Forest Science Institute of Vietnam (FSIV) — began to take an interest in acacias and other fast-growing species with commercial potential. During 1982–85, various provenance trials for acacias, eucalypts and other introduced species were established by RCTFI across eight locations in Vietnam. Most seedlots for testing were supplied by CSIRO-FFP through the Australian Tree Seed Centre (ATSC). These trials identified *A. auriculiformis*, *A. crassicarpa* and *A. mangium* as the acacia species with the greatest potential for commercial production in Vietnam.

In 1991, naturally occurring acacia hybrids were first observed growing at Ba Vi research station, 70 kilometres to the west of Hanoi. The station is operated by RCTFI and was one of the eight sites where acacias were being trialled. The parents of these natural hybrids were identified to be *A. mangium* and *A. auriculiformis*. In the following year, Professor Le Dinh Kha from RCFTI became aware of the technologies that had recently been developed by the ACIAR-funded Malaysia project on acacia hybridisation and propagation (FST/1986/030). Vietnamese scientists soon established a close working relationship with the CSIRO researchers who had been involved in the ACIAR-funded project. The clonal selection techniques and propagation methods developed by CSIRO were adopted by the Vietnamese in their hybrid selection program, which began in 1992 using hybrid plants from Ba Vi.

The operational steps involved in selecting, testing and commercialising hybrids are summarised in Figure 1. The hybrid specimens (or clones) must undergo extensive screening before being selected for commercial release. An initial round of selections is made, based on the best-performing hybrids observed growing in the field. But there is no guarantee that these superior traits will be maintained in trees propagated by cutting. This is because both genetics and environment influence

observed performance. To ensure the selected clones are indeed superior to their parents, the clones are grown under a variety of environmental conditions or zones and their performance is tested. In the case of Vietnam's program, this testing process took four years from the time of first selections in 1992 to commercial release in 1996.

Figure 1. Acacia hybrid selection process



1.3 ACIAR's contribution

The ACIAR-funded research on acacia hybrids (project FST/1986/03) was an important input to Vietnam's research program. The selection and propagation techniques developed by the joint Malaysia–Australia project in the early 1990s helped the RCFTI to establish its own breeding program. However, the contribution made through the ACIAR-funded project was part of a larger effort by the Vietnamese and other sponsors, including AIDAB (the predecessor of AusAID), the Food and Agriculture

Organization of the United Nations (FAO), and the Swedish International Development Cooperation Agency (SIDA). Note that the ACIAR-funded project did not provide the hybrid germplasm to Vietnam or direct financial support. Instead, its pivotal role was to provide the technical know-how to conduct a successful breeding program and subsequent propagation of hybrids. Discussions with Vietnamese scientists suggest that this technology has helped reduce the time taken to develop a suitable hybrid clone for commercial release.

A chronology of Vietnam's research program is shown in Table 1. In 1995, RCFTI started to establish comprehensive base and breeding populations of the best provenances of *A. mangium* and *A. auriculiformis*, in collaboration with CSIRO and with financial support from AusAID for the FAO Regional Tree Improvement Project (FORTIP). The base populations provided a genetic base to undertake advanced-generation breeding to improve vigour, form and adaptability to particular environments. Other research and development has included the testing of hybrid clones over a wider geographical range within Vietnam. This task commenced in the mid 1990s and is continuing. In the near future, RCFTI intends to examine the potential for artificial acacia hybrids.

Table 1. Vietnam's hybrid acacia research program

Date	Key milestone
1982–1985	• FAO and the World Food Program funded provenance trials for introduced tree species, including four *Acacia* species. • Seedlots were introduced by the CSIRO. • Trials were established at 8 locations in 6 provinces, including at Ba Vi research station.
1988	• CSIRO scientists first visit Vietnam to evaluate trials. • SIDA SAREC research project on tree improvement in Vietnam commences.
1991–1992	• Acacia hybrids were first observed growing at Ba Vi and other trial sites around Vietnam. • RCFTI makes first contact with ACIAR at an ACIAR-funded seminar in Malaysia.
1993	• First hybrid selections are made and field trials are established at Ba Vi.
1995	• Hybrid clone testing begins at Ba Vi. • Vietnam establishes a comprehensive base and breeding populations of the best provenances of *A. auriculiformis* and *A. mangium* in different ecological zones. Collaboration with CSIRO, AIDAB, and FAO's FORTIP Project.
1996	• Propagation and first release of acacia hybrid clones for commercial production.
1995–1999	• Trials of acacia hybrid clones in different ecological regions across Vietnam undertaken by RCFTI.

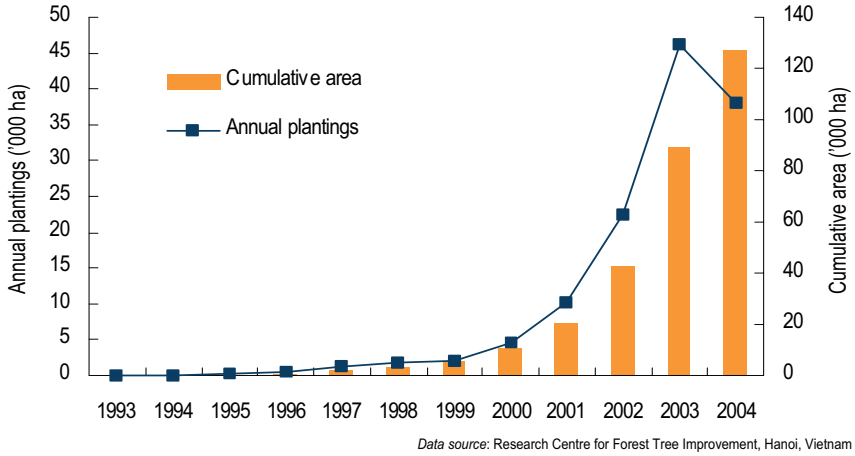
2 Adoption of acacia hybrids in Vietnam

In the past three years, significant areas of hybrid acacia plantations have been established in Vietnam. It is estimated that approximately 46,000 hectares of hybrids were planted in 2003, more than double the area planted in 2002. As at 2004, the total area of hybrids planted since their initial release in 1996 is estimated to be 127,000 hectares (Figure 2). Hybrids are beginning to replace the traditional acacia species grown in Vietnam, although some *A. mangium* and *A. auriculiformis* — about 37,000 hectares in 2003 — are still planted. The hybrids are expected to completely replace the traditional species once hybrid seedlings (grown from cuttings) become widely available at low cost.

To date, the bulk of plantations have been established in the south and central provinces of Vietnam. Less than 15% of the total area of acacia hybrids is located in the north. Southern areas are preferred because their warmer climate promotes faster tree growth. There is also good access to markets in the south, both in terms of strong demand by local paper mills and woodchip exporters who ship chips out of Ho Chi Minh City.

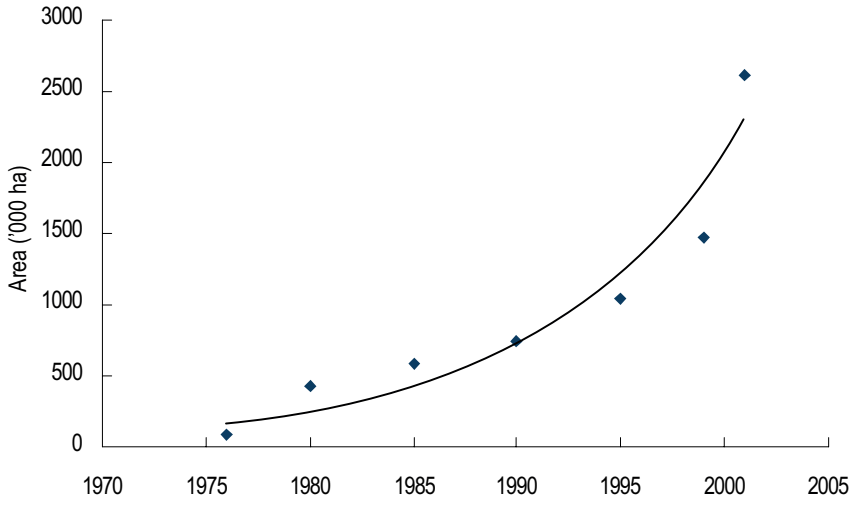
While acacia hybrids are rapidly becoming an important forest tree in Vietnam, the area of hybrids planted to date accounts for only about 5% of the total plantation estate. As at 2001, the total standing area of plantations was estimated to be 2.6 million hectares (GSO 2003). Approximately half of the plantation resource is designated for industrial use, including pulp and paper and artificial fibreboard. The remainder is to be used for furniture, special forest products and conservation purposes — or 'protection' plantations (MARD 2001). Last decade saw a substantial expansion in forestry plantations (Figure 3). A mixture of indigenous and introduced species was planted, including native pine, styrax, bamboo, eucalypts, melaleucas and acacias — both hybrid and non-hybrids. The current planting rate of acacia hybrid (46,000 hectares per year) represents about 24% of all new plantation area established in 2003 (CIEM 2004).

Figure 2. Adoption of acacia hybrid plantations in Vietnam



Data source: Research Centre for Forest Tree Improvement, Hanoi, Vietnam

Figure 3. Increasing area of plantations in Vietnam — all species



Data source: MARD (2001)

2.1 Government forestry programs and support measures

The Vietnam Government is actively promoting the expansion of plantation forests to counter the loss in natural forest cover, which has declined sharply in the past 25 years due to land clearing and over-exploitation for timber and fuelwood. Between 1992 and 1998, the government spent approximately US$213 million on Program 327, which had the aim of protecting existing forest areas and establishing new

plantations (Salmi et al. 1999). Over the course of the program, the Ministry of Agriculture and Rural Development (MARD) estimates that 638,500 hectares of tree plantations were established. Program 327 has been replaced by the 5 Million Hectare Reforestation Program (5MHRP), which was introduced in 1998. It has the aim of increasing the area of plantations by 5 million hectares by 2010. Of this target, 2 million hectares is to be established for production forestry, supplying raw material for:

- pulp and paper — 1 million hectares
- artificial fibre board — 0.4 million hectares
- firewood and other domestic uses — 0.4 million hectares
- furniture and special products — 1.2 million hectares.

It is expected that acacia hybrids will make up about 40% of the 1.8 million hectares targeted for industrial and domestic plantations. Eucalypts are to make up a smaller proportion; about 20%. Acacia hybrids are increasingly becoming viewed as preferable to eucalypts because of their rapid growth rate, adaptability to poor soil types, nitrogen-fixing capability and resistance to leaf diseases that are a problem for eucalypts.

The 5MHRP has a budget of US$2.5 billion over 10 years, over half of which is being funded by international aid agencies. Under the program, funds are provided only for establishing 'protection' plantations designed for conservation and environmental purposes. No direct financial support is available for commercial plantations, although assistance is provided in the form of infrastructure development such as roads.

While the 5MHRP focuses on funding protection forests, various other government support measures are provided to promote commercial plantations, including:

- low interest loans
- tax exemptions and subsidised electricity for foreign investors
- tariffs and restrictions on paper imports
- exemptions from land rent.

These measures effectively reduce wood production costs and possibly increase the prices received for products. However, they also potentially distort the efficient allocation of resources.

The Vietnam Government is also making efforts to accelerate the process of allocating land-use rights. Since 1993, forest land-use rights with a tenure of 50 years or more can be allocated to Vietnamese individuals, households and organisations (public and private). Foreign individuals and companies cannot own land but rental of land is permitted. In practice, about 42% forest land (plantations plus natural forest) belongs to State Forest Enterprises (SFEs), 18% is owned by households or private companies, and 40% remains 'unallocated' (MARD 2001). Unallocated land falls under the management authority of MARD.

Forest policy reforms are gradually changing this situation, with SFEs contracting the use of forest land to households, and some land, formerly used collectively by village communities for subsistence purposes, is now being allocated to private individuals and companies. This is encouraging investment in plantation forestry.

2.2 Demand for acacia products

Most of the hybrid acacia plantations being established — 92% according to statistics collected by RCFTI — are for commercial production. The intended products are pulpwood for domestic paper mills, raw material for manufacturing medium-density fibreboard (MDF) and woodchips for the export market. Another important product for rural people is fuelwood for cooking and heating, which utilises harvest residues. To date, negligible quantities of acacia hybrid have been used for sawlogs or construction.

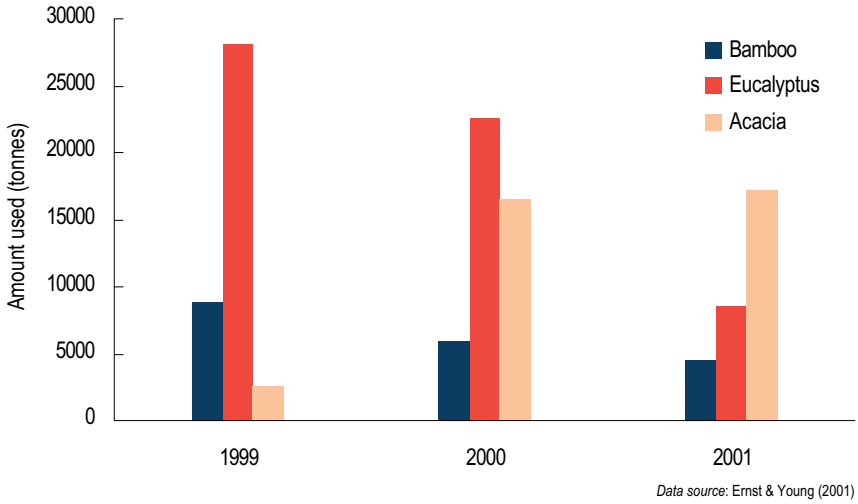
The Vietnam Forestry Corporation (Vinafor) is one of the country's largest forestry operators. It is a state-owned corporation and manages 35,000 hectares of plantations, of which 7200 hectares are of acacia hybrids. Currently, about half of the acacia hybrid wood produced by Vinafor is exported as woodchips and the other half is used locally for producing MDF. Vinapex is another large state-owned corporation. Through its member companies it is both a raw material supplier and processor of pulpwood. It owns 11,500 hectares of acacia hybrid plantations, with all raw material going into domestic paper production. Most of these plantations are located in southern and central regions.

In the last few years, acacia wood is beginning to make up an increasing proportion of the raw material consumed by local paper mills. Figure 4 shows that the Dong Nai Paper Company is gradually replacing eucalypts and bamboo material with acacia hybrid wood. Some of this raw material is from early plantings of traditional acacia species. More recently, acacia hybrids have begun to be used as feedstock. The Tan Mai mill (also located

in the south) has increased its consumption of acacia hybrid wood from 15% of its total fibre requirements in 2002 to 40% in 2003. At Tan Mai, acacia hybrids have replaced imported softwood logs, partly due to a rise in the price of imported logs last year and partly due to the lower production costs of local raw material achieved by the introduction of acacia hybrids. In the north, the use of acacia hybrids is much more limited. For example, the Bai Bang Mill uses mainly bamboo, styrax and eucalypts raw material, which is relatively abundant due to the maturing of plantations established in the early to mid 1990s under Program 327 and SIDA.

Table 2 summarises the current demand for pulpwood in Vietnam and the potential for increased future demand following the construction of new mills and artificial board factories. The future demand for acacia hybrid as a raw material for pulp and paper production will depend on Vietnam's capacity to compete with overseas producers of raw material and finished paper products. Domestic demand for paper exceeds local production by about 50% and the gap is made up by paper imports. While the Vietnam Government has plans to expand production significantly over the next five years (including the construction of 12 new pulp and paper mills), other countries such as Indonesia, Thailand and Malaysia have more modern mills, a lower cost structure and higher output capacity than Vietnam (Ernst & Young 2001). At present, Vietnamese mills are protected from cheap imports by a 40–50% tariff on imports. But following the signing of the ASEAN trade agreement, Vietnam is committed to reducing this tariff to 5% by 2006. This will make it imperative for Vietnam's paper mills to improve their efficiency and source low-cost raw material if they are to remain commercially viable. Acacia hybrids will play an important role in meeting these efficiency gains.

Figure 4. Increased use of acacia wood in paper production, Dong Nai Mill



Data source: Ernst & Young (2001)

Table 2. Wood consumption by Vietnam's paper mills and artificial board factories

	Wood consumption[a] (green tonnes)	Current annual output[b] (tonnes)
Pulp and paper mills		
Existing		
Bai Bang	270 000	127 000
Viet Tri	~50 000	25 000
Tan Mai	60 000	76 000
Dong Nai	40 000	24 000
Other small mills	~100 000	~50 000
Total	520 000	302 000
Additional planned in short term	1 460 000	730 000
Artificial board factories		
Existing	37 500	50 000
Additional planned in short term	100 000	300 000

[a] Does not include recycled paper and imported pulp.
[b] Includes pulp and paper products.
Source: Based on information contained in Ernst & Young (2001) and MARD (2001).

2.3 Plantation ownership

Most of the acacia hybrid plantations to date have been established by State Forest Enterprises (SFEs). Based on data from the RCFTI, approximately 70% is owned by SFEs and only 23% by farmer households and individuals. Foreign companies account for 7%. Part of the reason for the predominance of public ownership is that Vinapex, a State-owned corporation, controls the country's largest paper mills and is also responsible for supplying the mills with raw materials through its two plantation companies, Vinh Phu Paper Material Company (northern Vietnam) and South Paper Raw Material Company (southern Vietnam). There are, however, some provinces in the south, such as Dong Nai, where most of the new acacia hybrid plantations are currently being established by private entities — companies owned by either wealthy Vietnamese families or foreign interests.

The ownership structure of plantations is discussed at further length in chapter 5, which examines the potential for acacia hybrids to reduce poverty.

3 Research outcomes

The Research Centre for Forest Tree Improvement has released six hybrid clones for commercial production. From a pool of 15–20 hybrid specimens that are undergoing testing across various ecological zones in Vietnam, a further four clones are showing promise. The hybrids released to date have growth rates almost double that of their parents, while at the same time producing wood with acceptable pulp yields and pulping quality. Vietnam's hybrid breeding and selection program has therefore significantly improved the commercial attractiveness of growing acacias.

3.1 Wood yields

The hybrid acacias produced by RCFTI have growth rates that are almost double those of their parent species. The yield differentials vary across different regions but, on average, the hybrids produce an additional 10 cubic metres of wood per hectare each year (Table 3). The traditionally used acacia species have a mean annual increment (MAI) of 12 m^3/ha/year while hybrids achieve 22 m^3/ha/year under similar growing conditions. In the south, growth rates of up to 30 m^3/ha/year have been achieved by hybrids at a commercial scale. However, this is not representative of the whole industry.

The faster growth rates mean that hybrids can be harvested 2–3 years earlier than non-hybrids. It is common commercial practice (by companies) for acacia hybrids to be harvested at 5 years, while traditional species are typically harvested at 7 years. Farmers in some southern provinces are growing hybrids under a 'low input' regime and harvesting after only 3 years — mainly because they cannot afford to have funds tied up in forestry for longer than this.

One of the drawbacks of the rapid growth of hybrids is the increased risk of stem-break during storms. Because a full canopy quickly develops on a relatively thin stem, strong winds can cause stems to break. When this happens, little can be salvaged in the way of high-value pulp logs. The trees are generally downgraded to fuel wood. This tends to be a problem in the country's northern provinces.

The hybrid clones developed in Vietnam are more drought-tolerant than their parent species, meaning that the potential range of climatic zones for planting acacias has been extended.

Table 3. Acacia hybrid yields relative to traditional acacia species

		Traditional acacia species	Hybrid acacias
Mean annual increment (MAI)	m^3/ha/year	12	22
Rotation length	years	7	5
Yield at harvest	m^3/ha	84	110

3.2 Pulp yields and quality

Acacia hybrids produce wood of good quality for paper-making. The hybrids generally outperform their parent species in terms of pulping quality (Le Dinh Kha 2001). Paper mills in Vietnam are currently producing high-quality paper from acacia hybrid raw material. For example, the Tan Mai Paper Company in Dong Nai Province is currently processing 40,000 tonnes of acacia hybrid each year. This is 40% of the mill's feedstock.

The pulp yield of hybrid acacias is also superior to that of its parent species. Hybrids have an average pulp productivity of 232 kg/m^3 of wood, while the productivity of *A. mangium* is 195 kg/m^3 and *A. auriculiformis* is 223 kg/m^3 (Le Dinh Kha 2001). While the productivity gains are significant, paper mills do not appear to be offering a premium price for hybrid acacia raw material relative to traditional acacia material.

3.3 Environmental benefits

Like all legumes, acacias have the ability to fix atmospheric nitrogen. This is facilitated by a symbiosis between nitrogen-fixing bacteria and the plant's roots. Based on assessments of the number of nodules and nitrogen-fixing bacteria per plant, acacia hybrids have markedly better fixing ability than their parent species. Trials have also shown that hybrids create a more favourable environment for many other soil microorganisms, thus improving the physical and chemical properties of soil (Le Dinh Kha 2001). This could enhance the long-term sustainability of hybrid plantations grown continuously on the same site, relative to traditional acacias or other tree species. The capacity of acacia hybrids to improve infertile soil could provide an economic benefit to subsequent rotations of acacia or other crops (in terms of lower fertiliser requirements). This is difficult to estimate, however, because the actual quantity of additional nitrogen fixed by hybrids has not been assessed.

Acacia hybrid plantations have the potential to provide several other environmental benefits. In parts of central Vietnam, fast-growing acacias have been used to stabilise hill slopes, allowing agroforestry to be practised on steep land where previously cultivation would have caused excessive soil erosion. While acacia hybrids are beneficial for this application, they are unsuitable as windbreaks because of the tendency for trees to snap in high winds. Acacia plantations also have a role to play in reducing greenhouse gases, provided the wood is not harvested for pulp or firewood. The Japanese Government has recently funded a Clean Development Mechanism (CDM) project which will involve the establishment of 50,000 hectares of plantation forest, most of which will be of acacia hybrids. The net contribution of acacia hybrids to greenhouse benefits is dependent on the extent to which acacia hybrids are helping to increase reafforestation, relative to what would have eventuated without the hybrids. No attempt is made to quantify this contribution in this analysis.

Fast growing acacia plantations are also expected to reduce the pressure on native forests as a source of industrial raw material. As discussed before, Vietnam's native forests have been declining in area and quality. Plantation forestry will help to preserve the environmental integrity of native forests.

3.4 Production costs and returns

Table 4 summarises the profitability of acacia hybrids relative to traditional acacias grown in Vietnam. On average, the hybrids are almost twice as profitable as their parents. This is a result of significantly higher yields and a shorter rotation interval. The hybrids are estimated to return a net present value of A$894 per hectare over 5 years, while the traditional acacias return A$460 per hectare over 7 years.

In calculating these returns, allowance has been made for the higher input costs associated with growing hybrids. All hybrid plantations must be established using trees propagated from cuttings (at a cost of VND500 or A$0.05 per tree), which is more expensive than seed propagation, the usual practice for establishing traditional acacias. Furthermore, because the yield potential of hybrids is much higher, it becomes economic to increase the amount of fertiliser, weed control and other inputs. Based on consultations with plantation companies at various locations across Vietnam, the average cost of establishing hybrids is VND12 million per hectare (A$1130), while the average cost of traditional species is VND8 million per hectare (A$753). Unlike eucalypts, acacias must be replanted at the end of each rotation and cannot be coppiced.

Table 4. Typical production costs and returns for acacia plantations

	Traditional species		Acacia hybrids	
	'000 VND[a]	$A	'000 VND[a]	$A
Growing costs				
Establishment (per ha)	8 000	753	12 000	1130
Annual land rent (per ha per year)	250	24	250	24
Total per hectare nominal costs over whole rotation	9 750	918	13 250	1 248
Returns[b]				
Stumpage price (per m^3)	300	28	300	28
Nominal gross revenue (per ha)	25 200	2 373	33 000	3107
Net present value (per ha)[c]	4 886	460	9 497	894

[a] Assumes an exchange rate of 10,620 Vietnamese dong (VND) to A$1.00.
[b] Based on yields outlined in Table 3.
[c] Assumes a discount rate of 10 per cent.
Source: Based on information provided by Vinafor and South Paper Raw Material Company.

The land rental values of VND250,000 per hectare (A$24) represent the opportunity cost of land that could be used for other enterprises. On the types of land where acacias are being grown, the rental values are relatively low. This is particularly true in the north, where degraded forest land in mountainous regions is being used for plantations. In the south, where most of the acacia hybrid plantations are being established, land is more valuable. Here, acacias are grown on former grazing land. Acacias are also competing with rubber and cashews. Rubber is generally a more profitable enterprise for wealthy farmers who have sufficient financial reserves to fund the 10-year lag time until rubber trees start producing. However, poorer farmers who do not have sufficient cash reserves tend to favour hybrid acacias, which can be harvested after only 3 years.

Stumpage prices for pulp logs (net of harvest and transport costs) are in the range VND250,000–300,000 per m^3 (A$24–28 per m^3). Prices tend to be at the upper end of this range in southern Vietnam due to higher demand for raw material and more competition between mills. If pulp logs are delivered to the mill gate, prices are in the range VND380,000–480,000 per cubic metre (A$36–45 per m^3). Some mills pay a fixed guaranteed price at the lower end of this range to companies with a supply contract and, if more material is required in addition to the contracted quantity, the mill will pay a higher price in order to secure additional material.

Each year the government (through Vinapex) sets the price for deliveries of wood to the country's largest paper mills. Prices for acacia wood, particularly in southern Vietnam, tend to be dictated by the world price for pulpwood. This is because domestic paper mills readily substitute local

raw material with imported pulp logs from New Zealand and Australia if prices are competitive. Also, there are foreign-owned chip mills operating in the south which export woodchips to Japan and Taiwan. These export operations compete with local mills for raw material. In the north, plantation growers have fewer market outlets, and prices for pulpwood are lower and tend to reflect domestic supply conditions.

4 Benefit–cost assessment

This impact assessment focuses specifically on the economic returns to the investment in acacia hybrid research through the ACIAR-funded project FST/1986/030 rather than the *overall* benefits and costs of acacia hybrid development in Vietnam. There is a subtle but important difference between these. The first approach — and the one used in this assessment — assumes that acacia hybrids would have eventually become available in Vietnam, even without the technology provided by FST/1986/030. The contribution of the ACIAR-funded project was to fast-track Vietnam's research program, by furnishing the RCFTI scientists with 'ready-to-use' technical knowledge. This contribution would have brought forward the release date of hybrids for commercial production. The second approach, where the total benefits of acacia hybrids are assessed, is inappropriate for this evaluation because it would overstate the impact of the ACIAR-funded project. It would attribute all the benefits to the ACIAR-funded project while, in reality, there were other organisations involved in funding and managing Vietnam's hybridisation research.

4.1 Impact of the ACIAR-funded project

The impact assessment involves the calculation of net returns from growing acacias — both traditional species and hybrids — over a 30-year period, with and without the input from the ACIAR-funded project. In the 'with' scenario, it is known that hybrids were available for commercial production from 1996 onwards. Thus, from this point of time the annual plantings comprise a mix of traditional species and hybrids. The superior yield and profitability of the hybrids have meant that hybrid clones have been progressively replacing the parent species. While 37,000 hectares of traditional acacia was planted in 2003, discussions with plantation companies suggest that hybrids will completely replace the traditional species by 2005 for commercial use. If this is so, it will take a further 6 years for all the traditional plantations to be harvested. In the 'without

ACIAR project' scenario it is assumed that Vietnam would have taken a further 4 years to develop suitable hybrid clones for commercial release. In turn, this would have delayed the establishment and harvest of plantations with higher profitability.

A spreadsheet model is used to track the annual plantings (replacements plus new additions), areas harvested and cumulative area of the plantation estate under each scenario. Figure 5 shows the cumulative areas of hybrids and traditional acacias grown. For the 'without ACIAR project' scenario, traditional species continue to be planted for longer because it takes a further 4 years for hybrids to become available. The development of the total plantation estate over time under each scenario is shown in Figure 6. These curves are the summation of both traditional and hybrid plantings. The proportion of hybrids in the plantation estate is illustrated in Figure 7.

The maximum area of acacia hybrids for commercial production is assumed to be 430,000 hectares. In the 'with' scenario, this maximum is assumed to be met in 2014, while in the 'without' scenario it takes a further 4 years before the 430,000 hectares is achieved. This maximum takes a conservative view of what can be achieved in the next 15 years. It represents about 20% of the 2010 target set by the Vietnam Government for production plantations. Approximately 85,000 hectares of acacias would need to be planted each year by 2014 to maintain a plantation estate of 430,000 hectares. A conservative view is taken because there are numerous constraints facing the expansion of plantation forestry in Vietnam, including:

- limited suitable land
- insecure land tenure for forestry development
- available land is scattered, increasing the costs of harvesting and transport
- high cost of credit finance at commercial rates
- plantation damage from grazing animals, fire and theft is common
- labour productivity and management skills are low
- poor roads and transport infrastructure
- port capacities limit the size of woodchip carriers than can be used.

For this impact assessment, the absolute level of adoption level does not affect the results because the analysis assumes that the maximum is reached regardless of whether or not the ACIAR-funded project made a contribution to the development of hybrids. The impact of the ACIAR-funded project is to bring forward the time of reaching the maximum adoption level. Thus, it is the relative difference in plantation returns between the 'with' and 'without ACIAR project' scenarios that is important. Table 5 summarises the key parameters used to generate each scenario in the plantation growth model.

Figure 5. Cumulative area of hybrids and traditional acacias

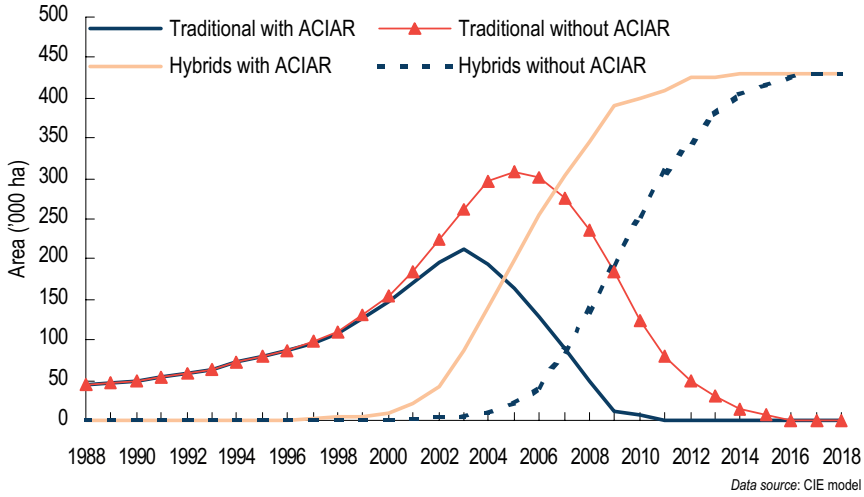


Figure 6. Cumulative area of acacias — all types

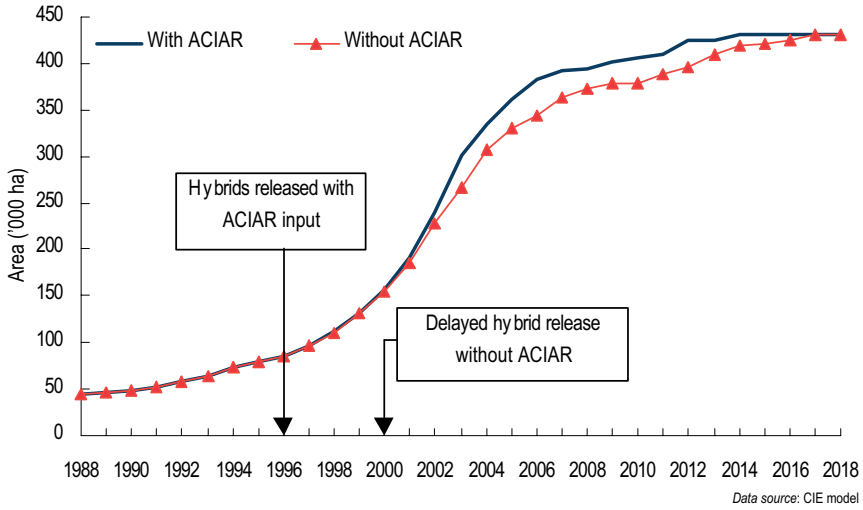
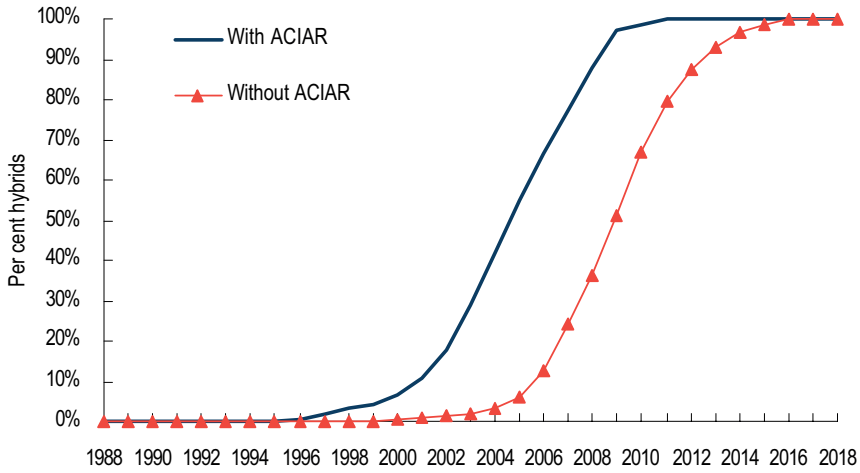


Figure 7. Proportion of hybrids in the acacia plantation estate



Data source: CIE model

Table 5. Key adoption assumptions

	With ACIAR project	Without ACIAR project
Initial area of acacia plantations in 1988	45,000 ha	45,000 ha
Area of acacia plantations in 1995[a]	80,000 ha	80,000 ha
Year of commercial release of hybrids	1996	2000
Year that plantings of traditional acacias cease	2005	2010
Maximum area of hybrids adopted for commercial production	430,000 ha	430,000 ha
Year of reaching maximum adoption	2014	2017

[a] Estimate from Turnbull et al. (1998)

Benefit calculation

The benefit attributable to the ACIAR-funded project is determined by the difference in net plantation returns with and without the ACIAR-funded project over the period of the analysis. The net plantation return *in any given year t* for a particular scenario is equal to the sum of returns from *new plantings* of hybrids and traditional species, which is determined by:

- the total area of new acacia plantings in year t (S_t)
- the proportion of hybrids ($\%H_t$) and traditional acacias ($\%T_t$) in the new area planted

- the per hectare net present value returns from growing a single rotation of hybrids (NPV_H) and from growing a single rotation of traditional acacias (NPV_T). Returns are recorded in the year that trees are *planted* (as net present values) rather than the year of harvest. Thus, harvest revenue from trees planted in the last year of the assessment period (2018) is included in the analysis.

The net plantation return in year t, denoted NPR_t, is given by:

$$NPR_t = [(\%H_t \times S_t \times NPV_H) + (\%T_t \times S_t \times NPV_T)]$$

The differential in plantation returns between the 'with' and 'without' scenarios is driven by the higher annual planting area (S) in the 'with' scenario from 2002 onwards and the greater proportion of hybrids in the planting mix ($\%H$), which are more profitable than the traditional acacias ($NPV_H > NPV_T$). The net benefit of the ACIAR-funded project over the whole 30-year period is equal to the discounted stream of plantation returns in the 'with' scenario, less the discounted stream of plantation returns in the 'without' scenario.

Other assumptions

Other assumptions made included the following:

- The profit differential between traditional acacias and the hybrids is A$434 per hectare net present value (VND 4611 per hectare), based on the values presented in Table 4. This differential is assumed to remain constant over the whole time horizon.

- Stumpage prices are assumed to remain constant in real terms over the time horizon. Given that pulp log prices in Vietnam are largely determined by the world market price for woodchips, prices are assumed to be unresponsive (inelastic) to increasing domestic supplies of wood. Vietnam is a small producer of pulpwood relative to other Pacific Rim countries, and therefore additional supply of raw material will not affect world price.

- The benefit–cost model uses a discount rate of 5%.

4.2 Research costs

The project funding contributions made by ACIAR, CSIRO and FRIM for the years 1988 and 1991 totalled A$502,727 in nominal terms, or approximately $1.0 million in present value terms. Table 6 summarises the annual investments.

Research costs were also incurred by the Vietnam Government and other sponsors of its research program. Over the period 1992 to 2000, the RCFTI estimates that about VND1.2 billion (A$113,000) was spent on acacia hybrid research and development. In present value terms, this equates to A$167,198. The various projects and funding bodies are itemised in Table 7. This estimate is probably conservative because it almost certainly does not include overheads. Increasing these costs by 30% to allow for overheads brings the total to A$217,357.

Table 6. ACIAR-funded project costs — FST/1986/030

	Nominal values	Present values[a]
	$A	$A
Cash		
1988–89	94,553	206,397
1989–90	65,527	136,226
1990–91	105,647	209,174
In–kind		
1988–89	79,000	172,447
1989–90	79,000	164,235
1990–91	79,000	156,415
Total	502,727	1,044,894

[a] Assumes 5% real rate of interest
Source: ACIAR project database and budget records

Table 7. Research costs, Vietnam's acacia hybrid program, 1992–2000

	Nominal values		Present values[a]
	Million VND	$A	$A
Project			
1991–2000: Research on selection and propagation of some main plantation tree species in Vietnam • Vietnam Government	300	28,249	43,188
1996–1999: Trials of acacia hybrids in some ecological regions in Vietnam • Vietnam Government • AIDAB/AusAID • FAO FORTIP project	700	65,913	92,820
1987–2000: Research on tree improvement in Vietnam • SIDA SAREC project	200	18,832	31,190
Total	1200	112,994	167,198

[a] Assumes a 5% real interest rate. [b] Assumes an exchange rate of 10,620 Vietnamese dong (VND) to A$1.00.
Source: RCFTI

The research costs of the Vietnam hybridisation program must be set against the benefits from the productivity gains delivered by the hybrids. The costs are spread over the period 1992–2000 in accordance to the approximate time at which the projects were undertaken. The costs are assumed to be incurred in both the 'with' and 'without' scenarios. However, in the absence of the ACIAR-funded project it is assumed that Vietnam's research program begins 4 years later, meaning that all costs are moved back by 4 years. It is possible that Vietnam would also have incurred greater costs if the technology developed by the ACIAR-funded project had not been available 'off the shelf'. But as this is difficult to determine, no attempt was made to incorporate higher research costs into the analysis.

4.3 Results

The analysis shows a strongly positive return to the investment in the ACIAR-funded project. The net present value (NPV) benefit of bringing forward the commercial release of acacia hybrids by 4 years in Vietnam is estimated to be A$152 million over the whole 30-year time horizon (1988–2018). This is a significant return on a relatively modest ACIAR research investment of A$1.04 million. Thus, a high benefit–cost ratio (BCR) of 145 and an internal rate of return (IRR) of 47% are estimated (Table 8).

The net benefit to date is also significant and is estimated to be A$74 million (BCR of 71). This benefit estimate is based on the observed plantings of acacia hybrids to date and the increased harvest returns that these hybrids have delivered (or are expected to deliver over the next 5 years) relative to the 'without' scenario. In the 'without' scenario, fewer hybrids would have been planted and the total area of the acacia estate would have been smaller.

The returns to investment in the ACIAR-funded project are high because, for a relatively small investment of a million dollars, the technology developed by the project has brought forward the release of hybrids in Vietnam with considerably higher yields to the traditional acacias they are replacing. On average, hybrid yields are 83% higher than the traditional acacias. Even allowing for higher input costs to support the higher yields, the profit differential between the hybrids and their parent species is $434 per hectare. Another factor contributing to the high return is the rapid rate of adoption that has been witnessed since the hybrids were released in 1996.

Table 8. Benefit–cost analysis results

Base case	Net present value[a]	Whole 30-year period		Impact to date	
		With	Without	With	Without
Plantation net returns	A$m	955	803	349	270
Vietnam research costs	A$m	0.22	0.18	0.22	0.18
ACIAR project costs	A$m	1.04	0	1.04	0
ACIAR attributable benefit	A$m	152		79	
Benefit–cost ratio (BCR)		145		76	
Internal rate of return (IRR)	%	47		46	
15% lower hybrid yield					
Plantation net returns	A$m	702	627	304	267
ACIAR attributable benefit	A$m	74		37	
BCR		71		35	
IRR	%	39		37	

[a] Discount rate of 5%.
Source: CIE model estimates.

The results are robust even with lower assumptions about the productivity improvements delivered by hybrids. If hybrid yields were 15% lower than those used in the standard base-case assessment, the net benefit to the ACIAR-funded project is still positive; $74 million and a BCR of 71 over the whole project period.

These results are conditional on the assumption that markets for acacia remain strong. Markets are likely to absorb the additional supply because there is considerable scope for replacing higher-cost sources of pulpwood used by local paper mills. Some mills, such as Bai Bang and Tan Mai, have recently expanded their capacity and it is planned to build a further 12 paper mills over the next 5 years or so. An emerging export market for woodchips will also help to bolster the prices for acacia wood.

5 Contribution to reducing poverty

About 75% of Vietnam's population lives in rural areas and many of these people suffer low living standards. While poverty across the whole nation has been falling over the past decade, approximately 30% of the population is living below the poverty line, as measured by the 2003 Vietnam Households Living Standards Survey (GSO 2003). Poverty arises when people have insufficient food, income and other inputs to

maintain an adequate standard of living. Asset poverty is defined as the lack of access to natural, physical, financial, human and social assets, leading to a situation of vulnerability to unforeseen events and a lack of capacity for self determination.

Since 1989, Vietnam has been embracing economic reforms in an effort to move towards a market economy. These reforms are gradually leading to a more industrialised country and improved living standards. In the period 1990 to 2001, the proportion of people living in rural areas fell from 80.5% to 75.2% (GSO 2003). Over the same period, the contribution of agriculture/forestry to GDP fell from 33% to 24%. The increased level of industrialisation, combined with agricultural land reforms, increased job creation by the private sector and increased integration of agriculture into the market economy, has helped to lower poverty levels. Poverty rates have fallen from 58% in 1993 to 29% in 2003 (GSO 2003). Thus, almost a third of the total population has been lifted out of poverty in less than 10 years.

While industrialisation and market reforms have generated employment and improved living standards in urban areas, rural provinces still suffer high poverty levels. The provinces worst affected are in the northwest and northeast of the country, with poverty rates of up to 70–80% (Minot et al. 2003). Rural areas have a largely unskilled and poorly educated workforce that cannot access new employment opportunities in the cities. Over three quarters of the rural labour force works in the agriculture and forestry sector. Therefore, improved incomes from agriculture and forestry, through productivity improvements and institutional reforms, will be important for overcoming poverty in rural provinces.

5.1 The potential for plantations to reduce poverty

Reforms to Vietnam's agricultural industry have been responsible for some of the reductions in poverty recorded over the last decade. The liberalisation of commodity markets and allocation of land to farmers has helped to transform Vietnam from a country suffering rice shortages in the 1980s to one of the world's major rice exporters. Similarly, it has dramatically expanded exports of coffee, seafood, fruits and vegetables. Over the period 1996–2001, the value added from agriculture grew at an average annual rate of 4.1%. Over the same period, value added from forestry grew at an average rate of only 1.0% per annum (GSO 2003). The slower growth rate for forestry is principally due to the slow pace of policy reform in the forestry sector and the tightening of controls on the commercial exploitation of native forests. Forestry also makes a much

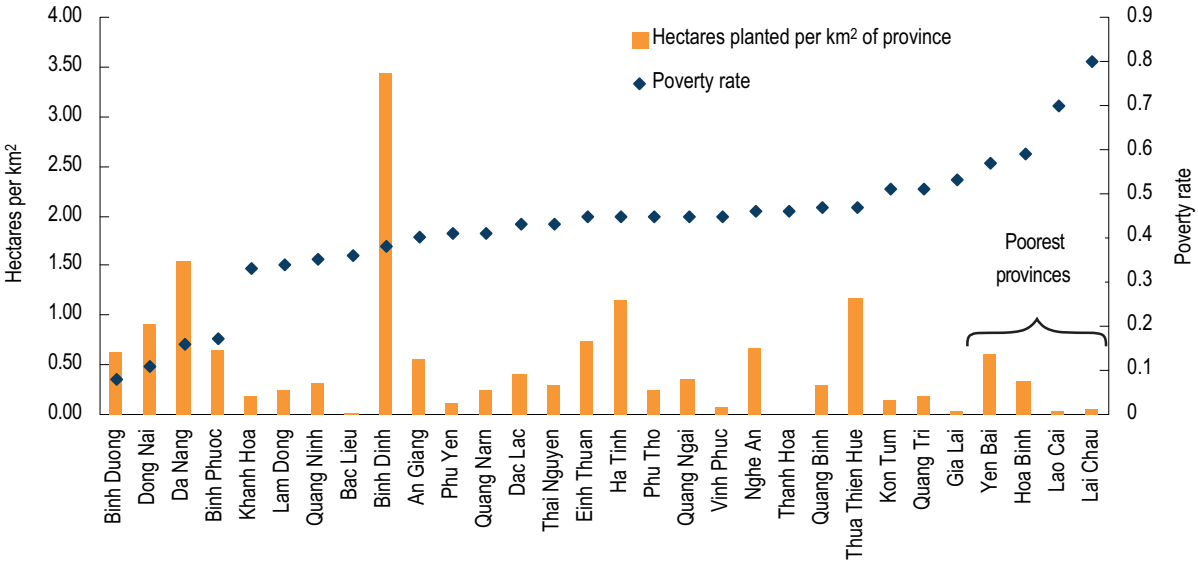
smaller contribution than agriculture to GDP in absolute terms. Forestry accounts for 1.3% of national GDP, while agriculture contributes 19%.

While the output from native forests has trended downwards over time, output from plantations has been increasing and has helped to stabilise the country's total production volume of wood at 2.5 million m^3 per annum. For reasons outlined below, the impact of plantation development on poverty reduction is unlikely to be as high as that witnessed from agricultural reform. The poorest of the poor are not expected to receive a large share of the benefits generated by plantations. The experience of many developing countries has been that forest industry development and forestry aid programs have not met with great success in reducing poverty (Arnold 2001). More often than not, labour requirements for growing the plantations and processing the products have been sourced from regions with a better educated and skilled workforce, which denies poor people from participating in the forestry activities. In some countries, rural people have been locked out of access to land that was formerly used for subsistence agriculture.

In Vietnam, forestry assistance programs in the early to mid nineties provided subsidies to poor households in northern provinces for the purpose of establishing industrial plantations (mainly eucalypts and species other than acacia). According to Salmi et al. (1999), however, these subsidies were spread too thinly and were not well targeted. Equity considerations superseded any profitability or business considerations. The dispersal of small-scale plantations throughout the country has resulted in difficulties in selling the end products, low prices and high harvesting, transport and marketing costs. As a consequence, many farmers have become disillusioned with plantation forestry and have replaced trees with perennial crops of higher economic value, such as cinnamon and tea. In some cases, farmers are selling their plantation pulpwood at low prices in order to service their increasing interest debts on bank loans (Tran Duc 2003).

Nevertheless, the future may hold greater promise for plantation forestry as a means of lifting income in rural areas of Vietnam. The development of fast-growing trees, such as hybrid acacias, is making plantations more commercially attractive to farmers and less dependent on subsidies. Furthermore, Vietnam's progress with allocating forest land to households for the purpose of commercial plantations, combined with an opening up of wood markets — for example, the capacity for farmers to sell their product for export and various domestic uses — is a step towards improved efficiency and higher rural incomes.

Figure 8. Spatial distribution of acacia hybrid plantations[a] and poverty rates[b]



[a] Excludes company plantations. Only includes provinces in which some acacia hybrids have been planted up to 2004.
[b] Proportion of population with per capita expenditure below the poverty line.
Data source: Plantation area data from RCFTI and poverty data from Minot et al. (2003){not listed}

5.2 Spatial distribution of acacia hybrid plantations

It is beyond the scope of this study to make a detailed quantitative assessment of whether or not acacia hybrids are reducing poverty in rural areas. However, a plot of poverty rates, by province, against the area of hybrids established per square kilometre of province, reveals that acacia hybrid plantations have been planted in both poor and wealthy provinces (Figure 8). The majority of provinces in which hybrids have been planted to date have poverty rates of between 30 and 45%. This level of poverty is slightly above the national average. Some plantations have been established in the very poor northern provinces of Yen Bai, Hoa Binh, Lao Cai and Lai Chau. However, the prospect of acacia forestry making significant improvements to the living standards of people in these provinces could be limited by the lower productivity of trees in the north and the smallness of markets for pulpwood in these regions.

5.3 Land allocation and plantation ownership

While most rural households are poor in absolute terms, there is considerable variation in levels of wealth within the rural poor, even at the level of individual communities. The poorest of the poor, particularly the ethnic

minorities, generally do not have the financial resources, skill or land resources to practice commercial agriculture, let alone engage in plantation forestry which has relatively long lead times till harvest. They rely on subsistence agriculture and limited harvesting of forest products from natural forest areas.

Plantation forestry is an activity that is generally restricted to households that are better endowed. Since the land law reforms of 1993, land use rights can be allocated to rural households, individuals and SFEs for forestry production. Provincial authorities tend to allocate forestry land to those households that have the financial capacity to undertake plantation activities (Tran Duc 2003). Typically, the land allocated for commercial plantation forestry is either degraded natural forested area, existing plantation or barren. To date, 40% of land currently under forestry plantation has been allocated to households (MARD 2001). The remainder has either been allocated to SFEs (40%) or has yet to be allocated (20%).

Land for forestry is allocated free for a period of up to 50 years. Up to 5–30 hectares can be allocated per household, depending on local availability. Households can rent additional forest land if required. The land cannot be sold, but the use rights can be transferred through inheritance. Households have the right to decide the timing and methods of harvest but they must replant within two years of harvesting. Land allocated for forestry cannot be converted to agriculture or vice versa.

To date, acacia hybrid plantations have been established under four different systems:

- **State-owned plantations on land allocated to SFEs.** As discussed in chapter 1, the bulk of acacia hybrid plantations have been established by SFEs. These state-owned companies have access to large continuous areas of land, capital resources and technical management skills. Rural people benefit indirectly from plantation development because the SFEs employ local labour. Two of Vietnam's largest state-owned plantation companies — the Southern Paper Raw Materials Company and the Vinh Phu Paper Material Company — together employ 3400 people in propagation nurseries, and plantation establishment and management (Ernst & Young 2001). The total number of jobs associated with plantation establishment across all SFEs is unknown.

- **State-owned plantations grown on farmers' land.** In some provinces the SFEs are having difficulties obtaining additional land for plantations. Some are entering into contractual arrangements with farmers, whereby the acacia plantations are established by farmers, on

their land, under company supervision. For example, the Hoa Binh Forestry Company (an SFE) has an arrangement whereby farmers are supplied with seedlings and VND5.6 million per hectare (A$527) to cover establishment costs. At harvest time, the company keeps the first 43 m^3 of wood produced per hectare (typically about one third of production from a well-managed plantation) and the farmer keeps the surplus. It is not known how many farmers entered such agreements.

- **Foreign company-owned plantations on rented land.** The area of acacia hybrids established by foreign interests amounts to only about 7% of the total acacia hybrid estate. Like the SFEs, these companies use local labour, although employment tends to be seasonal. Foreign companies have good access to markets. Some are growing acacias specifically for the export woodchip market and are vertically integrated with Japanese or Taiwanese paper mills.

- **Farmer-owned plantations**. Of the total area of acacia hybrids grown to date, about 23% has been established by households and individual farmers. There is diversity in the scale and level of sophistication in these plantations. While most smallholders are cultivating forestry plots of less than 3 hectares, wealthier households have much larger estates and some have joined other households to form private companies, which increases the scale and economies of their enterprise.

The allocation of secure land use rights has been an important step forward in promoting private investment in plantations because secure land tenure is needed for forest growers to attract finance and have sufficient incentive to invest in a relatively long-term tree crop. However, in some cases the allocation process has privatised forested or barren land that was formerly used in common by village communities for subsistence purposes. In these cases, it is possible that the land allocation process has been inequitable and has worsened the outlook for some households (Lang 2004). Adequate income support mechanisms could help alleviate this problem and help maintain the drive for improved land use efficiency.

Direct benefits to households from farmer-owned plantations

The scope for rural households to diversify and increase their income through growing acacias will depend on the capacity for farmers to access land, capital, wood-product markets and technology. For those small-holders with an allocation of forestry land, fast-growing acacias are proving to be a good cash crop. This is particularly true in the south of Vietnam where there is reasonably strong demand for wood and the prices paid for it are competitive with alternative perennial crops that can be

grown on similar land types. However, acacia forestry is not without its problems. Prices are variable from year to year, and smallholders generally do not have long-term supply contracts with mills. Furthermore, the potential profits are reduced considerably by middlemen in the supply chain between the farm gate and the mill door. The prices paid by the paper mills are set by government through Vinapex. The mills then issue purchase quotas to licensed organisations who operate across numerous provinces. These organisations fulfil their supply quota by purchasing raw material from private assembling firms. In turn, these firms purchase wood from farmers and organise transport logistics. Each firm along the supply chain takes a commission. Only a small proportion of farmers can sell directly to the paper factory because they do not have the means to transport timber and because the volume they produce is small.

Since 1999 the government has provided low interest loans to SFEs, organisations and households for the purpose of establishing production plantations. The interest rate for loans is 0.81% per month and the principal and interest (calculated as simple not compound interest) falls due upon harvest (Salmi et al. 1999). Plantations are also exempt from value-added tax. These measures are helping households to overcome the initial financial burden of establishing the trees and improving the profitability of tree growing but poor farming families still find it difficult to endure the 3–5 year wait until income is generated from the plantation. Thus, the very poor are unlikely to benefit *directly* from acacia hybrids.

Indirect benefits of plantation development

The poorer households in Vietnam's rural communities could benefit from some of the flow-on benefits of plantation development, such as increased employment opportunities in tree growing, harvesting, transportation and processing. For example, in the case of processing, the country's three largest paper mills collectively employ approximately 5600 people and the average monthly wage paid to labourers is VND1.2–1.7 million ($A113–160), depending on the mill (Ernst & Young 2001). The average national monthly wage for farm labourers is VND0.7 million, equivalent to A$66 (CIEM 2004).

Acacia plantations are also providing rural people with a reliable supply of firewood, which was beginning to become scarce in some provinces due to the deteriorating condition of natural forests. Households who own plantations use some of the firewood for their own fuel requirements and sell surplus harvest residues. Increased firewood supply should bring down the cost of obtaining fuel in those provinces where plantations are being grown.

6 Conclusion

6.1 Acacia hybrids are becoming an important plantation species in Vietnam

Vietnam's acacia hybridisation program has produced trees that have significantly higher yields and shorter rotation intervals than their parent species. The hybrids deliver commercial returns that are competitive with other alternatives such as cashews and rubber, particularly in the south where the warm climate promotes fast growth and there is good access to markets. The hybrids are also adaptable to relatively poor soil types on which other forms of production are not possible.

The relative advantages of hybrids have led to their rapid adoption since they were first released in 1996. Current planting rates are in the order of 45,000 hectares per annum, which represents 24% of the area of all new plantations established in 2003. To date, a total of 127,000 hectares has been established, mostly in the southern and central regions of Vietnam. Only 15%t of the hybrids have been planted in the north.

Acacia hybrids are gaining favour over eucalypts for commercial pulpwood production. They are faster growing, less susceptible to disease, and more adaptable to poor soil types.

There is a growing market for acacia hybrid pulpwood, particularly in the south. Domestic pulp mills are beginning to substitute acacia hybrid raw material for traditional feedstock such as eucalypts, bamboo, local pine and imported softwood logs. There are plans to expand the capacity of existing mills and to build 12 new pulp mills by 2010. Other markets include local MDF factories and woodchip exports to Japan and Taiwan. Because of the expanding local demand for wood and the existence of a sizeable world market for woodchips, the increasing supply of acacia wood is not expected to significantly affect prices received by growers.

However, for Vietnam to continue to expand its pulp and paper industry and its manufacture of artificial board, it will be imperative that these finished products are price-competitive with imports. At present, Vietnam is not price-competitive. Acacia hybrids will play an important role in achieving lower costs of production.

6.2 ACIAR's investment in acacia hybrids has yielded a high return

Since 1985, there have been numerous organisations involved in supporting Vietnam's hybrid acacia research program. The main contribution of ACIAR-funded project FST/1986/030 was to provide 'off the shelf' technology at a time when the Vietnamese were commencing their selection and propagation program for natural hybrids. In this assessment it is assumed that this technology effectively brought forward Vietnam's research program by 4 years.

The economic value of this 'bring forward' is substantial — estimated to be $152 million in net present value over 30 years to 2018. Given the relatively modest cost of the ACIAR-funded project (approximately $1.0 million in today's dollars), this benefit produces a high benefit–cost ratio of 145 to 1. These results are based on an MAI for hybrids of 22 m^3 per hectare and an MAI for traditional acacias of 12 m^3 per hectare. Even if the productivity for hybrids were reduced by 15% (to 18.7 m^3 per hectare), the project return remains strong at $74 million (BCR of 71).

6.3 Acacia hybrids have the potential to improve rural incomes

Just under a third of Vietnam's population lives below the poverty line and most of the poverty is concentrated in rural areas. Fast-growing acacia hybrids are providing rural households with an opportunity to diversify their farm enterprise and to make more profitable use of poor land. The relatively short rotation interval, only 3 years in some locations, makes acacias a feasible cash crop for farmers who have been allocated forest land. In addition, contract arrangements with SFEs are making plantation forestry more accessible to private individuals and households. It is estimated that households own 23% of the acacia plantations established to date.

Acacia forestry is generally only an option for wealthier households that have access to sufficient land, skills and financial reserves. The poorest of the poor generally do not have the capacity to grow plantations. High yielding, intensively managed plantations will remain the domain of private companies, wealthier households and SFEs, which have access to credit, land, product markets and better economies of scale. At present, about 70% of the acacia hybrid estate is owned by SFEs.

The development of acacia plantations in rural areas does provide scope for increased employment opportunities for poorer households, offering higher wages than current farm returns. There may be new employment

opportunities generated in the growing, harvesting, transport and processing of wood. The down-side is that some of this work is seasonal and some of the processing jobs may be available to skilled labourers only. Acacias should increase the supply of firewood and bring down the cost of fuel in provinces where plantations are being grown. This could be a significant factor in reducing poverty.

The potential of acacia plantations to reduce poverty levels will require ongoing reforms to Vietnam's forestry sector. The process of allocating forest land to households will need to continue. More progress could be made if a land market existed; the current absence of a land market is one of the factors impeding investment in plantation forestry. Benefits flowing to rural households would also be increased by further liberating the market for wood products and reducing the number of 'middlemen' in the supply chain.

7 Acknowledgments

The author thanks the staff of the RCFTI in Vietnam, especially Professor Le Dinh Kha, who kindly organised a two-week program of visits with agencies and individuals involved in acacia hybrid forestry. The author also acknowledges the assistance given by Dr Ha Huy Tinh, Director of RCFTI. The following people and institutions were visited in the compilation of this assessment and their time is much appreciated.

Pham Duc Tuan, Vice Director of Forestry Department, Ministry of Agriculture and Rural Development (MARD)

Nguyen Viet Khoa, Forestry Extension Officer, MARD

Phan Sy Hieu, Information Analysis Division, MARD

Dr Vu Van Me, Deputy Director, Forest Sector Support Program, MARD

Nguyen Thai Noc, Director, Vietnam Paper Corporation (Vinapex)

Tran Duc Sinh, Director, Vietnam Forest Corporation (Vinafor)

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Nguyen Tien Dai, Director, South Eastern Forest Science and Production Centre, Dong Nai

Dang Van Vuong, Vice Director, South Paper Raw Material Company, Bein Hoa City

Pham Danh Than, Director, Tan Mai Paper Company, Bein Hoa City.

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